Tropical Astrology

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To Urania, our heavenly muse.

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Zodiac

Order	Sign	Meaning	Referent	Symbol	Constellation	Sign Ruler (Domicile)	Starts	Classical Element	Alchemical Process
1	Aries	Ram	the golden-fleeced ram that rescued Phrixus and Helle	♈	Aries	Mars	on the northward equinox	fire (🜂)	calcination
2	Taurus	Bull	the form that Zeus took in order to seduce Europa	♉	Taurus	Venus	1/3 between the northward equinox and the northern solstice	earth (🜃)	congelation
3	Gemini	Twins	Castor and Pollux	♊	Gemini	Mercury	2/3 between the northward equinox and the northern solstice	air (🜁)	fixation
4	Cancer	Crab	the giant crab that Heracles killed	♋	Cancer	Moon	on the northern solstice	water (🜄)	dissolution (🝁, 🝂)
5	Leo	Lion	the Nemean lion that Heracles killed	♌	Leo	Sun	1/3 between the northern solstice and the	fire (🜂)	digestion

							southward equinox		
6	Virgo	Virgin	Astraea	♍	Virgo	Mercury	2/3 between the northern solstice and the southward equinox	earth (🜃)	distillation (🝪)
7	Libra	Balance	the scales of justice held by Astraea, Dike, Themis and Justitia	♎	Libra	Venus	on the southward equinox	air (🜁)	sublimation (🝞, 🝟)
8	Scorpio	Scorpion	the giant scorpion that killed Orion	♏	Scorpius	Mars	1/3 between the southward equinox and the southern solstice	water (🜄)	separation
9	Sagittarius	Archer	the satyr Krotos	♐	Sagittarius	Jupiter	2/3 between the southward equinox and the southern solstice	fire (🜂)	ceration
10	Capricorn	Horned Goat	the sea-goat form that Pan took in order to escape Typhon	♑	Capricornus	Saturn	on the southern solstice	earth (🜃)	fermentation (🝊)
11	Aquarius	Water-Carrier	Ganymede	♒	Aquarius	Saturn	1/3 between the southern solstice and the northward equinox	air (🜁)	multiplication
12	Pisces	Fishes	the ichthyocentaurs Aphros and Bythos who carried Aphrodite from the sea	♓	Pisces	Jupiter	2/3 between the southern solstice and the northward equinox	water (🜄)	projection

Note that astrology's influence upon individuals is real, although its effects upon humans is not based upon the distant stars, but rather the seasonal effects of the Sun. This of course means that the effects of the Sun's seasonal variance upon humans (particularly during gestation, of which has lasting lifelong consequences upon one's personality and upon one's susceptibility to various diseases) are diminished (though not eliminated) the closer one is to the equator; while these yearly effects are reversed for the Southern Hemisphere as compared with the Northern Hemisphere (since the seasons are reversed for said hemispheres). For some details on this, see the following papers:

- Gabriele Doblhammer and James W. Vaupel, "Lifespan depends on month of birth", *Proceedings of the National Academy of Sciences of the United States of America* (*PNAS*), Vol. 98, No. 5 (Feb. 27, 2001), pp. 2934-2939, doi:10.1073/pnas.041431898; also available here and here.
- Christopher M. Ciarleglio, John C. Axley, Benjamin R. Strauss, Karen L. Gamble and Douglas G. McMahon, "Perinatal photoperiod imprints the circadian clock", *Nature Neuroscience*, Vol. 14, No. 1 (Jan. 2011), pp. 25-27, doi:10.1038/nn.2699; also available here and here. "Supplement"; also available here and here.
- Zoltan Rihmer, Peter Erdos, Mihaly Ormos, Konstantinos N. Fountoulakis, Gustavo Vazquez, Maurizio Pompili and Xenia Gonda, "Association between affective temperaments and season of birth in a general student population", *Journal of Affective Disorders*, Vol. 132, Nos. 1-2 (July 2011), pp. 64-70, doi:10.1016/j.jad.2011.01.015; also available here and here.
- Mary Regina Boland, Zachary Shahn, David Madigan, George Hripcsak and Nicholas P. Tatonetti, "Birth month affects lifetime disease risk: a phenome-wide method", *Journal of the American Medical Informatics Association*, Vol. 22, No. 5 (Sept. 2015), pp. 1042-1053, doi:10.1093/jamia/ocv046; also available here and here. See also the following related diagram: "Birth Month and Disease Incidence in 1.7 Million Patients", Tatonetti Lab (Columbia University Medical Center), ca. June 8, 2015; also available here and here.

