A PERIODIC TABLE FOR THE PLANETS

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Building on the precedent set by the periodic table of elements for providing useful information at a glance for a large number of subjects, the table of planets depicts the Solar System's wide array of geophysical planets with useful dynamical and compositional information.

I. INTRODUCTION

I.A. The Geophysical Definition

The geophysical definition of a planet is as follows:[1]

> A planet is a sub-stellar mass body that has never undergone nuclear fusion and that has sufficient self-gravitation to assume a spheroidal shape adequately described by a triaxial ellipsoid regardless of orbital parameters.

This definition focuses foremost on the intrinsic qualities of an object in question with two key points. First, the object having never undergone nuclear fusion distinguishes it from stars (which fuse ^{1}H and heavier nuclides), brown dwarfs (which likely fuse ^{2}H and sometimes ^{7}Li), and stellar remnants (white dwarfs, neutron stars, and black holes). Second, the object must have a round shape achieved through self-gravitation. When objects have a sufficiently large mass, their combined gravity can overcome the mechanical strength of their material substituents and pull the object into a spheroidal shape. The stronger an object's material, and the slower its rotational period, the more spherical it will be. The weaker an object's material, and the faster its rotational period, the more oblate and ellipsoidal it will be. Regardless, a mass threshold depending on material composition will give a celestial object a spheroidal shape, a condition called hydrostatic equilibrium. Objects below this threshold are typically irregular.

While the first point provides a fairly clear and objective condition (the presence or absence of nuclear fusion within the object at some point in its existence), the second point is intentionally more lax and inclusive. While an individual rock or pile of gravel orbiting the sun would be called a planet by no one, and the Earth is accepted as a planet by all, the distinction between small, irregular objects and gravitationally rounded bodies is not always clear-cut. Judging whether an object's shape satisfies the hydrostatic equilibrium condition depends on precise knowledge of its size, mass, internal composition, rotational period, and other factors. As such, an object that initially formed with an equilibrium shape may later fall out of equilibrium if its rotational period changes, its shape is eroded by impacts, etc. While some earlier physical definitions explicitly mention the hydrostatic equilibrium condition,[2] the revised geophysical definition leaves the precise amount of gravitational roundness open for debate and interpretation. After all, objects like Mercury and Venus deviate from ideal hydrostatic equilibrium, and no planetary body has a perfectly smooth, ideal shape.[3]

I.B. Subjectivity of the Planet Taxon

Why require roundness as a condition for planethood? Gravitationally rounded objects tend to have qualitative differences with smaller, irregular objects such as greater internal differentiation and geological complexity. These are admittedly subjective points, but the distinction can be useful in planetary science. While the study of sub-planetary objects like irregular asteroids and comets is certainly important for planetary science and gaining knowledge of planetary formation, gravitationally rounded objects may be said to be more interesting for study on an individual basis. This is also in line with the Earth-analogous, cultural view of planets as globe-shaped worlds.

A taxon like planet, in absence of purely objective attributes (like the quantized differences between fundamental particles), is inevitably a subjective term used for its helpfulness in categorizing the natural world, just as the species taxon is used to distinguish between different organisms based on subjectively chosen qualities useful to biologists, like the general inability of two species to produce fertile offspring. The occasional fertility of interspecies hybrids, such as mules rarely being able to produce offspring with horses or donkeys, does not invalidate the species taxon, which is still generally useful and was never objective to begin with.[4] Taxa are tools for helping humans understand the relationships between natural phenomena and are not themselves natural laws.

As such, the geophysical planet definition provides an alternative to the International Astronomical Union's planet definition without requiring the latter to be invalidated or disused. The IAU definition defines a planet in the Solar System as an object that:[5]

1. is in orbit around the Sun,
2. has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape and,
3. has cleared the neighborhood around its orbit.

