And then there were eight

This past summer the International Astronomical Union (IAU) approved new definitions for objects in our solar system that orbit the Sun. The definitions now allow for only eight planets, while objects smaller than planets will be known as *dwarf planets*, and those even smaller will be referred to as *small solar system bodies*. Most notable of the changes was the redefinition of *planet* and the subsequent transfer of Pluto from planetary status to its new designation as a dwarf planet; Pluto's large moon, Charon, will now be known as a small solar system body. In addition to Pluto, the new dwarf planet category includes the former asteroid 1 Ceres, and another trans-Neptunian object previously known as 2003 UB313 and now officially named Eris. Trans-Neptunian objects (TNOs) are those solar system objects that have orbits ranging from the orbit of Neptune outward. This region of the solar system is further subdivided by distance into Kuiper belt objects, the scattered disk region, and the very distant Oort cloud.

While there may be some confusion and even some concern over the new definitions and reclassification of objects, the goals of these changes are to acknowledge newly discovered and potential future discoveries of TNOs in the distant regions of our solar system and to bring some clarity to how solar system objects should be grouped based on properties and orbits.

The planets

The eight planets are easily remembered with the old standby mnemonic: **M**y **V**ery **E**ntertaining **M**other **J**ust **S**erved **U**s **N**oodles (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune). The eight planets, as a group, have at least two properties in common, especially with regard to their orbits—*inclination* and *eccentricity*. The inclination is a measure in degrees that an object is from the Earth's orbit, or the plane of the ecliptic. Using that as a reference, all of the planets are within approximately seven degrees from the plane of the ecliptic with Mercury having the greatest inclination and Uranus the least. Eccentricity of the orbit is a measure of how circular or noncircular the shape of the orbit is. Using values ranging from zero to one, a zero value for eccentricity is a circle, while the closer to one, the more elliptical the orbit. With the exception of Mercury, the planets essentially have nearly circular-shaped orbits.

Current information about the planets, dwarf planets, and small solar system bodies is provided in Figure 1. The distances to the Sun are given as astronomical units (AU), where one AU is equal to the average Earth to Sun distance. The distances are measured at the object's *perihelion* (minimum distance from the Sun) and *aphelion* (maximum distance from the Sun).

Dwarf planets

This is a new category of solar system objects and currently has three members, although it is anticipated that new members will be added as the techniques for discovering these objects improve. Pluto, the second largest of the known dwarf planets, orbits the Sun (which takes approximately 248 years) with its half-sized near-twin companion, the moon Charon. While they are considered to be a binary system due to the closeness of their respective sizes and the location of the barycenter in space between them, there is no definition for a *dwarf planet binary system*. As a result, Charon is classified as a small solar system body orbiting a dwarf planet. The two follow an orbit around the Sun that is more consistent with other small solar system bodies and comets. The inclination of Pluto is great enough that Pluto can come closer to the Sun than Neptune, and most recently did so between 1979 and 1999.

Ceres, formerly, the largest of the asteroids, is now known as dwarf planet 1 Ceres. It has gone through several identity changes since its discovery in 1801 by Italian astronomer Giuseppe Piazzi. With a diameter of just under 1,000 km, 1 Ceres was originally described as a planet, then later reclassified as an asteroid. Following the new IAU definitions it is now a dwarf planet. The number *1* signifies that it was the first of these objects to be discovered.

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Questions for students

1. Use the websites from the Resources to learn more about names for planets, dwarf planets, and small solar system bodies.
2. From Figure 1, determine which of the three groups of solar system objects appears to have the greatest eccentricity and inclination. Which solar system object has the greatest inclination? Which has the greatest orbital eccentricity? *(From the data provided, both small bodies and dwarf planets appear to have the greatest inclination, while small bodies appear to have the greatest eccentricity of the three groups. Sedna has the greatest eccentricity, while Eris has the greatest inclination.)*
3. After answering the previous question, do you see any patterns or similarities? Describe the pattern or patterns you see. *(Most of the small bodies seem to be farther away from the plane of the ecliptic than other objects listed.)*
4. Do we have enough data to draw conclusions about the distribution of the solar system objects? Explain your answer. *(We do not have enough data to make any conclusions about the distribution of the small bodies and dwarf planets. After more objects are located and their orbits plotted, a better understanding of how they are distributed should be possible.)*
5. Is Pluto no longer a planet? *(As a dwarf planet, Pluto is still a planet, just as a dwarf star is still a star. In effect, we have a solar system composed of 11 planets, 8 of which are the traditional planets, and 3 of which are dwarf planets.)*

