# 4.7: Other Worlds - An Introduction to the Solar System (Exercises)

## For Further Exploration

### Articles

Davidson, K. “Carl Sagan’s Coming of Age.” *Astronomy.* (November 1999): 40. About the noted popularizer of science and how he developed his interest in astronomy.

Garget, J. “Mysterious Microworlds.” *Astronomy.* (July 2005): 32. A quick tour of a number of the moons in the solar system.

Hartmann, W. “The Great Solar System Revision.” *Astronomy*. (August 1998): 40. How our views have changed over the past 25 years.

Jewitt, D., & Young, E. “Oceans from the Skies.” *Scientific American* (March 2015): 36–43. How did Earth and the other inner planets get their water after the initial hot period?

Kross, J. “What’s in a Name?” *Sky & Telescope*. (May 1995): 28. How worlds are named.

Rubin, A. “Secrets of Primitive Meteorites.” *Scientific American*. (February 2013): 36. What meteorites can teach us about the environment in which the solar system formed.

Soter, S. “What Is a Planet?” *Scientific American*. (January 2007): 34. The IAU’s new definition of a planet in our solar system, and what happened to Pluto as a result.

Talcott, R. “How the Solar System Came to Be.” *Astronomy*. (November 2012): 24. On the formation period of the Sun and the planets.

Wood, J. “Forging the Planets: The Origin of our Solar System.” *Sky & Telescope*. (January 1999): 36. Good overview.

Young, E. “Cloudy with a Chance of Stars.” *Scientific American* (February 2010): 34. On how clouds of interstellar matter turn into star systems.

### Websites

Disk Detective Project: http://www.diskdetective.org/. The WISE mission is asking the public to help them find protoplanetary disks in their infrared data.

Gazetteer of Planetary Nomenclature: http://planetarynames.wr.usgs.gov/. Outlines the rules for naming bodies and features in the solar system.

Planetary Photojournal: http://photojournal.jpl.nasa.gov/index.html. This NASA site features thousands of the best images from planetary exploration, with detailed captions and excellent indexing. You can find images by world, feature name, or mission, and download them in a number of formats. And the images are copyright-free because your tax dollars paid for them.

The following sites present introductory information and pictures about each of the worlds of our solar system:

- NASA/JPL Solar System Exploration pages: http://solarsystem.nasa.gov/index.cfm.
- National Space Science Data Center Lunar and Planetary Science pages: http://nssdc.gsfc.nasa.gov/planetary/.
- Nine [now 8] Planets Solar System Tour: www.nineplanets.org/.
- Planetary Society solar system pages: www.planetary.org/explore/spa...opics/compare/.
- Views of the Solar System by Calvin J. Hamilton: http://www.solarviews.com/eng/homepage.htm.

### Videos

Brown Dwarfs and Free Floating Planets: When You Are Just Too Small to Be a Star: https://www.youtube.com/watch?v=zXCDsb4n4KU. A nontechnical talk by Gibor Basri of the University of California at Berkeley, discussing some of the controversies about the meaning of the word “planet” (1:32:52).

In the Land of Enchantment: The Epic Story of the Cassini Mission to Saturn: https://www.youtube.com/watch?v=Vx135n8VFxY. A public lecture by Dr. Carolyn Porco that focuses mainly on the exploration of Saturn and its moons, but also presents an eloquent explanation of why we explore the solar system (1:37:52).

Origins of the Solar System: www.pbs.org/wgbh/nova/space/o...ar-system.html. A video from PBS that focuses on the evidence from meteorites, narrated by Neil deGrasse Tyson (13:02).

To Scale: The Solar System: https://www.youtube.com/watch?t=84&v=zR3Igc3Rhfg. Constructing a scale model of the solar system in the Nevada desert (7:06).

Where Do Planets Come From?: https://www.youtube.com/watch?v=zdIJUdZWlXo. Public talk by Anjali Tripathi in March 2016 in the Center for Astrophysics Observatory Nights Series (56:14).

