# Chapter 19: Earth, Moon & Sun

I. Earth in Space (p. 660-665)

A. How Earth Moves

a. Earth moves in two major ways: rotation & revolution

1. Rotation

a. The imaginary line that passes through Earth at the N and S poles is the axis.

b. The spinning of Earth on its axis is called rotation

c. It takes earth 24 hours to make one rotation

2. Revolution

a. Revolution is the movement of one object around another.

b. One complete revolution of Earth is called a year.

c. Earth follows a path, or orbit, around the sun.

d. Earth's orbit is not quite circular, more like an oval called an ellipse.

B. The Seasons on Earth

1. How Sunlight Hits Earth

a. At the equator, sunlight hits Earth's surface most directly. (this will be warmer)

b. Near the poles, sunlight hits the surface at a steep angle. (this will be cooler)

2. Earth's Tilted Axis

a. Earth has seasons because its axis is tilted as it revolves around the sun.

b. Earth is always tilted at an angle 23.5* from vertical

c. Summer and winter are caused by Earth's tilt as it revolves around the sun.

d. The seasons are NOT caused by changes in the Earth's distance from the sun.

    i. In fact, Earth is farthest from the sun when it is summer in the N. Hemisphere

3. Earth in June

a. In June, the N. end of Earth's axis is tilted toward the sun – more direct rays

b. In N. Hemisphere, noon sun is high and there are more hours of daylight than darkness – Summer in N. Hemisphere

c. In S. Hemisphere Earth's axis is tilted away from the sun – spread over larger area

d. Sun is low in sky – Winter in S. Hemisphere

4. Earth in December

a. S. Hemisphere receives most direct rays, whereas N. Hemisphere rays are more slanted – Summer in S. Hemisphere & Winter in N. Hemisphere

5. Solstices

a. Solstice – when sun is farthest north or south of equator

b. Summer solstice =June 21 (sun farthest N)

c. Winter solstice = December 21 (sun farthest S of equator)

6. Equinoxes

a. Equinox – "equal night"; noon sun is directly overhead at equator; 12 hour days & 12 hour nights

b. Vernal (spring) = March 21

C. Autumnal (autumn) = Sept 22 (start of fall)

II. Gravity & Motion (p. 666-669)

a. A force is a push or pull

A. Gravity

a. Newton hypothesized that a force that pulls an apple down also pulls the moon toward Earth

b. Gravity – the force that attracts all objects toward each other.

c. Universal Law of Gravitation states that every object in the universe attracts another object.

d. The strength of the force of gravity between two objects depends on the mass of the objects and the distance between them

1. Gravity, Mass & Weight

a. Mass is the amount of matter in an object

i. The more mass, the more force

ii. Earth is much more massive than your textbook, therefore, Earth is exerting a much larger gravitational force on your book than you do

b. The force of gravity on an object is called weight.

i. Unlike mass, weight can change depending on its location

ii. You weigh less on the moon than on earth, but your mass doesn't change.

2. Gravity & Distance

a. The force of gravity decreases rapidly as distance increases.

b. For example, if the distance between 2 objects doubled (twice as far away), the force of gravity would decrease to ¼ of its value.

B. Inertia & Orbital Motion

1. Inertia

a. The tendency of an object to resist a change in motion is called inertia.

b. Newton's first law of motion says that an object at rest will stay at rest and an object in motion will stay in motion with a constant speed unless acted on by a force.

2. Orbital Motion

a. Newton concluded that 2 factors: inertia and gravity – combine to keep Earth in orbit around the sun and the moon in orbit around Earth.

i. Gravity pulls the moon towards Earth, at the same time, the moon keeps moving ahead because of inertia…

III. Phases, Eclipses & Tides (p. 670-677)

A. Motions of the Moon

a. Like Earth, the moon moves in 2 ways: it rotates on its axis and revolves around Earth

b. It takes the moon 27.3 days to revolve around the Earth

i. Because of this, one day is the same as one year on Earth

c. The changing relative positions of the moon, Earth and sun causes the phases of the moon, eclipses, and tides.