While the utility of these points can be debated, such as the definition being limited to our Solar System, or the precise definition of clearing the "neighborhood around its orbit", the IAU definition is not wrong, as it is merely another subjective definition. As opposed to the geophysical definition, the IAU voted for a dynamical definition that focuses on the arrangements of objects in gravitationally determined populations. While numerous objects exist in populations like the main asteroid belt, the Jupiter trojans, and the Kuiper belt, the eight IAU planets stand out as relatively solitary objects that have a more dominating gravitational influence on the objects around them than those objects have on each other. While it is true that the Earth wouldn't "clear its neighborhood" if it were past Neptune's orbit, this is irrelevant to the IAU definition which is concerned with orbital dynamics and populations.

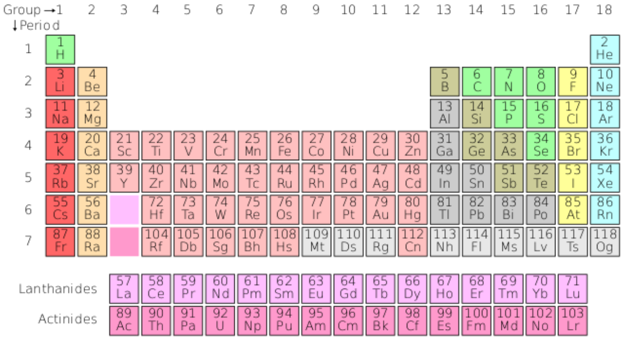
For those more interested in the intrinsic features of individual worlds than their orbital parameters, the geophysical definition may be more intuitive and useful. It may also serve to better educate the public on the incredible diversity of the Solar System rather than consigning objects other than the eight IAU planets to obscurity.

I.C. Pedagogical Precedence

A purported benefit of the IAU definition is that it results in there being only eight canonical planets: four inner, terrestrial planets (Mercury, Venus, Earth, Mars) and four outer, giant planets (Jupiter, Saturn, Uranus, Neptune). Eight planets are relatively easy to depict visually (if one disregards a consistent scale of their sizes and the distances between them) in simple diagrams dubbed "planetary placemats" by astronomer Mike Brown.[6] While certainly of some educational use, these diagrams show little more than the planets' names, appearances, a very rough sense of their relative size, and their order from the Sun. This can be expanded upon through use of scaled diagrams to depict the planets' sizes or orbits, but planetary placemats are ubiquitous given their comparative simplicity and approachability.

Fig 1. Example of a "planetary placemat" diagram made before IAU Resolution B5 in 2006.[6] Note that neither the sizes nor orbits of the planets are depicted to scale.

With the geophysical definition, the number of planets is well beyond eight (possibly in the hundreds), making a geophysical planetary placemat very crowded. This may be cited as a mark against the geophysical definition, that it is too difficult for students to learn about so many planets, but this argument may be dubious. While there are 118 known chemical elements, all of these elements are depicted, alongside some useful bits of information like proton number, standard atomic weight, etc., in the periodic table, a staple of scientific education included in classrooms and textbooks everywhere.



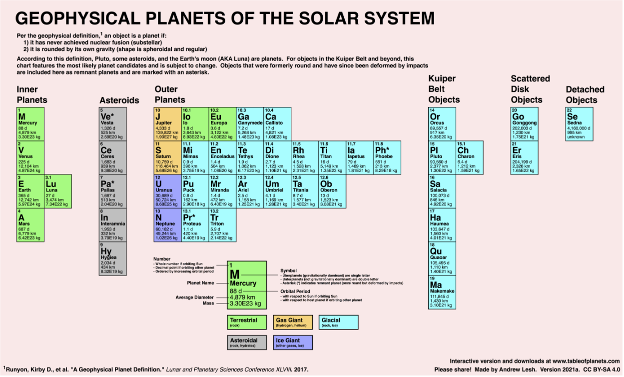
Group → ↓Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba		72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra		104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Ms	116 Lv	117 Ts	118 Og
Lanthanides			57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
Actinides			89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

Fig 2. The periodic table of chemical elements. (public domain image by Wikimedia user Cepheus)

While no high school chemistry student is expected to memorize the names and characteristics of every element, they will probably learn about a few standout elements (e.g., Hydrogen, Carbon, Oxygen, Nitrogen, etc.) and the properties of different groups of elements (e.g., alkali metals, transition metals, metalloids, noble gases, halogens, etc.). Since Dmitri Mendeleev's conception of the table in 1869, the periodic table has done a masterful job of depicting a large number of subjects in a simple, intuitive way useful as an educational and professional reference.

