AST 111: Tu-Thu 10:30am - 11:45am

STUDY GUIDE FOR EXAM 3

CLOSED BOOK

YOU MUST NOT USE YOUR LAPTOP, TABLET OR YOUR CELLPHONE BRING A PICTURE ID.

Perspective: I only covered P-1: Pages 170- 173. Material from this section is also covered in later chapters!

Chapter 19. Formation of the Solar System:

1. The earliest theories for the formation of the solar system assumed that the sun was already present and the planets formed later. This is WRONG! (The Sun and Planets formed at the same time from the same material)
2. LaPlace was the first to propose the nebular hypothesis in which the solar system formed from a contracting nebula. LaPlace understood gravity a lot better since he had the work of Newton on which to build.
3. What was the Angular Momentum problem? (The Sun rotates slowly - most of the angular momentum in the Solar System is in Jupiter)
4. The atoms in your body (except for hydrogen and helium) were formed by nuclear processes in stars.
5. The Solar Nebula Hypothesis assumes that the sun and planets were formed at the same time out of the same material but the sun formed slightly faster than the planets. This is slightly different from what is said in the textbook but more correct.
6. What is the evidence that the Solar nebula hypothesis is probably correct? (Observations of forming stars.)
7. What is an Extra-Solar planet? What physical principal is used to find these planets (the Doppler Shift discussed in an earlier chapter and figure 19-16) ? Which planets in our solar system do they resemble? (See section 19-4)
8. Remember the difference between rotation and revolution. A planet rotates on its axis and revolves around the Sun.
9. What are the facts that must be explained in order to understand the formation of our own solar system? Know the Solar System characteristics in Table 19-3.
10. What are the major similarities and differences between the inner Terrestrial planets and the outer Jovian planets? (Look at pages 410-411 and read the figure captions)
11. What is the importance of impact craters in determining the evolution of the solar system?
12. What is liquid hydrogen and metallic hydrogen? Where are they found?
13. Why are the 4 largest satellites of Jupiter called the Galilean Satellites?
14. Where are the Asteroids found? Comets? The Kuiper belt?
15. How is the age of the solar system determined? What is meant by the half-life of a radioactive element? What are some of the elements that are used to date the Solar System? (Figure 19-7)
16. Radioactive dating is used to determine the age of the solar system. The half-life is the time it takes for half of a radioactive isotope to decay into its daughter isotope. We measure the proportion of the original isotope to the daughter isotope to see how much time has passed.
17. Radioactive elements are produced in nova and supernova explosions. Possibly one went off nearby and caused the gas cloud to start collapsing into our Sun and planets.
18. What is meant by the condensation sequence of the gas in the solar nebula? (Table 19-2)
19. The planets formed in the spinning disk around the sun. Small particles condensed to form larger particles which collided to form planetesimals which collected into the proto planets. The planets closest to the sun lost most of their gas, those farther away did not.
20. Large amounts of gas from young stars is blown out into space at high speeds. This gas eventually accumulates with other gas to form new stars.
21. What is meant by differentiation of a planetary interior? The planet must be molten. (Figure 19-9)
22. What is meant by outgassing? How is this related to the present atmosphere of our earth? The first atmosphere?
23. Radiation pressure describes the fact that light exerts a force on gas and small particles.
24. What are the four effects for clearing the gas from the inner part of the solar nebula? (Pages 420-421)
25. The nebular theory has been confirmed by studying other solar systems and regions of space where stars are forming. (Pages 422-423)
26. The inner planets have higher densities - they are rocks and iron rich material. The outer planets are mostly thick atmosphere gas giants. They may have small rocky cores.
27. Asteroids and comets are the left-overs from the formation of the solar system. (The turkey on Friday the 28th).
28. There were enough asteroids and comets around in the young Solar System to fall onto the surfaces of all the planets and cause craters and reheating in some cases. We cannot see the surfaces of the outer planets but their moons (except Io) also show impacts.
29. We are searching, even as you read this, for possible large bodies that might impact the earth.
30. Deimos and Phobos are captured asteroids.
31. Our own Moon was probably caused by the impact of a large, Mars size, object with the Earth after differentiation had occurred. That is why its composition resembles the mantle and crust of the earth.
32. The latest results from the Kepler satellite is that virtually all stars that you see in the night sky have planets.

Chapter 21: The Moon and Mercury: Airless Worlds. Moon:

1. The key similarity between the Moon and Mercury is their heavily cratered surfaces. Their surfaces provide a history of the early formation of the Solar System.
2. The Moon keeps the same face toward the Earth because of Tidal Coupling.