B. Phases of the Moon

a. The moon does not give off light by itself – you see the moon because it reflects light off the sun

b. The different shapes of the moon you see from Earth are called phases.

c. The phase of the moon you see depends on how much of the sunlit side faces earth.

d. (pictures on page 672)

C. Eclipses

a. When the moon's shadow hits Earth or Earth's shadow hits the moon, an eclipse occurs

b. An eclipse is the total blocking of one object in space by another.

c. Two types of eclipses: solar (sun) and lunar (moon)

1. When Do Solar Eclipses Occur?

a. A solar eclipse occurs when the moon passes directly between Earth & the sun, blocking sunlight from Earth.

b. A solar eclipse occurs when a new moon blocks the view of the sun

2. Total Solar Eclipses

    a. The very darkest part of the moon's shadow, the umbra, is cone-shaped.

        i. From this point, the sun's light is completely blocked by the moon.

    b. Only people within the umbra experience a total solar eclipse

    c. During a solar eclipse, the sky gets dark as night in the middle of the day, the air gets cool and sky becomes an eerie color. You can see the stars and the solar corona

3. Partial Solar Eclipses

    a. The larger part of the shadow, the penumbra, casts a shadow on Earth, too.

    b. During a solar eclipse, people in the penumbra see only a partial eclipse

    c. It is NOT safe to look directly at the sun

4. When do Lunar Eclipses Occur?

    a. A lunar eclipse occurs at a full moon when Earth is directly between the moon and the sun.

    b. During a lunar eclipse, Earth blocks sunlight from reaching the moon

    c. It only occurs at a full moon because the moon is closest to Earth's shadow at this time

5. Total Lunar Eclipse

    a. The Earth has an umbra and penumbra

    b. When the moon is in earth's umbra, you see a total lunar eclipse

    c. Unlike a total solar eclipse, a total lunar eclipse can be seen anywhere on Earth that the moon is visible.

6. Partial Lunar Eclipse

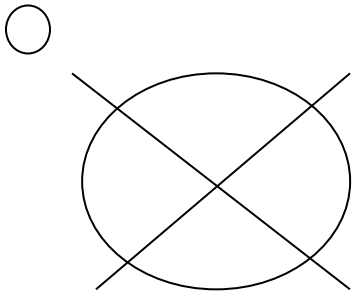
a. For most lunar eclipses, the Earth, moon, and sun are not quite in line, so you get a partial lunar eclipse

b. It occurs when the moon passes partly into the umbra of Earth's shadow.

D. Tides

a. A tide is the rise and fall of ocean water that occurs about every 12.5 hours.

b. Tides are caused mainly by differences in how much the moon's gravity pulls on different parts of Earth



1. The Tide Cycle

a. Moon's gravity at point A is stronger than moon's gravity on Earth as a whole

b. Water flows toward point A, causing a high tide.

c. The force of the moon's gravity at point C, which is on the far side of Earth, is weaker than moon's gravity on the Earth as a whole.

d. Water flows toward point C making a high tide.

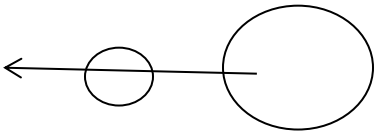
e. Water flows towards A and C, and away from B & D. B & D have low tides

f. As earth rotates, one high tide stays on the side facing the moon.

g. Each location sweeps through two high tides and two low tides every 25 hours or so

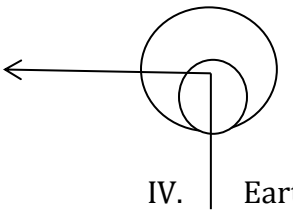
2. Spring Tides

a. The gravity of the sun and moon pull in the same direction. The combined forces produce a tide with the greatest difference between consecutive low and high tides is called a spring tide.



Neap Tide

a. Sometimes the line between Earth & the sun form right angles, this produces a neap tide



b. A neap tide is a tide with the least difference between consecutive low and high tides

c. This happens about 2x per month

IV. Earth's Moon (p. 680-683)

a. In 1690, Italian scientist Galileo Galilei heard about a telescope

b. Telescope is a device built to observe distant objects by making them appear closer.

c. He built his own and was surprised by what he could see

A. The Moon's surface

1. Maria

a. Maria - Dark, flat areas on the moon's surface

b. Maria is the Latin word for "sea" – Galileo thought that these were oceans

c. Actually they were formed from lava flows 3-4 bya

2. Craters

a. Crater – large round pits on moon's surface

b. Scientists thought these were from volcanoes, but found out that they were from meteoroids

i. Meteoroids – chunks of rock or dust from space

3. Highlands

a. Highlands – mountains on the moon

b. Light colored regions  casting dark shadows

B. Characteristics of the Moon

a. The moon is dry and airless

b. Compared to Earth, it is small and has large variation in surface temp

1. Size & Density

a. The moon is a little less than the distance across the US (3475 kilometers in diameter)

i. This is about ¼ the diameter of Earth

ii. The moon's mass is 1/80 of earth

b. Earth has a dense core with less dense outer layers, and the moon's density is closer to the Earth's outer layers