II. THE TABLE OF PLANETS

The "table of planets" builds on the precedent set by the periodic table to simply depict the large number of geophysical planets based on their compositional and dynamical attributes. Like the periodic table, the table of planets features numbers, symbols, vertically organized families, and other useful groupings. The table provided in this article includes 44 planets, but just as the periodic table has expanded with each elemental discovery, the table of planets can be revised and updated.



GEOPHYSICAL PLANETS OF THE SOLAR SYSTEM

Per the geophysical definition,[1] an object is a planet if:
1) it has never achieved nuclear fusion (substellar)
2) it is rounded by its own gravity (shape is spheroidal and regular)

According to this definition, Pluto, some asteroids, and the Earth's moon (AKA Luna) are planets. For objects in the Kuiper Belt and beyond, this chart features the most likely planet candidates and is subject to change. Objects that were formerly round and have since been deformed by impacts are included here as remnant planets and are marked with an asterisk.

Inner Planets
1 M Mercury 88 d 4,879 km 3.30E23 kg
2 V Venus 225 d 12,104 km 4.87E24 kg
3 E Earth 365 d 12,742 km 5.97E24 kg
3.1 Lu Luna 27 d 3,474 km 7.34E22 kg
4 A Mars 687 d 6,779 km 6.42E23 kg

Asteroids
5 Ve* Vesta 1,326 d 525 km 2.59E20 kg
6 Ce Ceres 1,683 d 939 km 9.38E20 kg
7 Pa* Pallas 1,687 d 513 km 2.04E20 kg
8 In Interamnia 1,953 d 332 km 3.79E19 kg
9 Hy Hygiea 2,034 d 434 km 8.32E19 kg

Outer Planets
10 J Jupiter 4,333 d 139,822 km 1.90E27 kg
10.1 Io Io 1.8 d 3,643 km 8.93E22 kg
10.2 Eu Europa 3.6 d 3,122 km 4.80E22 kg
10.3 Ga Ganymede 7.2 d 5,268 km 1.48E23 kg
10.4 Ca Callisto 17 d 4,821 km 1.08E23 kg
11 S Saturn 10,759 d 116,464 km 5.68E26 kg
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11.2 En Enceladus 1.4 d 504 km 1.08E20 kg
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11.5 Rh Rhea 4.5 d 1,528 km 2.31E21 kg
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12.4 Um Umbriel 4.1 d 1,169 km 1.28E21 kg
12.5 Ta Titania 8.7 d 1,577 km 3.40E21 kg
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Kuiper Belt Objects
14 Or Orcus 89,557 d 917 km 6.35E20 kg
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19 Ma Makemake 111,845 d 1,430 km 3.10E21 kg

Scattered Disk Objects
20 Go Gonggong 202,003 d 1,230 km 1.75E21 kg
21 Er Eris 204,199 d 2,326 km 1.65E22 kg

Detached Objects
22 Se Sedna 4,160,000 d 995 km unknown

Number
- Whole number if orbiting Sun
- Decimal point if orbiting other planet
- Ordered by increasing orbital period

Planet Name
Average Diameter
Mass

1 M Mercury 88 d 4,879 km 3.30E23 kg

Symbol
- Überplanets (gravitationally dominant) are single letter
- Unterplanets (not gravitationally dominant) are double letter
- Asterisk (*) indicates remnant planet (once round but deformed by impacts)

Orbital Period
- with respect to Sun if orbiting Sun
- with respect to host planet if orbiting other planet

Terrestrial (rock)
Gas Giant (hydrogen, helium)
Glacial (rock, ice)
Asteroidal (rock, hydrates)
Ice Giant (other gases, ice)

[1] Runyon, Kirby D., et al. "A Geophysical Planet Definition." *Lunar and Planetary Sciences Conference XLVIII*. 2017.

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Fig 3. The table of planets. A larger figure is included in the addendum.