FIGURE 1 **Official names and orbital information for solar system objects**

Official name	IAU designation	Diameter (km)	Perihelion-Aphelion (AU)	Orbital eccentricity	Orbital inclination
Mercury	Planet	4,880	0.307–0.466	0.205	7.0°
Venus	Planet	12,104	0.718–0.728	0.007	3.4°
Earth	Planet	12,757	0.983–1.016	0.016	0.0°
Mars	Planet	6,805	1.381–1.665	0.093	1.8°
1 Ceres	Dwarf planet	975	2.544–2.987	0.080	10.6°
Jupiter	Planet	142,984	4.951–5.455	0.048	1.3°
Saturn	Planet	120,526	9.020–10.053	0.054	2.5
Uranus	Planet	51,118	18.286–20.096	0.047	0.8°
Neptune	Planet	49,528	29.810–30.327	0.008	1.8
Pluto Charon	Dwarf planet Small body	2,320 1,205	29.658–49.305	0.248 -----	17.1° ------
90482 Orcus	Small body	1,500	30.53–48.31	0.225	20.5°
(136108) 2003 EL61	Small body	1,500	35.164–51.526	0.189	28.2°
136199 Eris	Dwarf planet	2,400	37.77–97.56	0.442	44.2°
50000 Quaoar	Small body	1,260	41.914–44.896	0.034	7.98°
Sedna	Small body	1,180–1,800	76.156–975.056	0.855	11.9°

The largest of the known dwarf planets is the object named Eris. Slightly larger than Pluto, Eris is a TNO orbiting the Sun at the outer fringes of the Kuiper belt. Traveling around the Sun in approximately 558 years with at least one moon (Dysnomia), Eris, when discovered, was near its maximum distance from the Sun and is currently the most distant solar system object. Eris has a very eccentric shape to its orbit and has the greatest inclination of these objects.

Small solar system bodies

All other objects in the solar system that orbit the Sun, other than natural satellites and Charon, are collectively known as *small solar system bodies*. This group includes asteroids, comets, and many of the TNOs. Quaoar orbits within the area between Pluto's aphelion and perihelion distances and has an orbital period of approximately 285 years. Interestingly, its orbital eccentricity and inclination are more similar to the planets than other TNOs.

Two of the largest small solar system bodies, 2003 EL61 and Orcus, are about the same size and both orbit the Sun following elliptical paths that lie in the region between Neptune and slightly past the aphelion distance for Pluto. EL61 has two small moons and takes 285 years to complete one revolution around the Sun. Orcus has no moons, or at least none have been detected so far, and orbits the Sun in approximately the same amount of time as Pluto.

Sedna, possibly the largest small solar system body, is estimated to have a diameter about the same size as Orcus or slightly larger. Orbiting within the scattered disk region, Sedna is a TNO with a 12,000-year orbital period and an extremely elliptical orbital shape that takes it as far out as 975 AU and as close as about 76 AU. At aphelion, Sedna may be within the inner region of the Oort cloud, a spherical area around the solar system thought to contain icy remnants from the original nebula that the formed solar system. The Oort cloud is considered to be the source of comets that come into the inner solar system.

Visible planets

- Mercury will move from superior conjunction, behind the Sun, to the evening skies and will be visible over the southwestern horizon after sunset toward the last half of the month.
- Venus will set one to two hours after the Sun and will become increasingly brighter and more noticeable over the western horizon.

The January "Old Moon" this month

Date	Moon event
1/3	Full Moon Right ascension: 6^h50^m, Declination: 27°1'
1/8	Descending node Illuminated fraction: 0.77
1/10	Apogee Distance: 404,337 km Apparent size: 0.4926°
1/11	Last quarter Right ascension: 12^h51^m, Declination: -8°22'
1/18	New Moon Right ascension: 19^h40^m, Declination: -26°36'
1/22	Perigee Distance: 366,932 km Apparent size: 0.5428° Ascending node Illuminated fraction: 0.13%
1/25	First quarter Right ascension: 1^h44^m, Declination: 13°39'

- Mars will rise about two hours before the Sun but, due to its distance, will be faint and difficult to see until later this spring.
- Jupiter will rise two to three hours before the Sun and will be about six degrees to the left of Antares, the reddish star marking the heart of Scorpius.
- Saturn will rise about two to three hours after sunset and will be about five degrees west from Regulus in Leo, moving in retrograde toward the west, away from Regulus.

Resources

SFA star charts—*observe.phy.sfasu.edu*

Daily Moon rise and set—*aa.usno.navy.mil/data/docs/RS_OneDay.html*

Monthly Sun and Moon rise and set—*www.sunrisesunset.com/custom_srss_calendar.asp*

IAU—*www.iau2006.org/mirror/www.iau.org/iau0603/index.html*

NASA Solar System exploration—*sse.jpl.nasa.gov/index.cfm*

How the planets and satellites got their names—*www.factmonster.com/ipka/A0875452.html*

Planetary linguistics—*www.seds.org/billa/tnp/days.html*

USGS Astrogeology—*planetarynames.wr.usgs.gov/append7.html*