

## Solar System Teacher Tips

### Primary, Intermediate, Junior

Created by the Classroom Cubed Initiative Grant (Illinois)

Rock Island County Regional Office of Education

Curriculum Development Team: Lynne Brandenburg, Rita Greathouse, Paul Hansen,

Denny Moore, Clayton Naylor, Dennis Steinmetz, Carol Van De Walle

### Key Points:

- **Consult the User Guide for operational questions.**
- **Primary focus** is to examine the components of our solar system, determine attributes, spatial relationships, rotational and orbital movements of objects.
- Planets orbit in elliptical, nearly circular, paths around the Sun.
- The Solar System is held together by gravity due to the Sun's immense size (one million times the size of the Earth). Our Sun's gravitational pull reaches 6,000 million kilometers (3,750 million miles).
- The four inner planets (closest to the Sun) are composed of rock.
- The four outer planets are gas giants surrounded by rings and many moons.
- The Solar System contains the Sun, planets, dwarf planets, moons, comets, meteors and asteroids.
- Definitions:
  - **Asteroid:** irregularly shaped chunk of rock/metal (usually iron) larger than a meteoroid, but smaller than a planet. Asteroids orbit the Sun.
  - **Asteroid Belt:** most asteroids orbit in a huge ring around the Sun and are concentrated between Mars and Jupiter. The dwarf planet Ceres is located in the main asteroid belt and was considered an asteroid until 2006.
  - **Atmosphere:** a layer of various gases, retained by gravity, surrounding some planets (and even some moons). The atmosphere becomes thinner with increasing altitude, with no definite boundary between the atmosphere and outer space. The Karman Line, at 100 km (62 mi), is often regarded as the boundary between Earth's atmosphere and outer space.
  - **Comet:** 'dirty snowball' made of dust and ice mixed together. The extremely elliptical orbits of comets carry them near the sun and then to the edge of the solar system, far beyond the farthest planet. As comets move toward the Sun, dust and gas stream away, forming a tail that glows in the sunlight. Tails always point away from the Sun.
  - **Craters:** holes that occur when the surface of a planet, moon, or asteroid is hit by a meteorite or asteroid.
  - **Day:** the time it takes for a single rotation of a planet.
  - **Dwarf Planet/Planetoid:** (including Pluto) rocky object orbiting a star but not a satellite of another planet. Dwarf planets are massive enough to be spherical as a result of their own gravity but are not large enough to clear the surrounding neighborhood.
  - **Gravity:** the force that pulls objects toward each other, holding planets, asteroids, comets, and meteors in orbit around suns, and moons in orbit around planets. It is the source of weight. All objects have gravity – the

- greater the mass, the stronger the gravitational pull. The gravity of the moon causes the tides in the Earth's oceans.
- **Kuiper Belt:** a band of icy rocks (including most planetoids) that orbit the Sun, extending from the orbit of Neptune to the Oort Cloud.
  - **Meteor:** meteoroid burning as it enters a planet's atmosphere (commonly, but incorrectly identified as "shooting stars").
  - **Meteorite:** a meteoroid that hits the surface of a planet.
  - **Meteoroid:** dust or small chunks of rock in orbit around the Sun.
  - **Moon:** a naturally occurring satellite in orbit around a planet or planetoid.
  - **Orbit:** the path of an object in space, as it travels around another object.
  - **Oort Cloud:** an area well beyond the planets (about one light year from the Sun) where billions of comets slowly orbit the Sun. The outer edge of the Oort Cloud is the gravitational boundary of our solar system.
  - **Planet:** a huge ball of rock or gas, which orbits a star. In order to be classified as a planet, an object must be massive enough (therefore having a strong enough gravitational pull) to be spherical and clear its neighborhood of debris.
  - **Smaller Solar System Bodies:** all other celestial bodies (asteroids, comets, satellites) not included as Planets or Dwarf Planets.
  - **Solar System:** a star (sun) and everything else which orbits around it.
  - **Space:** the cold, dark void that exists beyond any celestial body and its atmosphere. It is not completely empty (i.e. a perfect vacuum), but contains a low density of particles and energy. (Theoretically, it also contains dark matter and dark energy.)
  - **Star:** a ball of gas, massive enough to undergo nuclear fusion.
  - **Sun:** the medium sized star at the center of our solar system. The core of the Sun is a nuclear furnace that produces large amounts of energy and provides heat and light to the planets. The mass of the Sun accounts for 99.86% of the total mass of everything in the Solar System.
  - **Year:** the length of time it takes a planet to travel once around the Sun.