II.A. Planet Number

Each planet is assigned a number based on increasing orbital period (chosen as a compromise between periapsis and semi-major axis). The number is whole if the planet directly orbits the sun (e.g., Mercury = 1, Venus = 2). If the planet orbits another planet, it takes the host planet's number, with a second number added after a decimal point to signify increasing orbital period with respect to the host planet (e.g., Earth = 3, Earth's Moon AKA Luna = 3.1).

II.B. Planet Symbol

Each planet is given an abbreviated symbol based on its name. Planets with a single letter symbol are überplanets based on the dynamical classification of Stern and Levison, meaning that they clear their neighboring regions of planetesimals (e.g., Earth = E, Jupiter = J).[2] Every überplanet's symbol is the first letter of its name, except for Mars with symbol A. This is because M is already taken by Mercury, A is the second letter of Mars, and A is the first letter of Ares, the Greek name of Mars. All other planets have a double letter symbol (e.g., Ceres = Ce, Europa = Eu). This abbreviation system helps depict at a glance the dynamical characteristic valued by the IAU and many astronomers.

II.C. Dynamical Families

Planets in direct solar orbit are placed in columns, each depicting a dynamical family. Satellite planets are placed in rows alongside their host planet. The traditional terrestrial planets and Luna are organized in the inner planet family. Asteroid planets (including Ceres) are in the asteroid family. The giant planets and their satellite planets are in the outer planet family. Trans-Neptunian planets are distributed between the Kuiper belt, scattered disk, and detached families.

II.D. Compositional Types

Each planet is given a compositional type. Terrestrial planets are chiefly composed of rock, asteroidal planets of rock and hydrates, gas giants of hydrogen and helium, ice giants of other gases and ices, and glacial planets of rock and ice. All trans-Neptunian objects are currently categorized as glacial planets, as are all satellite planets except for Luna, Io, and Europa. While Europa is covered in ice, it has a predominantly rocky composition and an average density (3.02 g/cm^3) closer to those of other terrestrial planets (e.g., Luna = 3.34 g/cm^3) than the glacial planets (e.g., Ganymede = 1.94 g/cm^3).

II.E. Remnant Planets

Some objects are included as "remnant planets" and their symbol is marked with an asterisk. An interesting edge case of the geophysical definition exists with objects that originally formed with a spheroidal, equilibrium shape but have since been deformed by impacts. While it can be argued that these objects are not planets by the geophysical definition, their inclusion helps draw attention to interesting objects at the edge of the planet taxon that are certainly of greater individual interest than most sub-planetary objects. The asteroids Vesta and Pallas are included on this basis, as are the Saturnian moon Phoebe and the Neptunian moon Proteus.[7,8,9,10]

It is also up for debate whether these objects are still spheroidal enough to be considered planets outright, given that the geophysical definition sets no specific criterion for roundness other than the object being "adequately described by a triaxial ellipsoid", with the precise meaning of "adequately described" being left open to interpretation. Regardless, the study of remnant planets may help elucidate the processes of planetary formation in ways that other objects cannot and their inclusion in the table helps indicate their scientific value.

While the Saturnian moon Hyperion is intermediate in diameter between the remnant planets Proteus and Phoebe, Hyperion's shape is highly irregular. Its porosity is quite high with a void fraction of approximately 0.46, indicating that its accretion is quite loose.[11] It is possible that Hyperion is the result of fragments from the breakup of a much larger, spheroidal proto-Hyperion loosely reaccreting (with other fragments impacting neighboring Titan with which Hyperion is in a 3:4 mean-motion resonance).[12] For these reasons, Hyperion is merely regarded as a large sub-planetary object, as it is not itself a bombarded spheroid, but reaccreted debris. It may be argued that the remnant planet concept should be expanded to include this case, and later versions of the table may reflect this.

II.F. Other Notable Inclusions (Hygiea, Interamnia, Puck, and Trans-Neptunian Objects)

In addition to the inclusion of the remnant planets Vesta and Pallas, the asteroids 10 Hygiea and 704 Interamnia are included as planets outright. While Ceres is the only asteroid currently regarded by the IAU as a dwarf planet, Hygiea and Interamnia (the fourth and fifth most massive asteroids, respectively) have been recently found to have regular spheroidal shapes. Hygiea has a nearly spherical shape according to observations with the VLT/SPHERE instrument, while Interamnia's spheroidal shape is consistent with an object that formed in hydrostatic equilibrium before having its rotational period changed.[13,14] The next largest asteroids, 52 Europa and 511 Davida, appear to have significant departures from an ellipsoidal shape.[14] Regardless, asteroids in addition to Hygiea and Interamnia may soon be revealed as planets (remnant or outright) as observations improve.

