Astronomy 311: Revision

- Gravity
  - Newton's law of gravity:

    $$F = \frac{GM_1M_2}{R^2},$$

    where G is the gravitational constant.
  - A more accurate treament is the theory of general relativity which talks about gravity being due to the curvature of spacetime.
  - An observational test is observation of the precession of the perihelion of Mercury.
  - Newton's law of gravity leads to Kepler's laws of motion. Kepler's third law states that

    $$P^2 = \frac{4\pi^2 a^3}{G(M+m)}.$$

    If M is much bigger than m then in appropriate units $P^2 = a^3$.
  - An N body calculation is a way of calculating the dynamics of the Solar System.
  - What are Lagrange points.
  - Orbital resonances, Kirkwood gaps, Dynamics of ring systems, shepherd moons, gap moons. Synchronous rotation. Planetary migration.
  - Milankovitch cycles: eccentricity, obliquity and precession.
  - perihelion, aphelion, eccentricity.
    - Terrestrial Planets
      - Core mantle, crust structure of terrestial planets.
      - Lithosphere.
      - Differentiation.
      - Geological activity - how interiors get hot, accretion, heat from differentiation and radioactive decay.
      - Interior cooling: conduction, convection and radiation - which is the most important in the Earth's interior?
      - Mantle convection cells.
      - Role of planetary size in cooling: surface area of a sphere $4\pi r^2$, volume of a sphere $\frac{4}{3}\pi r^3$.
      - Requirements for a planetary magnetic field - which planets have reasonable magnetic fields and why?

- Why do terrestrial planets have different geological histories? Size, distance from Sun and rotation.
- four types of processes that shape planetary surfaces: cratering, volcanism, tectonics and erosion.
- Outgassing by volcanos.
- Terrestrial planet magnetic fields.

* Terrestrial Planet Atmospheres
  - Whats an atmosphere?
  - Which of the terrestrial planets have atmospheres?
  - Atmospheric pressure, ideal gas law $\frac{P}{\rho} = RT$. Generally contracting/expanding gases heat up/cool down.
  - How can atmospheres affect planets?
  - Greenhouse effect - name some greenhouse gases.
  - Planetary temperatures are affected by planet's distance from the Sun and the planet's overall reflectivity.
  - Note
    $$T = 280 \times \sqrt[4]{\frac{1 - ref}{d^2}} K,$$
    where ref is the reflectivity or albedo and d is the distance of the planet from the Sun. This is a slight modification of the Stefan-Bolztmann law: $L = 4\pi\sigma R^2 T^4$.
  - This entails the inverse square law, surface area of a sphere, concept of reflection and absorption of radiation and the black body spectrum.
  - Variation of atmospheric properties with latitude: troposphere, stratosphere, thermosphere and exosphere.
  - What types of radiation can pass through these atmospheric layers.
  - Xrays, UV, Visible and IR.
  - Ionization, dissociation transmission and absorption.
  - Reflectivity and Absorption
  - Scattering of light by the atsmphere: why is the sky blue, why are sunsets red.
  - Heating of the troposphere by IR light from the ground after visible light heats up the ground. Temperature inversion further up. Temperature structure of the atmosphere, convection.
  - Earth is unique in having a stratosphere. Ozone - lack of convection.

- Whats the ionosphere?
- X rays and the upper atmosphere.
- Temperature profile of the atmosphere.
- Comparative structure of terrestrial planet atmospheres.
- Circulation cells in the Earth's atmosphere with and without the effect of the Coriolis force.
- The coriolis force - what it is and how does it affecct the circulation cells in the Earth's atmosphere.
- Water cycle on the Earth, CO_2 cycle.
- Factors affecting long term climate change: solar brightening, axis tilt, reflectivity and greenhouse gases.
- Volcanic outgassing as the primary souce of terrestrial planet atmospheres.
- Thermal escape, $V_{esc} = \sqrt{2kT/m_H} >$
- Thin atmosphere of the moon and mercury - why?
- History of Martian atmosphere - change in magnetic field? How could this have affected its atmosphere.
- Solar wind, magnetosphere etc.
- Strong greenhouse effect on Venus.
- Earth's pleasant atmosphere, the CO_2 cycle.
- Seasons on Earth, further out, ellipticity also affects severity of seasons eg. Mars' elliptical orbit.

* Jovian Planet Systems
  - Rotation and shape.
  - Dependence of radius on mass for a jovian planet - self compression.
  - Composition - frost line.
  - Basic structure: rocky core, metallic H, liquid H, gaseous H, cloud tops.
  - Comparative structure of Jovian planets.
  - Internal heat sources - helium rain.
  - Atmospheric structure on Jupiter: water, ammonium hydrosulfide and ammonia clouds. Their respective colors and why.
  - Temperature structure.
  - Comparative jovian planet atmospheres.
  - Magnetospheres on jovian planets - bow shock, magnetopause - relation of magnetic NS axis to rotation axis.
  - Jovian satellites, ring systems.