### Activities/Background Knowledge to use While Viewing Simulation:

- The orbits of all objects in the solar system approximately take the form of circles and ellipses with the Sun at one of the foci. Bounded orbits are where the object keeps going around the Sun. In an unbounded orbit, an object travels one parabolic arc around the Sun, then escapes the sun's gravitational field and never comes back.

#### Inner Planets – Terrestrial (rocky)

- **Mercury** – closest to the Sun (about 58 million km) and one of the smallest planets. It has no moons. There is almost no atmosphere, and the temperature variations are too extreme for life. The planet is very dense with a large core of iron. It is covered with craters caused by meteorites.
- **Venus** – second planet from the Sun (about 108 million km). It spins backward (retrograde) and has no moons. The Venutian surface is covered with thick clouds of frozen carbon dioxide, dust, and poisonous drops of sulfuric acid. The greenhouse effect traps the Sun's energy making Venus the hottest planet. It is rocky with mountains, canyons, volcanoes and plains. Venus passes nearer to the Earth than any other planet.

- **Earth** – Third planet from the Sun (about 150 million km). It has one moon. Earth has a thin atmosphere composed of mainly nitrogen and oxygen. Earth is located an optimal distance from the Sun to have the right temperature for water to exist in the liquid state.
- **Mars** – Fourth planet from the Sun (about 228 million km). It is orbited by two moons, Phobos and Deimos. Mars has a very thin atmosphere of carbon dioxide. Winds whip up iron-rich red dust storms, so it's often called the Red Planet. It has the largest known volcano in the solar system, and there is evidence that water once flowed on the surface.

### **Outer Planets – Gas Giants**

- **Jupiter** – Fifth planet from the Sun (about 778 million km), bigger than all the other planets in our solar system put together. It's made of gas and liquid with no solid surface. The Great Red Spot, Jupiter's most identifiable feature, is a storm at least 300 years old. Jupiter spins faster than all the other planets, so fast that it flattens out a little at the poles and bulges at the equator. The fast spin and winds cause the colored bands on its atmosphere. Jovian gravity is so strong (2.4 times that of Earth's) that any comet passing too close can be thrown out of the Solar System or pulled into orbit around Jupiter. Some believe its gravity may have prevented the birth of a planet between Jupiter and Mars. Over 60 moons have been discovered, the largest being those discovered by Galileo: Io, Europa, Ganymede and Calypso. Europa may be the only living world in the Solar System besides Earth.
- **Saturn** – Sixth planet from the Sun (about 1,427 million km), the second biggest planet. It has a rock/water core and it rains helium. It has thousands of bright rings that stretch out in thin layers around the planet. They are made of millions of chunks of rock, dust and ice that reflect the sunlight. Saturn gives off 2 ½ times more heat energy from its core than it gets from the Sun. Titan, the largest of Saturn's 60+ moons, has an atmosphere.
- **Uranus** – Seventh planet from the Sun (about 2,871 million km). An extremely cold planet, with a frozen core that possibly contains rock. The atmosphere is mainly hydrogen and helium, with methane causing it to appear light blue. Uranus seems to "roll" around the Sun, spinning on its side, perhaps due to an ancient collision with a planetary sized object. There are 27 known moons.
- **Neptune** – Eighth planet from the Sun (about 4,500 million km). It too is extremely cold, with winds reaching 2,000 km/hour, making it the windiest planet. It has an atmosphere of hydrogen and helium with methane giving it its bright blue color. One of its thirteen known moons, Triton, orbits Neptune backward (retrograde).

