Study Guide for Exam 3 (AST)

Key: Everything highlighted in yellow is a quiz question

- **Science**
- **Steps to testing an observation:**
- Observation, Hypothesis, Prediction, Test.
- A scientific theory must make testable predictions
- **Units**
- Meter: measures distance
- Second: measures time
- **Constellations**
- The human tendency to find patterns where none exist
- **Telescopes**
- Most modern telescopes are reflectors
- Modern telescopes are generally either located on mountains or in space because there is less atmosphere to "see" through
- **Earth's tilt**
- Earth's axis is actually tilted with respect to the plane of its orbit
- Earth's tilt causes it's seasons
- **Kepler**
- Kepler's First Law: The orbital paths of planets are elliptical with the Sun at one focus
  - Any given point on the ellipse has the same sum of the distance from each focus (the major diameter)
- Kepler's Second Law: While orbiting the Sun, an imaginary line connecting Sun and planet sweeps out equal areas of the ellipse in equal intervals of time
- Kepler's Third Law: The square of a planet's orbital period is proportional to the cube of its semi-major axis
  - $P^2 = a^3$ (where P is years and a is in A.U.)
- Orbital period: time taken to traverse the full elliptical orbit
- Perihelion: point of closest approach to the sun
  - a(1-e)
- Aphelion: point of greatest approach to the sun
  - a(1+e)
- Semi-Major Axis: half the length of the long side of the ellipse
- Eccentricity: distance between the foci divided by the length of the major axis.
  - A circle is just an ellipse with an eccentricity of zero
  - Does not affect the period
- Modified Kepler Law: The orbit of a planet about the sun is an ellipse, having the center of mas of the planet-Sun system at one focus.
- **Newton**
- Newton's First Law of Motion: An object at rest remains at rest, and a moving object continues to move forever in a straight line with constant speed, unless some external force changes their state of motion.
  - Also known as Law of Inertia
- Newton's Second Law of Motion: The acceleration of an object is directly proportional to the net applied force and inversely proportional to the object's mass
  - Acceleration: rate of change of velocity or speed
  -Inversely proportional to mass: the heavier, the less you accelerate for the same force applied
  -"net force:" sum of forces acting on you
- Newton's Third Law of Motion: To every action there is an equal and opposite reaction
- Universal gravitation: 6.67 x 10^{-11} Nm^2/Kg^2
- **Diffraction Limit**
- Diffraction limit: The amount to which diffraction limits how well we can resolve objects depends on both the aperture of the telescope and the wavelength of the light
- **Wien's Law**
- Relates the peak radiated wavelength to the temperature
- Can calculate surface temperature of other planets using this law
- Shows the color and spectra

- Earth's atmosphere is not transparent to all electromagnetic radiation

Terrestrial Planets

- **Facts on Terrestrial Planets:**
- Closest planets to the sun
- Venus is closest in size to Earth
- Made up of Mercury, Venus, Earth, and Mars
- Venus and Earth are warmer than Mars and Mercury due to the greenhouse effect, however, the greenhouse effect takes place on Mars as well
  - Carbon dioxide, water vapor, and methane are all green house gases
- Both Mars and Venus have atmospheres composed of mainly carbon dioxide
- **Principle Processes Shape the Surfaces**
- Impact cratering: meteorite impacts rough up the surface
- Tectonism: convection currents drive the tectonic plates against each other
- Volcanism: eruption of hot material from the lower crust and upper mantle
- Erosion: smooth's out surface topology by action of wind and water

