The end game

- **Current version of grades should be posted by this evening**
- **Numerical score on final will be posted the day after the final**
- **Letter grades will not be posted or given in person**

Venus

- **thick atmosphere of CO_2 - greenhouse effect**
- **Earth-like in most other respects**
  - two continents with volcanoes
  - lots of ocean floors
  - but no plate tectonics, rotation, or magnetic field
- **origin of Earth's primitive and secondary atmospheres**

Mars

- **small cold atmosphere of CO_2**
- **polar caps of water and CO_2**
- **Tharsis bulge, Valley of the Mariners**
  - intense tectonic activity when planet was young
- **cratered southern hemisphere, smooth northern hemisphere**
- **2 types of water flow - flash floods, rivers from Earth-like climate**
- **Super-oxide soil**
- **terraforming**

Mars life

- **Earth-like climate during middle period**
- **if life is inevitable then started on Mars too**
  - life on Earth started as soon as solid surface formed
- **Mars meteorites show evidence of fossil simple life, exposure to water**
  - But other interpretations possible
- **Super-oxide soil would kill surface life**
  - simple life could exist underground

Fermi Paradox

- **100 million Earth like planets in galaxy**
- **simple life probably starts on most (??)**
- **evolution to advanced life inevitable (??)**
- **should be vastly advanced civilizations across galaxy**
- **where are they?**

Jovian Planets

- **Large, mostly liquid hydrogen worlds with lots of moons**
- **terrestrial core surrounded by massive primitive atmosphere (the liquid H)**
  - much larger than terrestrial planets since made of most abundant molecule
- **we see clouds in atmosphere of water, methane, ammonia**

Moons of Jovian Planets

- **Mercury-sized and smaller, mostly made of water and rocks**
- **formed with Jovian planets**
  - dozens of them
- **heating by tidal stretching important for some**
- **Europa - liquid water deep inside**
- **Titan - dense nitrogen atmosphere, methane oceans**
- **Pluto - composition, size, similar to Jovian moons**

Comets

- **most of mass in planetary system**
- **few miles across, mostly water, rocks**
- **mostly far outside orbit of Pluto**
- **vaporized when pass through inner solar system**

Asteroids

- **small (few miles) to hundreds of miles across**
- **large planetesimals formed, but gentle accretion prevented by gravity of Jupiter**
- **today 1/25 of moon's mass there**