### **Planetoids/Dwarf Planets**

- In 2006, this classification was created to help define planets and other objects.
- A planetoid (dwarf planet) is massive enough to be spherical as a result of its own gravity, but has not cleared its neighboring region, and is not a satellite (moon) of a planet.
- Debate continues concerning the necessity of the "Dwarf Planet" category. Some advocate dwarf planets be classified as planets or asteroids.

- the International Astronomical Union (IAU) currently recognizes five Dwarf Planets—Ceres, Pluto, Haumea, Makemake, and Eris (listed by nearest to farthest from the Sun).
- While an estimated 2000 Dwarf Planets may exist, it is expected that 40 will be positively identified in the near future.
- **Ceres** – the smallest Dwarf Planet and the one found nearest the Sun. Ceres orbits within and comprises one third of the mass in the main asteroid belt. Discovered in 1801 by Giuseppe Piazzi, Ceres was considered a planet for the first 50 years, then was classified as an asteroid until 2006. It is named for the Roman goddess of growing plants, harvesting, and motherly love.
- **Pluto** – Classified as a planet from 1930-2006. Located in the Kuiper Belt, Pluto has three known moons: Charon, Nix, and Hydra. Pluto's orbit is very elliptical, bringing it closer to the sun than Neptune during part of its orbit.
- **Haumea** – (formerly known as 2003 EL<sub>61</sub>) Found in the Kuiper Belt, Haumea has two moons, Hi'aka, and Namaka. Discovered in 2003 by the team headed by Mike Brown of California Institute of Technology, although a Spanish Team announced discovery first, they did so without verification and perhaps using Brown's data. It is a Pluto-sized, football-shaped, ice-coated rock which tumbles end over end every four hours. There is a spot on Haumea's dimmer side that reflects more red light than blue. Named for the Hawaiian goddess of childbirth
- **Makemake** – (formerly known as 2005 FY<sub>9</sub>) Third largest dwarf planet, located in the Kuiper Belt, with no known moons. There is evidence that Makemake may have an atmosphere when it comes closer to the Sun. Makemake is named for the fertility god of the Rapa Nui people from Easter Island. Discovered in 2005 by Mike Brown's team.
- **Eris** – (formerly known as 2003 UB<sub>313</sub>, and/or Xena) located in the Kuiper Belt, Largest Dwarf Planet, has a very erratic orbit, one moon named Dysnomia (was Gabrielle). The discovery of Eris led to the reclassification of Pluto. Discovered in 2003 by Mike Brown's team, named for the Greek goddess of discord and strife, since there has been debate concerning who actually discovered it.
- **Sedna** – Not yet IAU recognized as a Dwarf Planet. Sedna is almost as red as Mars, has an extremely elliptical orbit, and may have one tiny moon. Located in the Oort Cloud, it never comes closer than eight billion miles to the Sun; Sedna's orbit is estimated to take 12,000 years. Standing on the surface of Sedna, you could block the entire Sun with the head of a pin held at arm's length. Named for the Inuit goddess of the sea.

	Compared to Earth					# of Moons
	Distance from Sun	Mass	Gravity	Length of Day	Length of Year	
Mercury	0.387	0.0553	0.378	175.9	0.241	0
Venus	0.723	0.815	0.907	116.8	0.615	0
Earth	1	1	1	1	1	1
Mars	1.52	0.107	0.377	1.03	1.88	2
Ceres	2.5	0.0002		0.38	4.6	0
Jupiter	5.2	317.8	2.36	0.414	11.9	63
Saturn	9.58	95.2	0.916	0.444	29.4	62
Uranus	19.2	14.5	0.889	0.718	83.7	27
Neptune	30.5	17.1	1.12	0.671	163.7	13
Pluto	39.24	0.0021	0.059	6.39	248	3
Haumea	51.5	0.0007		0.16	282.76	2
Makemake	53.1	0.0007			309.88	0
Eris	97.6	0.0025		0.3	557	1