Jovian Planets

- **Facts on Jovian Planets**
- Jupiter, Saturn, Uranus, and Neptune are all known as the Jovian Worlds.
- Jupiter is the most massive of the Jovian planets.
- They receive less energy from the sun compared to the terrestrial worlds, as they are further away from the sun.
- Have many rings and moons, widely spaced orbits, large radii and masses, composed of mainly gas, no solid surface, low density, fast rotation, and strong magnetic fields.
- They are large, cold, and massive.
- We know less of Jovian worlds than we do terrestrial worlds because of how far away they are from the sun and us as well.
- Uranus is the only Jovian planet that does not exhibit any internal heating.
- Uranus has extreme seasons due to its tilt. Each season, winter and summer, last 42 continuous years.
- All have offset field lines, less in Jupiter, but very much so in Neptune and Uranus, which is probably why Uranus has such extreme seasons.
- Unlikely to find life in the Jovian worlds.
- **Their Atmosphere**
- We only see the outermost parts of the Jovian worlds atmospheres, which seem to look like cloud-tops. The cloud-tops are where the atmosphere merges into a more condensed atmosphere, and later and further along into the planet, the atmosphere then merges into denser liquids or solid cores.
- Cold at the cloud-tops
- Chemically, different clouds form at different levels in the Jovian worlds due to the difference in their condensation points.
- Contain high temperatures. This comes from the Jovian worlds continued collapse and liberation of gravitational energy. However, Saturn is exempt from this because on Saturn, Helium sinks deep into the core depleting it from the atmosphere and enriching the core. This liberates additional gravitational energy, which is an example of differentiation.
- **What makes up Jovian Planets?**
- Made of larger, less dense materials than terrestrial planets.
- Jupiter and Saturn's compositions are similar to the sun's composition.
- Uranus and Neptune are much more dense than Jupiter and Saturn and so their composition is nothing like the suns.

- On the inside things are hot and dense.
- Under enough pressure, molecular hydrogen condenses into a metallic state known as metallic hydrogen. Metallic hydrogen is when the electrons dissociate from protons in hydrogen under the right temperature and pressure. This happens on Saturn less, as Saturn has less pressure.
- Methane causes Uranus and Neptune to appear blue.
- **Great Red Spot**
- One of the most prominent features of Jupiter.
- About the size of two Earths.
- Will swallow up smaller storm systems.
- **Great Dark Spot**
- Not as sustained as the Great Red Spot.
- On the surface of Neptune.
- **Magnetosphere**
- Substantial magnetic fields of the Jovian worlds.
- Jupiter has the king of magnetospheres.
- Tells us what is going on in regard to the surface rotation of the planets.
- **Rings**
- All Jovian planets have rings, except Saturn's are the most obvious.
- Rings are unstable and some of their material may drift away or spiral into the atmosphere through collision.
- **Roche Limit**
- Definition: A distance from massive objects within which gravitational "tidal forces" will destroy objects held together under gravity.
- The inexorable gravitational grinding down of one of its moons within the Roche limit is probably what gave Saturn its rings.
- Because part of an object is closer to a planet, a larger gravitational pull is imposed on the side of the object closest to the planet.

Small Bodies of the Solar System

- **Dwarf Planets**
- To be a planet you must have enough mass to pull yourself into a round shape, clear the area around your orbit, and orbit the sun (not a planet).
- Dwarf planets meet the first criteria and not the second (and naturally the third).
- Pluto and Ceres are some examples of dwarf planets.
- **Moons**
- Io: One of Jupiter's moons. Has a sign of volcanic activity, which is constantly re-smoothing its surface. The gravitational tidal forces from Jupiter are constantly flexing Io's crust and generating thermal activity, which is the cause of the volcanism. Its colors are formed through mixtures of sulfur, sulfur dioxide, and other materials.
- Volcanic activity on Io is driven by gravitational forces from Jupiter.
- Enceladus: One of Saturn's moons. Shows a different type of volcanism than Io, which is called cryovolcanism. Cryovolcanism is like normal volcanism, but driven by low temperature volatiles instead of molten rock. Driven by the same kind of tidal force heating as on Io.
- Triton: One of Neptune's moons. Also displays cryovolcanism. Orbits Neptune in the "wrong direction," which means it orbits in the opposite direction of the planet's spin. Tidal forces degrade Triton's orbit, which leads to the belief that it will either enter the Roche limit and become a new set of rings for Neptune, or crash into Neptune.