3. Where is the Terminator (the answer is not: “in California”)? What is a Mare (plural is Maria)?
4. Why are the highlands on the Moon thought to be very old? And older than the Maria?
5. Read about impact craters - I went into this in some detail in class. What do the rays from some craters tell us? What and when was the Late Heavy Bombardment? (Pages 452-453)
6. Where and what is Mare Orientale?
7. Is there any evidence that impacts on the Moon blasted off rocks that fell onto the Earth? (Yes)
8. Know about the various missions to the Moon in the 1960's and 1970's. (Table 21-1)
9. All the rocks brought back to the earth are igneous - formed by the solidification of molten rock.
10. What is meant by anorthosites, breccias, regolith, vesicules? (Figure 21-5 on page 457)
11. How did we learn about the internal structure of the moon?
12. How did the Maria form? About how long ago? How do we know that they are younger than the highlands?
13. The only currently viable hypothesis for the formation of the Moon is the Large-Impact hypothesis originated by Al Cameron and collaborators. (Figure 21-9)

MERCURY:

1. How long is the Mercury Day? How does it compare to the Mercury year (Figure 21-12)?
2. What does the surface of Mercury look like? What kind of craters are found on Mercury?
3. Remember that Mercury is tidally locked to the sun but does not keep the same face to the Sun.
4. What is the Caloris Basin? How did its formation produce the lineated terrain? (Figure 21-15)
5. What caused the dark lava Plains? The Scarps?
6. What do we know about the internal structure of Mercury? It’s origin and evolution?
7. We know less about the interior of Mercury because it does not have a moon. It was only recently that the MESSENGER satellite began orbiting Mercury .
8. One of the Messenger discoveries about Mercury is that at one time it had a large number of volcanoes.

Chapter 22 Venus and Mars: VENUS

1. Does Venus go through phases as seen from the Earth? (Yes)
2. What is the rotation period of Venus, why is the direction of its rotation unusual? (Clockwise)
3. Why is it difficult to see the surface? What are the clouds made of? What is the composition of the Venusian atmosphere? (The most abundant molecule is carbon dioxide)
4. The high temperatures on Venus are a result of a runaway Greenhouse effect.
5. How do we know what the surface of Venus looks like? What was the purpose of the Magellan mission?
6. The surface of Venus has both lava flows and rolling plains. There are both impact and volcanic craters on Venus.
7. Venus also has Shield Volcanoes. Where are some prominent shield volcanoes on the Earth?
8. What are Coronae? What is the evidence that Plate Tectonics did not occur on Venus?
9. Who sent landers to the surface of Venus? What did they show?

MARS:

1. What do we know about the surface of Mars? What are the names of the various orbiters and landers?
2. What is the composition of the Martian atmosphere? How did it probably originate? Could we live on Mars without breathing apparatus? (No)
3. What molecules were able to escape from Mars (Figure 22-13)?
4. What is the importance of the amount of argon gas in the Martian atmosphere? (Mars once had a thick atmosphere)
5. Does Mars have a magnetic field?
6. Mars has huge dust storms that last for months.
7. Mars has both shield volcanoes and impact craters - but in different regions.
8. What is Olympus Mons?
9. What is the evidence that there were large amounts of flowing water on the surface of Mars billions of years ago?
10. What are outflow channels? Runoff channels? Where do we think the water is now?
11. What is the composition of the Martian polar caps? Are the two caps identical?
12. What do we know about the Martian meteorites?
13. What are Phobos and Deimos? They most closely resemble captured asteroids.
14. Be familiar with the material on pages 496-497.

Chapter 23: Jupiter and Saturn JUPITER

1. Jupiter is the largest planet in the solar system and the second most massive object
2. It can be considered a Failed Star - why? It radiates more heat than it receives from the Sun. What is the heat source?
3. We find Jupiter sized planets around other stars. How do we know this? (Figure 19-16)
4. The Great Red Spot is a very long lived storm. Who first saw it? (Pages 508-509)
5. How does the average density of Jupiter compare to that of the Earth?
6. What is the average composition of Jupiter and Saturn? Of the atmosphere of Jupiter and Saturn? How deep do we see into their atmospheres? (Pages 508-509)
7. Jupiter is not a perfect sphere. It is oblate (flattened) because it is rotating rapidly.
8. What are the rotation periods and how fast do the winds move on Jupiter and Saturn? (Shown in class)
9. We detect radio waves from Jupiter. They are produced by what feature of Jupiter?

10. Do Jupiter and Saturn have Aurorae? (Yes)
11.What is the Io Plasma Torus? What is Io?
12. What are the Belts and Zones of the Jovian atmosphere? What are they telling us about the heat flow from the interior? Which are rising and which are falling? (Pages 508-509)
13. What happened to the Galileo Probe?
14. All the Jovian planets have rings. When were the rings of Jupiter discovered and how? (Page 517-518)
15. What is the Roche Limit? What does it have to do with Planetary Rings?
16. I discussed the Shoemaker-Levy 9 impact. Do we have any evidence that such impacts have occurred elsewhere in the Solar system? (Yes! And on Jupiter more recently)
17.What do we know about the Jovian and Saturnian interiors? What happens to hydrogen gas as the pressure increases?
18. Why do we think that Jupiter and Saturn might have dense cores since we can't see deep into the atmosphere?
19. Why does Saturn radiate more energy than receives from the Sun? (Page 519)
20. I discussed the Galilean Moons of Jupiter in some detail. They are Io, Europa, Ganymede, and Callisto. (Know Table 23-2)
21. You will need to know the distinguishing features of these moons. Why is Io so interesting? Why is Europa so important?
22. Io has a large number of erupting volcanoes. These blast sulfur into space to form the Io torus. What causes the heating that results in volcanoes on Io?
23. Europa probably has a liquid ocean underneath a thick ice layer. Why do we think this?
24. Ganymede has both old and young surface regions. The craters look like they were formed by impacts with shaved ice.
25. Callisto has cratered regions and probably an old surface. It has not suffered as much tidal heating as the other moons.
26. Are the rings of Jupiter old? (No: Page 518)