Despite its diminutive size with a mean diameter of 162 km, the Uranian moon Puck is also included as a planet. Discovery images taken by Voyager 2 show that the object is quite spherical with "a polar radius at least 95% of b and an axes ratio b/a of 0.97 ± 0.04".[15] While little is known about Puck aside from its shape and icy composition, this currently smallest planet is included in the table barring further information that would result in its reclassification.

Of the trans-Neptunian objects, several of the largest bodies have been included alongside the planets Pluto and Charon. This includes the remaining IAU dwarf planets Eris, Makemake, and Haumea as well as Orcus, Salacia, Quaoar, Gonggong, and Sedna. Including these objects and not more was a subjective choice, given the relative confidence that these objects are large and massive enough to have spheroidal shapes. While there may be hundreds and perhaps thousands of trans-Neptunian planets, there is reason to believe that most candidate objects with diameters below 1000 km may be too porous to have reached shapes near equilibrium, given their low densities.[16] This means even trans-Neptunian objects as large as Orcus and Salacia may not be planets. Regardless, more observations are required of these distant, poorly understood objects and the table is certainly open to revision. Perhaps even the largest centaurs will one day be known as planets, with objects such as 10199 Chariklo, (523727) 2014 NW_{65}, and 2060 Chiron having diameters above 200 km and being listed as possible dwarf planets by Mike Brown.[17]

III. CONCLUSION

The table of planets is offered as a simple way of displaying information about the wide array of geophysical planets that is useful at a glance. Regardless of whether one wants to exclude remnant planets or include more trans-Neptunian objects they feel have a sufficient likelihood of being round, the table of planets framework can be easily adapted. Dynamical families can be added (such as dividing Kuiper belt objects into cubewanos and resonant objects), compositional types can be changed, the numbers can be ordered with increasing periapsis instead of orbital period, etc. The framework can easily accompany whatever specific information is desired just as different versions of the periodic table display different parameters of interest for the chemical elements. Whether alone or alongside other visual aids, the table of planets can help reveal the organization and diversity of our increasingly observed, but ever mysterious, Solar System.