Classical Planets

Order	Name	Symbol	Roman Deity	Greek Deity	Norse Deity	Mesopotamian Deity	Hindu Deity	Day of the Week	Metal
1	Sun	☉	Sol	Helios; Apollo	Sól	Utu/Shamash	Surya	Sunday (1)	gold (aurum, Au; atomic number: 79; group: 11; period: 6)
2	Mercury	☿	Mercury	Hermes; Apollo	Odin	Nisaba; Nabu	Budha	Wednesday (4)	mercury (hydrargyrum, Hg; atomic number: 80; group: 12; period: 6)
3	Venus	♀	Venus	Aphrodite	Frigg	Inanna/Ishtar	Shukra	Friday (6)	copper (cuprum, Cu; atomic number: 29; group: 11; period: 4)
4	Moon	☽	Luna; Diana	Selene; Artemis	Máni	Nanna/Sīn	Chandra	Monday (2)	silver (argentum, Ag; atomic number: 47; group: 11; period: 5)
5	Mars	♂	Mars	Ares	Týr	Nergal	Mangala	Tuesday (3)	iron (ferrum, Fe; atomic number: 26; group: 8; period: 4)
6	Jupiter	♃	Jupiter	Zeus	Thor	Marduk	Bṛhaspati; Indra	Thursday (5)	tin (stannum, Sn; atomic number: 50; group: 14; period: 5)

7	Saturn	♄	Saturn	Cronus	Njord	Ninurta/Ninĝirsu	Shani	Saturday (7)	lead (plumbum, Pb; atomic number: 82; group: 14; period: 6)

The ancient world's concept of planet was as a wondering star (ἀστήρ πλανήτης, astēr planētēs), i.e., a regularly-occurring light in the sky (a "star") which unlike the many fixed stars of the celestial sphere, moved across said fixed stars in regular patterns (as opposed to, say, meteors, which were thought of as shooting stars, or falling stars). According to the *Oxford English Dictionary*'s entry for "planet", referring to the ancients, "The seven planets, in the order of their accepted distance from the Earth, were the Moon, Mercury, Venus, the Sun, Mars, Jupiter, and Saturn." (See John A. Simpson and Edmund S. C. Weiner [Eds.], *The Oxford English Dictionary* [Oxford, UK: Clarendon Press, 2nd ed., 1989].) The classical planets were variously also called the Seven Stars, or the Seven Luminaries.

The ancient Greeks initially thought that Mercury was two different planets: they named it Apollo when visible in the morning; and Hermes when visible in the evening. Later the Greeks realized that these seemingly two different planets were actually the same planet, and they kept the name Hermes for it. Apollo later came to be identified with the Sun.

Additionally, the ancient Greeks initially thought that Venus was two different planets: they named it Phosphorus when visible in the morning; and Hesperus when visible in the evening. Again, eventually the Greeks realized that these seemingly two different planets were actually the same planet, and they then associated it with the goddess Aphrodite. Coming later, the ancient Romans knew that Venus in its Morning Star and Evening Star appearances was actually a single planet, but when wishing to specify which appearance aspect they were referring to, called the morning appearance Lucifer, and the evening appearance Vesper (the Roman equivalents of their Greek counterparts); while their general name for the planet was Venus, the Roman version of Aphrodite.

Due to the ancient conception of a planet as being a wondering star, often when wishing to specify that they were referring to the planet rather than the actual god/goddess, the ancients would refer to it as, e.g., the Star of Aphrodite, etc.

Modern Planets

Order	Name	Symbol	Sidereal Orbit Period	Orbital Eccentricity	Sidereal Rotation Period	Axial Rotation in Relation to the Sun	Number of Moons
1	Mercury	☿	87.969257 SI day	0.2056302929816634	58.6463 SI day	prograde	0
2	Venus	♀	224.70079922 SI day	0.006755786250503024	243.018484 SI day	retrograde	0
3	Earth	⊕, ♁	365.256363004 SI day	0.01670236221760735	0.9972695663290843 SI day	prograde	1
4	Mars	♂	686.98 SI day	0.09331510156759697	1.02595675 SI day	prograde	2
5	Jupiter	♃	4332.589 SI day	0.04877487712602974	0.41353831 SI day	prograde	79
6	Saturn	♄	10755.698 SI day	0.05572339502033634	0.4440093 SI day	prograde	82
7	Uranus	♅, ⛢	30685.4 SI day	0.04440556667821134	0.718333 SI day	retrograde	27
8	Neptune	♆	60189 SI day	0.01121522948737634	0.67125 SI day	prograde	14