SATURN
1. Saturn is the second most massive planet and it has a lower density than Jupiter.
2. It also rotates rapidly, almost as rapidly as Jupiter, and so it is oblate (flattened).
3. It radiates nearly twice as much heat as it receives from the Sun. What is the source of heat for this planet? (Page 519)
4. Saturn also has a magnetic field. But it is weaker than that of Jupiter.
5. Why are the clouds of Saturn less distinct than those of Jupiter? (Methane haze)
6. What is the name of the spacecraft orbiting Saturn? What was the name of the Titan lander?
7. Read about the discovery that the rings are actually particles and not solid. The pictures from the various spacecraft flybys revolutionized our understanding. For example, the Spokes seen in Voyager images. The breaking up of the rings into many smaller narrower rings. The Shepherd satellites associated with the F ring. (Pages 528-529)
8. Saturn has a lot of moons. Some are more important and interesting than others.
9. Titan is definitely known to have an atmosphere and the existence of this atmosphere has been known for sometime.
10. What are some of the organic compounds detected in the atmosphere of Titan? (Table 23-3)
11. Titan probably has a rocky core but the rest is very icy. It is larger than Mercury. There are lots of unanswered questions.
12. The Huygens lander probed the atmosphere and surface of Titan.
13. Read about the smaller moons.
14. Parts of the surface of Enceladus resemble the surface of Europa: cracks and new surface plus regions that are heavily cratered. Plus gas is being ejected right now.
15. How do we determine the relative ages of the moon's surfaces? (Number of craters)

Chapter 24: The Outermost Planets: Uranus, Neptune, Pluto

Uranus:
1. Look at Celestial Profile 9 and 10 (Page 548: Look at the Celestial Profiles for all the planets)
2. When was Uranus discovered and by whom? (Page 536)
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 24-3)
4. What is the structure and composition of its atmosphere? I showed recent pictures of the clouds in class.
5. What do we know about the internal structure of Uranus?
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 24-7)
7. How were the rings of Uranus and Neptune discovered? How do they differ from those of Saturn? (See pages 544-545)
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?
10. The largest moon is Titania. How does its size compare to that of our own Moon? (Figure 24-9)
11. Look at the pictures on Pages 543 and 546. What are the various explanations of the surface features of Miranda? (Figure 24-11)
12. Where, in the Solar System, is it thought that Uranus and Neptune originated?
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) (pages 547-548)
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?
4.Do the rings of Neptune also have shepherding satellites?
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?
3 What is Charon. How was Charon discovered?
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? What is its surface like?
8. What are the Kuiper Belt Objects?
9. What space craft is on its way to Pluto and when will it arrive? (Page 554)

Chapter 25. Solar System Leftovers: Meteorites, Asteroids, and Comets

Meteorites:

1. What are meteoroids, meteors, meteorites, meteorwrongs? Where do the particles in meteor showers come from? What is a radiant? (Figure 25-5)
2. What is a Fall and what is a Find? (Table 25-1)
3. Where is the Barringer Meteorite Crater? How old is it?
4. What are the different kinds of meteorites? What is the importance of carbonaceous chondrites?
5. What is meant by pre-solar grains in meteorites?
6. What do the existence of iron, stony-iron, and stony meteorites tell us about the asteroid belt?
7. Do some meteorites come from Asteroids? From the Moon? From Mars? (Yes)
8. When are some of the important meteor showers? (Table 25-2).

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? (Page 568-569)
3. What are the Kirkwood gaps? 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 568-569)
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 569)
8. What recent spacecraft visited Vesta and took pictures (The Dawn Probe).
9. What is the evidence that some meteorites come from Vesta? (Pages 568-569)

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 574-575)
3. What does the nucleus of a comet look like? (Figure 25-14)
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?
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?
12. What was the Tunguska Event? When did it happen? What do people think was the cause?
13. There was a large impact in Siberia last year. They happen frequently.
14. The European ROSETTA mission reached Comet 67P/Churymov–Gerasimenko on August 6, 2014. It orbited the comet, and will orbit the comet as the comet passes through perihelion and beyond. On November 12, 2014 the Philae lander reached the surface of the comet and bounced but returned a large amount of data. I discussed this mission and the results a number of times in class.