ACKNOWLEDGMENTS

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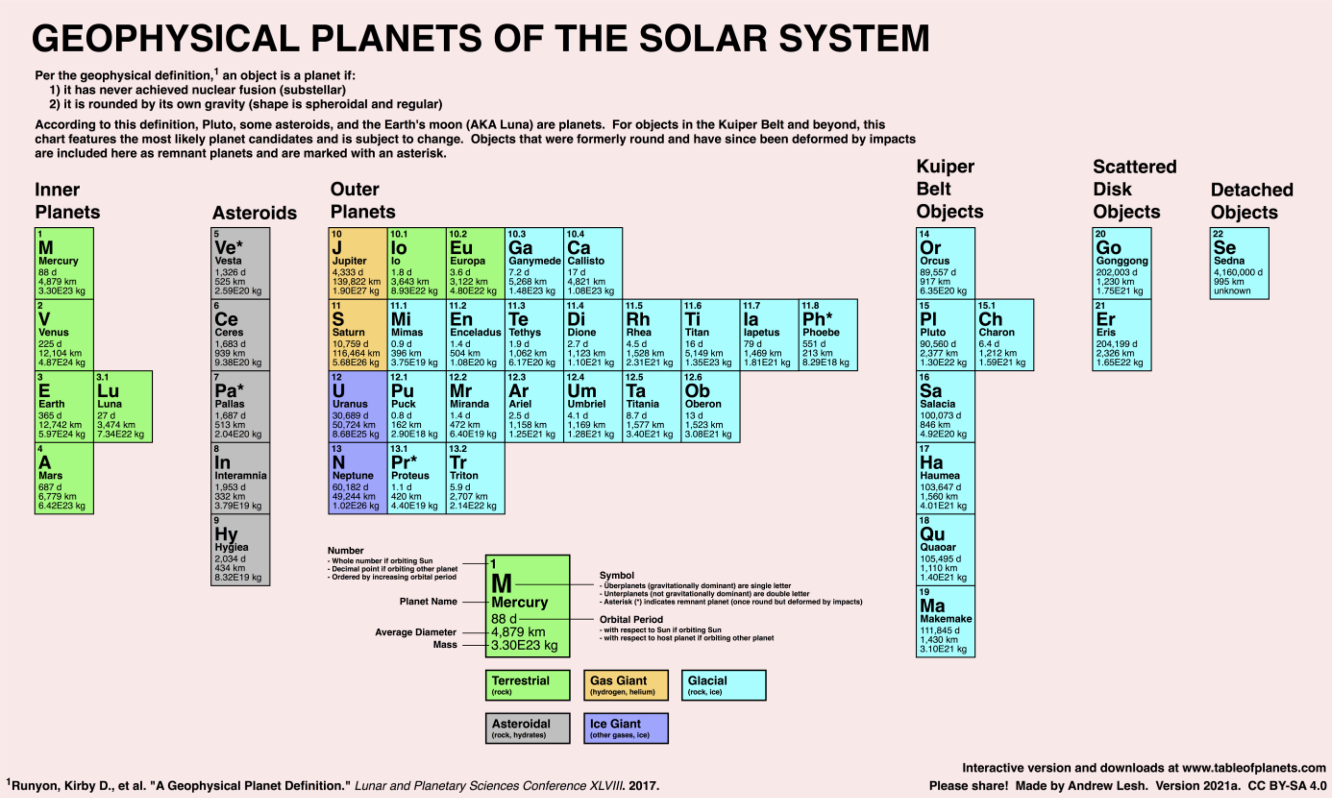
REFERENCES

1. Runyon, Kirby D., S. A. Stern, T. R. Lauer, W. Grundy, M. E. Summers, and K. N. Singer. "A geophysical planet definition." In Lunar and Planetary Science Conference, no. 1964, p. 1448. 2017.
2. Stern, S. Alan, and Harold F. Levison. "Regarding the criteria for planethood and proposed planetary classification schemes." Highlights of Astronomy 12 (2002): 205-213.
3. Burša, M. "Secular Love numbers and hydrostatic equilibrium of planets." Earth, Moon, and Planets 31, no. 2 (1984): 135-140.
4. Savory, Theodore H (1970). "The Mule". Scientific American. 223 (6): 102–109.
5. "Resolution B5: Definition of a Planet in the Solar System". Resolutions of the 26th General Assembly of the International Astronomical Union. (2006)
6. Brown, Michael E. "Planetary Placemats". Mike Brown's Planets (2009).
7. Rayman, Marc D., and Robert A. Mase. "Dawn′s exploration of Vesta." Acta Astronautica 94, no. 1 (2014): 159-167.
8. Marsset, Michaël, Miroslav Brož, Pierre Vernazza, Alexis Drouard, Julie Castillo-Rogez, Josef Hanuš, Matti Viikinkoski et al. "The

violent collisional history of aqueously evolved (2) Pallas." Nature Astronomy 4, no. 6 (2020): 569-576.

