AST 105

Introduction to Astronomy: The Solar System
How is the pace of the course?

A) Way Too Slow
B) Too Slow
C) About right
D) Too fast
E) Way too fast
Next:

Introduction to the Solar System

- Comparative Planetology
- Basic Structure of the Solar System
- Major Features of the Planets
- Patterns in the Solar System
Comparative Planetology

• We can learn more about a world like our Earth by studying it in context with other worlds in the solar system.

• Stay focused on processes and trends common to multiple worlds instead of individual facts specific to a particular world.
1. Large bodies in the solar system have orderly motions.
2. Planets fall into two main categories: 
   - Rocky (Terrestrial) and Gaseous (Jovian)
3. Swarms of asteroids and comets populate the rest of the solar system.

Several notable exceptions to these general trends stand out.
Let’s Tour the Solar System!

• Don’t worry about taking detailed notes. These is all just information to help us later!
• Over 99.9% of solar system’s mass
• Made mostly of H/He plasma
  • Trace amounts of other elements
• Made of metal and rock; large iron core
• Desolate and cratered
• Very hot and very cold: 800°F (day), −270°F (night)
Venus

- Nearly identical in size to Earth; surface hidden by clouds
- Hellish conditions due to an extreme greenhouse effect
  - Even hotter than Mercury: 900°F, day and night
- Spins backwards (clockwise from above)
Venus rotates from East to West. Where does the Sun set and rise?

A. It rises East and sets West
B. It rises West and sets East
C. It rises East and sets South
D. It rises South and sets North
E. It rises West and sets South
Venus rotates from East to West. Where does the Sun set and rise?

A. It rises East and sets West
B. It rises West and sets East
C. It rises East and sets South
D. It rises South and sets North
E. It rises West and sets South
• The only surface liquid water in the solar system
• An oasis of life (only life that we know of)
• A surprisingly large moon
Mars

- Half the size of Earth
- Very thin atmosphere
- Polar caps, river valleys
  - Once had liquid water
    - Life??
- Most-studied planet
  - 5 current missions!
Asteroid Belt

- Rocky leftovers
- A failed planet?
  - Bullied around by Jupiter
• Much farther from Sun than inner planets
• Mostly H/He; *no solid surface*
• 300 times more massive than Earth
• Many moons, AND rings …
Jupiter’s moons can be as interesting as planets themselves, especially Jupiter’s four Galilean moons:

- **Io** (shown here): Active volcanoes all over
- **Europa**: Possible subsurface ocean
- **Ganymede**: Largest moon in solar system
- **Callisto**: A large, cratered “ice ball”
Saturn

- Giant and gaseous like Jupiter
- Spectacular rings
- Most moons in the Solar System
  - Including cloudy Titan (only moon with an atmosphere)
- Cassini spacecraft currently studying it
Uranus

- Smaller than Jupiter/Saturn; much larger than Earth ($R=4 \, R_E$)
- Made of H/He gas & hydrogen compounds (water, ammonia, methane)
- Extreme axis tilt
- Moons & rings
Neptune

- Similar to Uranus (except for axis tilt)
- Many moons (including Triton: with ‘backward’ rotation and nitrogen geysers)
Clicker Question

**HOW can we know the masses of planets?**

A. Measure the orbital period & distance of the planet from the Sun
B. Measure acceleration of an object falling on the planet
C. Measure the orbital period & distance of a moon
D. Measure their size, use density of Earth to get mass.
E. Measure the orbital period & distance of a spacecraft orbiting around them
**Clicker Question**

**HOW can we know the masses of planets?**

A. Measure the orbital period & distance of the planet from the Sun
B. Measure acceleration of an object falling on the planet
C. Measure the orbital period & distance of a moon
D. Measure their size, use density of Earth to get mass.
E. Measure the orbital period & distance of a spacecraft orbiting around them
Poll Question  (ungraded)

What was the main reason Pluto was declassified?

A. It is too small
B. It is too far out in the SS
C. It is made of different materials than the rest of the planets
D. Its orbit is tilted
E. A combination of reasons
In YOUR opinion, should Pluto have remained classified as a planet?

A. Yes
B. No
Pluto (R.I.P)

- Much smaller than all other planets
- Icy, comet-like composition
- Its moon Charon is similar (12%) in size
- Astronomers using HST have found four other moons!
Hubble’s Best Pictures

Smoothed and modeled images

Pluto
PRC96-09a · ST ScI OPO · March 7, 1996 · A. Stern (SwRI), M. Buie (Lowell Obs.), NASA, ESA
Its orbit was not like the other planets.
Its composition didn’t match the other patterns of the solar system.
But Pluto had long been known to lie in the Kuiper Belt.
Kuiper Belt Object Detection

Planet hunting team of Brown, Trujillo, & Rabinowitz @Caltech
http://www.mikebrownsplanets.com
At first, Kuiper Belt Objects were no real threat to Pluto.
But it was only a matter of time …
But it was only a matter of time ...
What is the definition of a planet?

Is Pluto a planet?
Proposed Definition:

A Planet...

1. orbits the Sun (rather than a moon that orbits a planet)
2. is big
3. is big enough so that its own gravity pulls it together into a sphere
(1) A planet¹ is a celestial body that
   (a) is in orbit around the Sun,
   (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and
   (c) has cleared the neighbourhood around its orbit.

(2) A "dwarf planet" is a celestial body that
   (a) is in orbit around the Sun,
   (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape²,
   (c) has not cleared the neighbourhood around its orbit, and
   (d) is not a satellite.

(3) All other objects³, except satellites, orbiting the Sun shall be referred to collectively as "Small Solar System Bodies".
Now that you know the facts:
In your own opinion, should Pluto have remained a planet?
(regardless of the IAU definition)

A. Yes
B. No
Poll Question (ungraded)

Did astronomers come up with a good definition of a planet?

A. Yes
B. No
Mnemonics

- **Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto**
  - *My Very Excellent Mother Just Served Us Nine Pizzas*

  Problem: Pluto now a “dwarf planet”

- **My Very Excellent Mother Just Served Us Nachos**
- “Many Very Extinct Maps Just Sold,” Utters NASA

- **Want to include Ceres, Pluto, Eris?**
  - National Geographic winner: *My Very Exciting Magic Carpet Just Sailed Under Nine Palace Elephants??*
  - Since this contest, both Makemake and Haumea were declared dwarf planets.