## Review Questions

1. Venus rotates backward and Uranus and Pluto spin about an axis tipped nearly on its side. Based on what you learned about the motion of small bodies in the solar system and the surfaces of the planets, what might be the cause of these strange rotations?
2. What is the difference between a differentiated body and an undifferentiated body, and how might that influence a body's ability to retain heat for the age of the solar system?
3. What does a planet need in order to retain an atmosphere? How does an atmosphere affect the surface of a planet and the ability of life to exist?
4. Which type of planets have the most moons? Where did these moons likely originate?
5. Explain our ideas about why the terrestrial planets are rocky and have less gas than the giant planets.
6. Do all planetary systems look the same as our own?
7. What is comparative planetology and why is it useful to astronomers?
8. What changed in our understanding of the Moon and Moon-Earth system as a result of humans landing on the Moon's surface?
9. If Earth was to be hit by an extraterrestrial object, where in the solar system could it come from and how would we know its source region?
10. List some reasons that the study of the planets has progressed more in the past few decades than any other branch of astronomy.
11. Imagine you are a travel agent in the next century. An eccentric billionaire asks you to arrange a "Guinness Book of Solar System Records" kind of tour. Where would you direct him to find the following (use this chapter and Appendix F and Appendix G):
    1. the least-dense planet
    2. the densest planet
    3. the largest moon in the solar system
    4. excluding the jovian planets, the planet where you would weigh the most on its surface (Hint: Weight is directly proportional to surface gravity.)
    5. the smallest planet
    6. the planet that takes the longest time to rotate
    7. the planet that takes the shortest time to rotate
    8. the planet with a diameter closest to Earth's
    9. the moon with the thickest atmosphere
    10. the densest moon
    11. the most massive moon
12. What characteristics do the worlds in our solar system have in common that lead astronomers to believe that they all formed from the same "mother cloud" (solar nebula)?
13. How do terrestrial and giant planets differ? List as many ways as you can think of.
14. Why are there so many craters on the Moon and so few on Earth?
15. Where would you look for some "original" planetesimals left over from the formation of our solar system?
16. What was the solar nebula like? Why did the Sun form at its center?
17. Describe the solar nebula, and outline the sequence of events within the nebula that gave rise to the planetesimals.
18. Why do the giant planets and their moons have compositions different from those of the terrestrial planets?
19. Explain the role of impacts in planetary evolution, including both giant impacts and more modest ones.
20. Why are some planets and moons more geologically active than others?

## Thought Questions

1. What can we learn about the formation of our solar system by studying other stars? Explain.

2. Earlier in this chapter, we modeled the solar system with Earth at a distance of about one city block from the Sun. If you were to make a model of the distances in the solar system to match your height, with the Sun at the top of your head and Pluto at your feet, which planet would be near your waist? How far down would the zone of the terrestrial planets reach?
3. Seasons are a result of the inclination of a planet's axial tilt being inclined from the normal of the planet's orbital plane. For example, Earth has an axis tilt of 23.4° (Appendix F). Using information about just the inclination alone, which planets might you expect to have seasonal cycles similar to Earth, although different in duration because orbital periods around the Sun are different?
4. Again using Appendix F, which planet(s) might you expect not to have significant seasonal activity? Why?
5. Again using Appendix F, which planets might you expect to have extreme seasons? Why?
6. Interview a sample of 20 people who are not taking an astronomy class and ask them if they can name a living astronomer. What percentage of those interviewed were able to name one? Typically, the two living astronomers the public knows these days are Stephen Hawking and Neil deGrasse Tyson. Why are they better known than most astronomers? How would your result have differed if you had asked the same people to name a movie star or a professional basketball player?
7. How do we know when the solar system formed? Usually we say that the solar system is 4.5 billion years old. To what does this age correspond?
8. We have seen how Mars can support greater elevation differences than Earth or Venus. According to the same arguments, the Moon should have higher mountains than any of the other terrestrial planets, yet we know it does not. What is wrong with applying the same line of reasoning to the mountains on the Moon?

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