9. Castillo-Rogez, Julie C., T. V. Johnson, P. C. Thomas, M. Choukroun, D. L. Matson, and J. I. Lunine. "Geophysical evolution of Saturn’s satellite Phoebe, a large planetesimal in the outer Solar System." Icarus 219, no. 1 (2012): 86-109.
10. Croft, Steven K. "Proteus: Geology, shape, and catastrophic destruction." Icarus 99, no. 2 (1992): 402-419.
11. Thomas, Peter C., J. W. Armstrong, S. W. Asmar, Joseph A. Burns, Tilmann Denk, B. Giese, Paul Helfenstein et al. "Hyperion's sponge-like appearance." Nature 448, no. 7149 (2007): 50-53.
12. Farinella, P., F. Marzari, and S. Matteoli. "The disruption of Hyperion and the origin of Titan's atmosphere." The Astronomical Journal 113 (1997): 2312.
13. Vernazza, Pierre, Laurent Jorda, Pavel Ševeček, Miroslav Brož, Matti Viikinkoski, Josef Hanuš, Benoît Carry et al. "A basin-free spherical shape as an outcome of a giant impact on asteroid Hygiea." Nature Astronomy 4, no. 2 (2020): 136-141.
14. Hanuš, Josef, Pierre Vernazza, Matti Viikinkoski, Marin Ferrais, Nicolas Rambaux, Edyta Podlewska-Gaca, Alexis Drouard et al. "(704) Interamnia: a transitional object between a dwarf planet and a typical irregular-shaped minor body." Astronomy & Astrophysics 633 (2020): A65.
15. Karkoschka, Erich. "Voyager's eleventh discovery of a satellite of Uranus and photometry and the first size measurements of nine satellites." Icarus 151, no. 1 (2001): 69-77.
16. Grundy, W. M., K. S. Noll, M. W. Buie, S. D. Benecchi, D. Ragozzine, and H. G. Roe. "The mutual orbit, mass, and density of transneptunian binary G!kúnǁ'hòmdímà (229762 2007 UK126)." Icarus 334 (2019): 30-38.
17. Brown, Michael E. "How many dwarf planets are there in the outer solar system? (updates daily)". California Institute of Technology. Accessed March 2021.

ADDENDUM



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2 **V** **Venus** 225 d 12,104 km 4.87E24 kg	
3 **E** **Earth** 365 d 12,742 km 5.97E24 kg	3.1 **Lu** **Luna** 27 d 3,474 km 7.34E22 kg
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Outer Planets

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11 **S** **Saturn** 10,759 d 116,464 km 5.68E26 kg	11.1 **Mi** **Mimas** 0.9 d 396 km 3.75E19 kg	11.2 **En** **Enceladus** 1.4 d 504 km 1.08E20 kg	11.3 **Te** **Tethys** 1.9 d 1,062 km 6.17E20 kg	11.4 **Di** **Dione** 2.7 d 1,123 km 1.10E21 kg	11.5 **Rh** **Rhea** 4.5 d 1,528 km 2.31E21 kg	11.6 **Ti** **Titan** 16 d 5,149 km 1.35E23 kg	11.7 **Ia** **Iapetus** 79 d 1,469 km 1.81E21 kg	11.8 **Ph*** **Phoebe** 551 d 213 km 8.29E18 kg
12 **U** **Uranus** 30,689 d 50,724 km 8.68E25 kg	12.1 **Pu** **Puck** 0.8 d 162 km 2.90E18 kg	12.2 **Mr** **Miranda** 1.4 d 472 km 6.40E19 kg	12.3 **Ar** **Ariel** 2.5 d 1,158 km 1.25E21 kg	12.4 **Um** **Umbriel** 4.1 d 1,169 km 1.28E21 kg	12.5 **Ta** **Titania** 8.7 d 1,577 km 3.40E21 kg	12.6 **Ob** **Oberon** 13 d 1,523 km 3.08E21 kg		
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Kuiper Belt Objects

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16 **Sa** **Salacia** 100,073 d 846 km 4.92E20 kg	
17 **Ha** **Haumea** 103,647 d 1,560 km 4.01E21 kg	
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21 **Er** **Eris** 204,199 d 2,326 km 1.65E22 kg

Detached Objects

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Number
- Whole number if orbiting Sun
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- Ordered by increasing orbital period

Planet Name

Average Diameter

Mass

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M
Mercury
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Symbol
- Überplanets (gravitationally dominant) are single letter
- Unterplanets (not gravitationally dominant) are double letter
- Asterisk (*) indicates remnant planet (once round but deformed by impacts)

Orbital Period
- with respect to Sun if orbiting Sun
- with respect to host planet if orbiting other planet

Terrestrial (rock)
Gas Giant (hydrogen, helium)
Glacial (rock, ice)
Asteroidal (rock, hydrates)
Ice Giant (other gases, ice)

[1] Runyon, Kirby D., et al. "A Geophysical Planet Definition." *Lunar and Planetary Sciences Conference XLVIII*. 2017.