**Introduction to Astronomy  
Earth/Moon Relationship**

**Chapter 27**

**Early Astronomy (600bc to 200ad)**

1. What did they know about the Universe?
   1. In the course of a year 5 stars like objects moved across the night sky faster than the stars. These were called planets.
      1. Mercury, Venus, Mars, Jupiter and Saturn
   2. Earth was round (a sphere)
   3. Moon goes through phases
   4. Earth was about 25,000miles in circumference
   5. They developed a star catalog system based on star’s brightness.
   6. Sun is further from Earth than the Moon
   7. Sun was many times larger than Earth
   8. **They were able to predict the motion of the planets**
   9. They believed in the **geocentric** view of the universe
   10. Earth was at the center of the universe
       1. The Sun, planets and all the stars orbit the Earth
       2. The orbits were in **perfect circles**
2. What did they NOT know about the Universe?
   1. **Stars are far away**
   2. **Earth is a planet**
   3. Size of the solar system and the universe
   4. About galaxies
   5. Earth rotates on its axis
   6. **Earth revolves around the sun**
   7. **The sun is a star**
   8. Some of the other planets have moons

**Modern Astronomy (1400 to present)**

1. Copernicus:
   1. **Heliocentric:** Sun is the center of the solar system
2. Kepler Law’s of Planetary Motion
   1. First Law: **Planets, comets, asteroid orbit the sun in an elliptical pattern**
   2. Second Law: **Planet’s orbit velocity is not uniform**
      1. Velocity increases as they approach the sun, decreases as they travel away from the sun
   3. Third Law: **The further a planet is a from the sun, the longer its orbital period**
3. Galileo Galilei: invented the optical telescope
   1. First used to study the sky
   2. **Refracting telescope: used glass lenses to collect and focus light**
   3. What did Galileo see with his telescope?
      1. **Four large moons orbiting Jupiter**
      2. Planets are disk-shaped like Earth
      3. Venus has phases like our moon
      4. Moon’s surface is not smooth. Has mountains and craters
      5. **Sun has sunspots**
      6. Able to estimate sun’s rotation period (about a month)
   4. **His observations confirmed that Earth cannot be at the center of the universe.**
4. Isaac Newton:
   1. **Invented the reflecting telescope**
   2. Explained gravity using equations
      1. Viewed as a force that depends on the mass of the objects and distance between them squared
   3. Developed 3 Laws of Motion
      1. Applicable to 99% of the observed motion in the universe
   4. Significance of Newton’s Laws of Gravity and Motion
      1. **The more mass an object possesses, the greater its gravitational pull**
      2. The stronger the gravitational pull, the greater objects weigh on that planet
      3. Mass refers to the **amount of matter** an object possess
      4. Mass **remains the same everywhere in the universe**
      5. Weight is a measure of the pull of gravity on an object’s mass
      6. Its value changes in respect to the pull of gravity on a planet
   5. Isaac Newton’s Universal Law of Gravity explained Kepler’s 2nd Law of Planetary Motion
   6. When applied to Kepler’s 3rd Law it can be used to determine the mass of a body when the orbit of one of its satellites (moons) is known
   7. Newton’s 3rd Law (for every action there is an opposite and equal reaction) **explains why rockets can accelerate and decelerate in the near vacuum of space**
   8. Newton’s 2nd Law (Law of Forces) **explains why the planets orbit the sun at great speed and the sun hardly moves at all in space**

**Earth Moon Sun System**

1. Two Main Motions of the Earth
   1. **Rotation: spinning of a body on an imaginary axis. (23.5o)**
      1. **Counterclockwise**
      2. Determines length of day (23 hours 56 minutes)
      3. Speed is about 1000mph at the equator, 0mph at the poles
         1. **Revolution: motion of one body around another**
         2. **Counterclockwise**
         3. Determines the length of a year (364.25 days)
         4. Orbital speed is approximately 66,000mph
         5. Average distance from Sun is 93 million miles (150,000,000km)
2. One Minor Motion of the Earth
   1. **Precession: a slow wobbly motion of Earth’s axis that traces out a cone over a period of 26,000 years)**
      1. Right now Earth’s axis points toward the star **Polaris** (in the Little Dipper)
      2. In 14,000 years it will point toward the star **Vega** (in constellation Lyra)
      3. It will affect when the season begins each year. The start of each season will slowly begin a little late