The foregoing table's orbital parameters are taken from the below National Aeronautics and Space Administration's (NASA) Horizons On-Line Ephemeris System (except for the Earth's orbit and rotation periods, which are taken from the below section's IERS citation). To use the website-interface to obtain ephemeris data for Mercury, select Ephemeris Type: Orbital Elements; Target Body: Mercury; Center: @sun; and Time Span: 2000-01-01 12:00 to 2000-01-02, with Step Size: 1 day (the Step Size simply needs to be longer than the two Time Span parameters, otherwise one gets multiple ephemeris datasets, each at the interval of the Step Size). To obtain data for other planets, change the Target Body parameter to the desired planet. The values for the orbital eccentricities were obtained by setting the Target Body to the respective planet's Barycenter. The given Time Span parameters set the time to January 1, 2000, noon Barycentric Dynamical Time (acronymized as TDB, from the French: Temps Dynamique Barycentrique), which corresponds to the international astronomical epoch standard of J2000.0. When the unit of a year is given in the Horizons system's data output, it is often defined as the astronomical standard Julian year of 365.25 SI day.

- "Horizons Web-Interface", NASA Jet Propulsion Laboratory (JPL) Horizons On-Line Ephemeris System; Horizons System homepage. As of this writing, the JPL Development Ephemeris (DE) version that the Horizons System uses is DE431. For more information on the JPL DEs, see: William Folkner, "JPL Planetary and Lunar Ephemerides: Export Information", JPL Solar System Dynamics (SSD), Apr. 30, 2014; also available here. To download the JPL ephemerides in different formats (including in ASCII encoding, i.e., plain text), see here and here.

See also the following resource for additional physical data on the major celestial objects within the Solar System:

- David R. Williams, *Planetary Fact Sheets*, NASA Space Science Data Coordinated Archive (NSSDC; NASA Goddard Space Flight Center), individual pages updated independently; Internet Archive Wayback Machine website mirror.

Metrological Units of Time

- "Leap Seconds", Time Service Department, US Naval Observatory, ca. Dec. 2016; also available here and here.

From the foregoing reference:

mean solar day = 86400.002 second

Hence:

mean solar week = 604800.014 second

⁂

- "Useful Constants", Paris Observatory International Earth Rotation Service (IERS) Centers, updated Feb. 13, 2014; also available here and here.

From the foregoing reference:

day (in the International System of Units; Système International d'Unités; SI) = 86400 second

tropical year (or solar year; its period determines the seasons) = 31556925.2507328 second ≈ 365.2421819473199 mean solar day ≈ 52.17745456390284 mean solar week

sidereal year (its period is in reference to the fixed stars) = 31558149.7635456 second ≈ 365.2563545489918 mean solar day

sidereal month (a lunar month; its period is in reference to the fixed stars) = 2360591.55792 second ≈ 27.32166091755415 mean solar day

Hence:

month ([tropical year]/12) = 2629743.7708944 second ≈ 30.43684849560999 mean solar day ≈ 4.348121213658570 mean solar week

⁂

- John R. Lucey, "Lunar Sidereal and Synodic Periods", *User's Guide to the Night Sky*, Department of Physics, Durham University (UK), undated (ca. Jan. 29, 2014, since updated); also available here and here.

Using the equation from the foregoing reference with the above values from IERS:

synodic month (a lunar month; its period determines the phases of the Moon) = 1/(1/[sidereal month] - 1/[sidereal year]) = 1/(1/[2360591.55792 second] - 1/[31558149.7635456 second]) ≈ 2551442.877200854 second ≈ 29.53058817291294 mean solar day ≈ 4.218655453273277 mean solar week

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Astronomical Software

For a useful command-line program that can accurately compute the positions of various celestial bodies for given past and future times (while conversely capable of computing times for various events such as equinoxes and solstices; phases of the Moon; sunrises and sunsets; etc.), see the following websites for Skyfield, which is cross-platform, free and open-source software, and which uses the Python programming language:

- Brandon Craig Rhodes (project maintainer), Skyfield, Rhodes Mill; at GitHub; and at the Python Package Index. Skyfield uses the same ephemerides that the aforementioned JPL Horizons System uses (and one can select which JPL ephemeris one wishes to use). For an older and less accurate—though easier to use—ephemeris program by Rhodes, see PyEphem, Rhodes Mill; at GitHub; and at the Python Package Index.

