

**AST 111**  
**FINAL EXAM**  
**Tuesday December 8, 2015**  
**9:40 - 11:40 am**  
**PSF 166**

**CLOSED BOOK**

**YOU MUST NOT USE YOUR TEXTBOOK, LAPTOP, TABLET OR YOUR CELLPHONE BRING A PICTURE ID.**  
**You must use a Number 2 Pencil. Bring an eraser to be safe.**

**Chapter 15: The Outermost Planets: Uranus, Neptune, Pluto**

**Uranus:**

1. Look at Celestial Profile 9 and 10 (Page 341: Look at the Celestial Profiles for all the planets)
2. When was Uranus discovered and by whom? (Page 329)
3. How is the direction of rotation of Uranus different from that of the Earth? How does that affect the seasons on Uranus? (Discussed in class and Figure 15-2)
4. What is the structure and composition of its atmosphere? How does it compare to Neptune's atmosphere? I showed recent pictures of the clouds in class. (Figure 15-4)
5. What do we know about the internal structure of Uranus? (Page 333)
6. What is the direction and strengths of the magnetic fields of the outer planets? Why are those of Uranus and Neptune so unusual? (Figure 15-6)
7. How were the rings of Uranus and Neptune discovered? How do they differ from those of Saturn? (See pages 338-339)
8. What do we know about the Shepherd satellites of the Uranus rings?
9. How many moons does Uranus have? How many had we found before the Voyager flights? (15-8)
10. The largest moon is Titania. How does its size compare to that of our own Moon? (Figure 15-8)
11. Look at the pictures on Pages 336 and 337. What are the various explanations of the surface features of Miranda? (Figure 15-10)
12. Where, in the Solar System, is it thought that Uranus and Neptune originated? (Page 340)
13. What is the relationship to their motion outward from where they formed to the Late Heavy Bombardment

**Neptune**

1. When was Neptune discovered and by whom? (A triumph of Newton's laws and the Law of Gravity) (page 342)
2. We know very little about Neptune - even with the Voyager flyby. It shows a lot more atmospheric features than does Uranus.
3. What do we know about the internal structure of Neptune? Remember that it has a source of internal heat.
4. Do the rings of Neptune also have shepherding satellites? (Yes)
5. What are some of the unusual features of Triton? What is its possible fate in the far future?
6. How is the orbital plane of Triton and Nereid tilted with respect to the ecliptic? What causes the nitrogen plumes and geysers?
7. How and when were the nitrogen geysers discovered?

**Pluto**

1. How was Pluto discovered? Could there be any more "planets" as large as Pluto in our Solar System but farther away? (Yes: larger)
2. What is the surface of Pluto like? I showed the New Horizons pictures in class – they are not in the book, obviously.
3. What is Charon. How was Charon discovered? (Page 348 and Figures 15-17 and 15-18)
4. How many moons does Pluto have? (Lots)
5. Is Pluto massive enough to affect the orbit of Neptune? (No) How long have we known this?
6. What was important about the transits of Charon across Pluto?
7. Does Pluto have an atmosphere? Yes?
8. What are the Kuiper Belt Objects?
9. What space craft passed Pluto and Charon in July 2015 and is now sending back pictures? (New Horizons: Page 348)
10. The "heart" on the surface of Pluto is one of the more remarkable features on its surface. There are others.

**Chapter 16. Solar System Leftovers: Meteorites, Asteroids, and Comets**

**Meteorites:**

1. What are meteoroids, meteors, meteorites, meteorwongs? Where do the particles in meteor showers come from? What is a radiant? (Figures 16-5 and 16-6)
2. What is a Fall and what is a Find? (Page 355 and Table 16-1)
3. Where is the Barringer Crater? How old is it? (Figure 16-20)
4. What are the different kinds of meteorites? What is the importance of carbonaceous chondrites? (Figure 16-2)
5. What is meant by pre-solar grains in meteorites? (They appear to be almost unchanged since they were formed in stars atmospheres)
6. What do the existence of iron, stony-iron, and stony meteorites tell us about the asteroid belt? (Page 362-363)
7. Do some meteorites come from Asteroids? From the Moon? From Mars? (Yes)