## Integrated Curriculum:

### Language Arts

1. Determine which ancient “wanderer” each day of the week is named for.
2. Write a creative story about life on another planet. It can be based on a book such as Dr. Xargle’s Book of Earthlets.
3. Research naming of planets/planetoids.
4. Create a post card from a planet/planetoid, write a message back to family on Earth describing your experiences.
5. Research planetoids and why/how Pluto was re-classified as one.
6. Research astronomers (i.e. Copernicus/Kepler/Tombaugh) and their findings.
7. Compare the extremes: the most moons, the fastest spinning, the shortest/longest day/year; brainstorm other extremes to investigate.
8. Debate how many planets there are; give your reasoning.
9. Write a poem about how Pluto feels about being reclassified as a planetoid.
10. Research items (i.e. food, electronics, fabric) developed for space travel. How do they impact our daily lives?
11. Research people/homes/vehicles that have been hit by meteorites.
12. Write and present a weather forecast for another planet.
13. Research exoplanets
14. Create a mnemonic to remember the planets/planetoids in order.

### Math

15. Research the distance of each planet/planetoid from the sun. Calculate the distance between planets/planetoids. Create a scale model.
16. Chart/compare/contrast the diameter and circumference of each planet/planetoid.
17. Calculate the weight of an object on another planet, such as student bookbags.
18. Calculate the time to travel to another planet or sun by car or jet liner.

## **Science**

19. Compare the characteristics of planets, dwarf planets, comets and asteroids.
20. Research the development of telescopes.
21. Design and build a telescope
22. Observe the night sky using “Starlab”
23. Research space probes and the data they have collected.
24. Classify planets into different groups based on chosen criteria: number of moons, gas/rocky, location, atmosphere, volcanoes, etc.
25. Observe planets. Keep a log of observations.
26. Make craters by dropping marbles (asteroids) into a base of flour dusted with cocoa. Experiment with height, angle, and size of marbles. Measure and chart results.
27. Research Kepler’s Law; draw the two orbits.
28. Infer and describe how a ball would bounce on each planet.
29. Share some of the information satellites have gathered about the planets that could not have been known using only telescopes.
30. Research “Nemesis,” a theoretical dark companion star of our Sun.

## **Social Science**

31. Plan a Mars colony for explorers: include government, daily life, jobs and responsibilities, etc. Compare to your city/town. Make a model of the colony.
32. Debate who should be credited with the discovery of Haumea.
33. Survey 20 adults asking how many planets there are, compile class data.
34. Debate how you view space exploration as a relative priority compared with the present needs of society. Should it be governmental or privately funded?
35. Create a timeline of the “firsts” in space exploration (1<sup>st</sup> man-made satellite, 1<sup>st</sup> man in space, 1<sup>st</sup> man to walk on moon, 1<sup>st</sup> woman astronaut, etc.)
36. Create a timeline of space exploration of each planet (and moons)
37. Compare and contrast historical understandings of our solar system. (i.e. Galileo discovering Jupiter’s moons, Kepler’s study of orbits, Haley’s Comet, solar eclipses)
38. Research the medicine wheels (Bighorn, et. al.), examine how native Americans counted time

## **Fine Arts (Art and Music)**

39. Create a trivia game using facts about the sun, planets, asteroids, comets, etc
40. Construct planets of paper mache and color them accurately
41. Construct a mobile of the solar system, or a planet and its moons
42. Act out the revolutions and rotations of the sun, planets and moons.
43. Write a song that teaches about a planet (at least five facts)
44. Recreate ancient celestial ceremonies
45. Build a Stonehenge that accurately displays a solstice when light is properly positioned
46. Build a sundial (as simple a stick in the ground). Mark where the shadow falls each hour.

