

# Astronomy 1140 Quiz 4 Review

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## I Jupiter

1. How do Jupiter's mass, size, day and year compare to Earth's?
  - Mass: 318 Earth masses (or about 1/1000th the mass of the Sun).
  - Radius:  $\sim 11$  Earth radii.
  - Day:  $\sim 0.4$  Earth day.
  - Year: 11.86 Earth years.
2. Why are the Jovian planets much more massive than Earth?
  - They accreted enough planetismals to form a large solid core which lets them gravitationally collect light elements in a runaway effect.
3. Jupiter and Saturn are seen to emit more energy than they receive. Where does this excess come from?
  - Gravitational contraction.
4. In what state is the hydrogen just outside Jupiter's solid core (in the mantle)?
  - It's liquid and metallic, meaning that the electrons are freely moving around. These free electrons contribute to generating Jupiter's strong magnetic field.
5. What are Jupiter's stripes?
  - Alternating bands of convection belts where the atmosphere is rising and falling for the light and dark stripes, respectively.
6. What properties of Jupiter lead to it having a strong magnetic field?
  - It has a large core, metallic hydrogen, and a very rapid rotation.
7. What are the 4 Galilean Moons of Jupiter? Which is the largest moon in the solar system?
  - Io, Europa, Ganymede and Callisto.
  - Ganymede is the largest moon in the solar system, but less dense than the inner moons, Io and Europa.

8. Which is the closest Galilean Moon to Jupiter? What is unique about this moon in particular?

- Io.
- It has a very young surface (evident from a lack of craters) and intense volcanic activity caused by tides from Jupiter. We can even detect sulphur emission spectrum from Io.

## II The Outer Planets in General

1. How do the sizes, masses and densities of the outer planets compare with the inner planets?

- The outer planets are larger, more massive, but also less dense than the inner planets. This is because they are comprised of many more gases and ices (as opposed to rocky material), lowering their overall densities despite having more mass.

## III Saturn

1. How do Saturn's mass, size, day and year compare with Earth's?

- Mass: 95 Earth masses.
- Radius:  $\sim 9$  Earth radii.
- Day:  $\sim 0.4$  Earth day
- Year: 29 Earth years

2. What is unique about Saturn's density?

- It is less than that of water. It is the least dense of all the planets.

3. What are Saturn's rings composed of?

- Ice mostly.

4. How did Saturn's rings likely form?

- A failed or broken moon (they are within its Roche radius).

5. What are Shepherding Moons?

- Tiny moon between rings on Saturn that help maintain their substructure.

6. Are the rings continuous?

- No, there are many gaps in the rings caused by resonances and perturbations from Saturn's many moons.
- There are likely thousands of individual rings.

7. What is Saturn's largest moon? Why is it especially interesting?

- Titan.
  - It is interesting because its conditions are not too different from those on the primordial Earth and possesses a methane atmosphere. It is not massive enough to hold onto lighter gases.
8. What makes up Saturn's atmosphere?
- Molecular hydrogen, mostly, unlike that of Uranus and Neptune, which we will come to shortly.

## IV Uranus and Neptune

1. William Herschel discovered which planet?
  - Uranus.
2. Which planet was first predicted mathematically based on the orbits of other planets?
  - Neptune.
3. How do Uranus' mass, size, day and year compare with Earth's?
  - Mass: 14.5 Earth masses.
  - Radius:  $\sim 4$  Earth radii.
  - Day:  $\sim 0.7$  Earth day.
  - Year: 84 Earth years.
4. How do Neptunes' mass, size, day and year compare with Earth's?
  - Mass: 17 Earth masses.
  - Radius:  $\sim 3.9$  Earth radii.
  - Day:  $\sim 0.7$  Earth day.
  - Year: 165 Earth years.
5. What's the tilt of Uranus' rotation axis compared with its orbit around the Sun?
  - 98 degrees!
6. What molecule is prominent in the atmosphere of Uranus and Neptune, giving them their colors?
  - Methane.
7. What is special about Neptune's moon Triton compared with the other moons in the solar system??
  - It is denser than the rest of Neptune's moons and on a retrograde orbit.
  - Suggests it is actually a Kuiper Belt Object that was captured by Neptune.
8. How do Uranus and Neptune compare with Jupiter and Saturn in terms of mass and size?

- Their cores did not grow enough in mass to be able to capture hydrogen in a runaway process.
  - Their cores were massive enough to retain heavier gases, however, so they are both much larger and more massive than the Earth, but not on the same scale that Jupiter and Saturn are.
  - Consequently, Uranus and Neptune do *not* have metallic hydrogen in their mantle.
9. How do Uranus' and Neptune's rings compare to Saturn's? Are they stable?
- They are made of rocks rather than ice and are unstable.
  - Not nearly as impressive as Saturn's rings, they were discovered when they occulted (blocked out) background stars.
10. Which planet does the moon Miranda orbit around? What is unique about it?
- Miranda orbits around Uranus and is unique from its fractured surface, likely caused by strong impact.

## V Minor Bodies (Sorry Pluto!)

1. How do Pluto's mass, size, day and year compare with Earth's?
- Mass: 0.002 Earth mass.
  - Radius:  $\sim$  0.18 Earth radius.
  - Day:  $\sim$  6.4 Earth days.
  - Year: 248 Earth years.
2. What planet is Pluto in a resonance with?
- Pluto is in a 3:2 resonance with Neptune. Even though it crosses Neptune's orbit, this resonance ensures that the two will not collide.
3. What is the primary composition of comets? Asteroids?
- Comets are made of ice, asteroids of rocks. They have a nucleus, surrounding coma, H cloud, then elongated tail that gets more pronounced the closer they are to the Sun.
  - Comets freeze when they are far from the Sun, and their tails are the Sun's radiation melting them. As such, the tails are not behind their direction of motion, but always pointing in the opposite direction of the Sun.
  - Being that icy is generally much more reflective than rocks, comets also tend to be much brighter (if at the same distance from the Sun) because of their higher albedo.
4. What's the difference between a meteor and meteorite?
- Both are space rocks entering the Earth's atmosphere. Meteorite, however, survive entering through the Earth's atmosphere rather than burning up before landing.
5. Why are the planets (and dwarf planets like Pluto) spherical while comets and asteroids can have strange shapes?
- (Dwarf) Planets are massive enough to have very strong gravity to deform them into

spheres. Asteroids and comets, however, are not nearly as massive, as a consequence, the material forces of the rocks and ice that they are made of are able to resist the crushing pressure of gravity and remain in unique shapes. Gravity isn't strong enough to collapse them into sphere.

6. What are the major resevoirs of minor bodies?

- Asteroid belt, located between Mars and Jupiter. Held in place by these two planets, mostly comprised of asteroids, as the name suggests.
- Kuiper belt, objects outside the orbit of Neptune. Pluto is one of these trans-Neptunian objects and in resonance with Neptune.
- Oort cloud, even more distant objects out in the solar system, such as the long period comets.