8. When are some of the important meteor showers? (Table A-12 in the Appendix: page A-9) There is one just after Finals.

### **Asteroids:**

1. Who was the first to discover an asteroid? When was this and which asteroid was it? How many are known now- roughly?
2. Where are most of the asteroids located? What do they look like? What are their sizes? (Pages 361, 362, 363)
3. What are the Trojan asteroids? Where are they located? What is the importance of earth crossing asteroids to us?
4. What is the evidence for asteroid collisions?
5. NEAR orbited and took pictures of which asteroid? (Pages 362-363)
6. What is so interesting about Mathilde? (It has a low density)
7. What are the major classes of asteroids? (C-type, S-Type, M-type –see page 363)
8. What recent spacecraft visited Vesta and took pictures (The Dawn Probe). It is now taking pictures of Ceres that I showed in class.
9. What is the evidence that some meteorites come from Vesta? (Pages 362-363)

### **Comets:**

1. What are the various parts of a comet? How big are they? What is the composition of the Coma?
2. What is a gas tail? A dust tail? What causes them to face away from the sun? What are the names of some famous comets? (Pages 368-369)
3. What does the nucleus of a comet look like? (Figure 16-14)
4. What happens to the debris from a comet after a passage near the sun? How is this material related to Meteor Showers?
5. How long does a comet last? How does its appearance change as it orbits the sun?
6. What was Shoemaker-Levy 9? What does its existence and behavior tell us about hits on the earth?
7. What is the Oort cloud? The Kuiper belt? (Page 373-374)
8. What is meant by a “Shower of Comets” (discussed in class)
9. How often do collisions of asteroids and comets with the Earth occur?
10. What is the evidence for these collisions? Is there a nearby crater?
11. What is now thought to have caused the extinction of the dinosaurs? Where is the crater probably located? (Figure 16-24)
12. What was the Tunguska Event? When did it happen? What do people think was the cause? (Figure 16-21)
13. There was a large impact in Siberia 2 years ago. They happen frequently.
14. The European ROSETTA mission reached Comet 67P/Churyumov–Gerasimenko on August 6, 2014 and is still orbiting the comet. The comet has now passed through perihelion and is moving away from the Sun. On November 12, 2014 the Philae lander reached the surface of the comet and bounced. I discussed this mission and the results in class. There are some recent pictures on Astronomy Picture of the Day.

### **Chapter 17: Life in the Universe**

1. Read Section 17-1 but you will not be held responsible for this material.
2. When did life begin on the Earth? (Figure 17-2)
3. What is the evidence that life may have existed at one time on Mars - probably not correct. (Page 396 and Fig 17-10c)
4. How do we know that some meteorites found on Earth originated on Mars?
5. The Miller experiment showed that the conditions on the early Earth were sufficient to form large molecules including amino acids the building blocks of proteins.
6. Analyzing the Murchison meteorite shows that Carbonaceous Chondrite meteorites also contain amino acids produced by non-biological processes (Figure 17-5).
7. Look at Figure 17-8 and realize that humans appeared only very recently compared to the age of the Earth.
8. Pages 394, 395, and part of 396 discuss where else in our Solar System life might have developed. The key ingredient is water for “Life as we KNOW it.”
9. What is the message sent out by the Arecibo Radio Telescope in 1974. (Figure 17-11) When do we expect an answer? (44,000 yrs)
10. What is an anticoded message? (Figure 17-11)
11. What is the importance of the “Water Hole” in radio astronomy communication (Figure 17-12).
12. What is the Habitable zone of a star? How many planets in our own solar system can be found in the habitable zone of the Sun? This was discussed in class.
13. Is there any evidence that we have been visited by Extra-terrestrial Aliens? (NO).
14. The Drake equation is an attempt to quantify some of the factors that go into estimating the number of communicating galactic civilizations. Some of them are better known than others. (Table 17-1)
15. Do you think you could figure out the message in Figure 17-11 without help?