2. Temperature & Atmosphere

a. Moon's surface ranges from 130*C to -180*C

b. No atmosphere means it can't retain heat

3. Water

a. No liquid water – but there is evidence that there might be ice patches near poles

C. Origin of the Moon

a. Scientists have a theory called the collision-ring theory. It says that 4.5 byo, when Earth was young, some rocky debris from the solar system hit Earth.

b. This chunk of Earth separated and circled the Earth forming a ring

c. Gravity caused this to become the moon

V. Traveling into Space (p. 684-691)

a. A rocket is a device that expels gas in one direction to move in the opposite direction.

a. The first rockets were made in China in the 1100s

A. How Do Rockets Work?

a. A rocket is propelled forward when gases shooting out the back of the rocket push it in the opposite direction

1. Action and Reaction Forces

a. The movement of a rocket demonstrates a law of physics: for every action force, there is an equal and opposite force, or reaction

b. The reaction force that propels a rocket forward is called thrust.

c. Thrust depends on the mass and speed of the gasses

d. The greater the thrust, the greater the velocity

e. Velocity is the speed in a given direction

2. Orbital and Escape Velocity

a. Once a rocket is lifted off the ground, it must reach a certain velocity to go to orbit

b. Orbital velocity is the velocity a rocket must achieve or reach in order to establish an orbit around Earth.

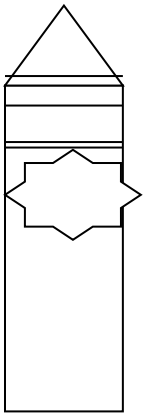
c. If it moves slower than orbital velocity, Earth's gravitational pull will bring it back to Earth

d. If it is able to get a velocity of 40,200 km/h or more it can escape Earth's gravity and fly off into space

e. Escape velocity is the velocity a rocket must reach to fly beyond a planet's gravitational pull.

3. Multistage Rockets

a. The advantage of a multistage rocket is that the total weight of the rocket is greatly reduced as the rocket rises.



i. Smaller rockets are stacked on top of each other

ii. As each rocket uses up its fuel, the empty container falls away and the next is ignited.

b. *Saturn V* made it to the moon and the solar system

B. The Race for Space

a. In the 1950s, the US and the Soviet Union began to compete in the exploration of space

b. The tensions (political and military power) were so high that they were said to be in a "cold war"

c. In 1957 the Soviets launched *Sputnik I*, a satellite, into orbit.

d. As a result the US sped up its space program.

e. The rivalry between the US and the Soviet Union over the exploration of space was known as the "space race"

1. The First Artificial Satellites

a. A satellite is an object that revolves around another object in space.

b. *Sputnik I* was the first artificial satellite.

c. In 1958, the US launched its own satellite, *Explorer I*

d. In 1958, NASA was born! National Aeronautics and Space Administration

2. Humans in Space

a. 1961, the Soviets launched the first human into space – Yuri Gagarin – flew one orbit around Earth aboard *Vostok I*

b. One month later, Alan Shepard became the first American in space aboard *Freedom 7*

c. 1962, John Glenn was launched into space aboard the Friendship 7 – first American to orbit Earth

C. Missions to the Moon

a. President John F. Kennedy (1961) launched an enormous space exploration and scientific research program

b. The American effort to land astronauts on the moon was called the Apollo Program

1. Exploring the Moon

a. US spacecraft *Surveyor* landed on the moon – we found out the moon's surface was solid

2. Moon Landings

a. 1969 – *Apollo 11* – Neil Armstrong, Buzz Aldrin, Michael Collins (pilot) *Eagle*

b. Armstrong first set foot on the moon

D. Exploring Space Today

1. Space Shuttles

a. A space shuttle is a spacecraft that can carry a crew into space, return to Earth, and be reused for the same purpose.

b. NASA has used space shuttles to take satellites into orbit, repair damaged satellites and carry astronauts and equipment to and from space stations

2. Space Stations

a. A space station is a large artificial satellite on which people can live and work for long periods

b. A space station provides a place where long-term observations and experiments can be carried out in space

c. 1980s, the US and 15 other countries began the construction of the International Space Station (ISS)

i. 1998, the first module was put into orbit

3. Space Probes
    a. A space probe is a spacecraft that carries scientific instruments that can collect data, but has no human crew
    b. Space probes gather data about distant parts of the solar systems where humans cannot easily travel.
    c. Each space probe is designed for a special job/mission
    d. Some probes have small robots called rovers that move around the surface