## Resources for Teachers:

### Books/Magazines/Videos

- [Amazing Journeys Across the Solar System](#) by Rod Theodorou
- [Astronomy in Ancient Times](#) by Isaac Asimov
- [Book of Astronomy and Space](#) Usborne by Lisa Miles and Alastair Smith, internet linked
- [Breakthroughs in Science: Astronomy](#) by Carol J. Amato
- [Calendars of Native Americans](#) by Lynn George
- [Space Circles](#) by Kerri O'Donnell
- [Did Comets Kill the Dinosaurs?](#) by Isaac Asimov
- [Don't Know Much About the Solar System](#) by Kenneth C. Davis
- [Dr. Xargle's Book of Earthlets](#) by Jeanne Willis
- [The Everything Kid's Astronomy Book](#) by Kathi Wagner and Sheryl Racine
- [Fact Scope: Universe](#) by Saddleback Educational Publishing
- [Far Planets](#) by Robin Kerrod
- [First Field Guide: Night Sky](#) by Gary Mechler
- [The Greatest Intergalactic Guide to Space Ever](#) by Carole Stott
- [How Did We Find Out About Comets?](#) by Isaac Asimov
- [The Hubble Space Telescope](#) by Greg Roza
- [Math in Our Solar System: Applying Problem-Solving Strategies](#) by Barbara Linde
- [Meteors and Meteorites: Voyagers from Space](#) by Patricia Lauber
- [The Moons of Jupiter](#) by GEMS
- [The Mystery of Mars](#) by Sally Ride and T. O'Shaugnessy
- [Near Planets](#) by Robin Kerrod
- [New Astronomer](#) by Carole Stott
- [Out of the World](#) AIMS
- [The Planet Hunters](#) by Dennis Brindell Fradin
- [The Planets in Our Solar System](#) by Franklyn M. Branley
- [Postcards from Pluto](#) by Loreen Leedy
- [Telescopes](#) by Adele Richardson
- [Tell Me Who Lives in Space?](#) Chrysalis Children's Books
- [Ten Worlds: Everything That Orbits the Sun](#) by Ken Crowell
- [Usborne Discovery: Astronomy](#) by Stuart Athinson
- [Usborne Discovery: Internet-Linked Astronomy](#) by Rachel Firth
- [Usborne Discovery: Space](#) by Ben Denne and Eileen O'Brien, internet linked
- [The Usborne First Encyclopedia of Space](#) by Paul Dowswell
- [The Usborne Internet-Linked Book of Astronomy and Space](#) by Lisa Mills and Alastair Smith
- [Women Astronomers: Reaching for the Stars](#) by Mabel Armstrong
- [11 Planets, A New View of the Solar System](#) by David A. Aguilar
- [100 Things You Should Know About Space](#) by Sue Becklake

### **Field Trips/Guest Speakers**

- Astronomer/Astronomy clubs
- Astronaut
- Woodhenge – Cahokia Mounds State Historic Site (Illinois)
- Planetarium or observatory
- Planetary society
- Storyteller
- Smithsonian Museum
- Challenger Learning Centers
- Visit a meteorite impact site

### **Internet Search/Keywords**

- International Astronomical Union (IAU)
- Mike Brown's Planets
- Woodhenge
- Barringer meteor crater
- Oort Cloud
- Kuiper Belt
- Karman Line
- Nemesis (possible companion star)
- [nasa.gov](http://nasa.gov)

### **Related Simulations:**

- Conic Sections
- Lunar Landings

### **Illinois Learning Standards:**

12. Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.  
12.F.1a, 12.F.2a, 12.F.3b

### **Illinois Assessment Frameworks:**

- **Astronomy**  
Identify the order of planets from the Sun...  
12.4.47  
Understand the objects in the solar System...regular and predictable motion...  
12.7.91  
Identify the differences among the planets in our solar system...  
12.7.93

Applying Bloom's Taxonomy Across the Curriculum					
	Language Arts	Math	Science	Social Science	Fine Arts
Evaluation	Activity #7			#29, 31	
Synthesis	# 1, 3,11	#14	# 19		# 40, 41, 42
Analysis	#2, 4, 5, 6, 9, 10,12	#15	# 18, 21, 22, 23, 24, 25, 28	#30, 34, 35	# 43, 38, 39
Application	#8		# 20, 26		# 36, 37
Comprehension	#13	#16, 17	#27	#32, 33	
Knowledge					