**Earth Moon System**

1. Lunar Orbit and Distances
   1. Size: 3500 km (**1/4 Earth’s diameter**)
   2. Surface gravity is **1/6th**  Earth’s gravity
   3. Moon’s orbit is **counterclockwise**
   4. Moon’s orbits around Earth is **counterclockwise**
   5. Moon’s average distance: 239,000miles (384,000km)
      1. **Apogee**: Moon at its furthest distance from Earth
         1. 248,000miles (406,000km)
      2. **Perigee**: Moon at its closest distance to Earth
         1. 221,4000miles (363,104km)
2. Lunar Motions:
   1. Period of Rotation: **27.3 days**
   2. Period of Revolution: **27.3 days**
   3. Why? Gravitational pull between Earth and Moon locks moon so that one side always faces Earth
3. Lunar Phases
4. Eclipses
   1. When one object passes between two other objects
   2. Shadows
      1. **Umbra: darker, inner shadow**
      2. **Penumbra: lighter, outer shadow**
   3. Usually no more than **4** eclipses each year
      1. The Moon orbits Earth on a different orbital plane than the Earth-Sun plane
5. Solar Eclipse
   1. **The Moon casts a shadow on the Earth**
   2. Lasts about 7.5 minutes
   3. Occurs only during the **new moon** phases
   4. Only those within the **umbra** experience total eclipses
      1. Shadow path is about 150 miles wide
      2. People in penumbra see a partial solar eclipse
6. Lunar Eclipse
   1. **The Earth casts a shadow on the Moon**
   2. Lasts several hours
   3. Everyone on the side facing the moon can see it
   4. Occurs only during a **full moon** phase

**The Moon**

1. General Characteristics
   1. About **¼** the size of the Earth
   2. Completely solid
   3. Density is 6/10 of Earth’s
   4. Moon’s iron core is very small
   5. Moon’s gravity is 1/6 of Earth’s gravity
   6. **No atmosphere due to low gravity**
   7. Not geologically active
      1. **That means NO plate tectonics, active volcanoes or earthquakes**
2. Lunar Surface: little has changed since formation
   1. Craters:
      1. **Circular depressions caused by meteor and asteroid impacts**
      2. There are thousands of craters
      3. Earth has only about 200
      4. Why do few on Earth?
         1. **Plate tectonics has recycled Earth’s surface**
         2. **Weathering and Erosion has leveled and filled many in**
      5. Lunar Craters: central peak formed as crust rebounds from impact
   2. **Highlands** 
      1. Makes up over half of lunar surface
      2. Light colored rock surfaces
      3. Rugged with many craters
      4. Cover most of the **far side** of the moon
      5. Contains many mountain ranges. Highest peaks are about 5 miles high
   3. Maria
      1. Dark, relatively smooth areas
      2. **Ancient basaltic lava beds**
      3. Origin: early in Moon’s history thousands of asteroid impacts punctured surface.
         1. **Lava leaked out**
         2. Maria lava are over 3000 ft thick
   4. Regolith
      1. **Layer of loose gray debris due to impacts covers the lunar surface**
      2. Origin: debris kicked up from asteroid impacts
      3. Composed of igneous rocks, dust and glass beads
      4. In maria, regolith is about 10 feet thick
3. Lunar History: Origin
   1. **4.5 billion years ago, Earth struck by a Mars-sized object**
   2. Impact liquefied portions of Earth’s surface
   3. **Material from Earth’s crust and mantle were ejected**
   4. **Some portions of the material were caught in Earth’s orbit and formed the moon**
   5. Evidence
      1. Ejected Earth material should be iron poor
      2. Ejected material would lose water in space
4. Evolution of Lunar Surface 3 phases
   1. About 4.5 billion years ago. Original crust formed composed of same rock material as the rocks of the highlands. Today’s highland are remnant of original crust
   2. 3.2 to 3.8 billion years ago. Mara Basins from impacts. Portions of surfaced melted as well as some of moon’s interior. Lava flows fill low areas form maria. Overlap some highlands
   3. Few millions of years ago rays formed. Elongated streaks of ejected materials