For a planetarium program useful for visualizing the arrangement of celestial objects in the sky for given past and future times, see the below website for KStars, which is cross-platform, free and open-source software:

- KStars, KDE Education Project.

See also the below website for XEphem, which is an ephemeris and planetarium program that runs on Unix-like operating systems (and it will run under the Microsoft Windows operating system using virtual machine software such as VirtualBox with Linux installed as the operating system on the virtual machine). It is free and open-source software. (Just to note, the above PyEphem program uses XEphem's 'libastro' C library.)

- Elwood Charles Downey (original project maintainer), XEphem, Clear Sky Institute; also available here; GitHub repository.

For Unix-like operating systems, see also the following websites for Sunclock, which displays different maps of the Earth with the overhead positions of the Sun and Moon for desired times, additionally showing which parts of the Earth are illuminated by the Sun at the set times. Sunclock is free and open-source software.

- Sunclock, maintained by the Debian Project (Software in the Public Interest, Inc.); source repository. "sunclock", at Debian developer Roland Rosenfeld's website; GitHub repository. "Sunclock", *Arvernes Wiki*, July 29, 2008; also available here and here. Sunclock is by Jean-Pierre Demailly, and is based on an earlier version by John Mackin, which in turn was derived from the program Suntools by John Walker.

The following command-line program for Unix-like operating systems is able to output the lunar phases for given times, and the times for sunrises and sunsets for given locations and days. It is free and open-source software.

- Kevin Boone (project maintainer), Solunar.

Mathematical Software

Below are some free and open-source Computer Algebra Systems (CAS). Such systems can perform symbolic computations, arithmetic, series operations (e.g., summations and products), calculus operations, and more. Most such systems can also create graphs of functions (i.e., plots). These systems can perform arbitrary-precision calculations with integers and floating-point numbers (e.g., the significand of floating-point numbers can be precise to millions of digits on 32-bit computers, and billions of digits on 64-bit machines). All the below CAS run natively on Unix-like operating systems, and some have native ports to the Windows operating system.

- Maxima information site; the SourceForge projects site. Maxima has also been natively ported to Windows. Maxima is based on a 1982 version of Macsyma (MAC's SYmbolic MAnipulator), programming of which began in July 1969 by the Massachusetts Institute of Technology's (MIT) Project MAC (Project on Mathematics and Computation). The 1982 version of Macsyma was continued as DOE-Macsyma by the US Department of Energy (DOE), of which was acknowledged by the DOE as open-source software on Oct. 6, 1998 in response to a request by Prof. William F. Schelter of the University of Texas at Austin.

- FriCAS information site; GitHub source repository; SourceForge projects site; FriCAS Documentation Homepage. FriCAS is a fork of Axiom by Numerical Algorithms Group, of which was previously named Scratchpad II, development of which began in 1977 by IBM (International Business Machines Corporation).

- Reduce information site; SourceForge projects site. Reduce has also been natively ported to Windows. Reduce originally began to be written by Prof. Anthony C. Hearn in 1963.

- PARI/GP Development Headquarters; *Catalogue of GP/PARI Functions*. PARI/GP has also been natively ported to Windows. PARI/GP's progenitor was a program named Isabelle, an interpreter for higher arithmetic, written in 1979 by Profs. Henri Cohen and François Dress at the Université Bordeaux 1.

- YACAS (Yet Another Computer Algebra System) information site; at GitHub; Documentation. YACAS has also been natively ported to Windows. Development of YACAS began in 1999 by Ayal Z. Pinkus and Serge Winitzki.

Below is a very advanced virtual-desktop calculator which is able to perform many of the functions that Computer Algebra Systems are able to perform. It comes with both graphical user-interface and command-line versions. It features arbitrary-precision arithmetic with integers and floating-point numbers. It is cross-platform, free and open-source.

- Hanna Knutsson (project maintainer), Qalculate!; GitHub repository.

The following resources feature two emulators of the HP 48GX scientific graphing calculator by Hewlett-Packard, which was produced from 1993-2003. The first emulator is Emu48, which is Windows software but runs well under the WINE (Wine Is Not an Emulator) Windows-compatibility layer on Unix-like operating systems. The second is x48, which runs on Unix-like platforms. Both are free and open-source software. Hyperlinks to the necessary ROM file are included below. Lastly, the documentation for the HP 48GX is also included.

- Christoph Gießelink (project maintainer), Emu48. Emu48 was originally released as open-source software by Sébastien Carlier in Aug. 1997. For an improved skin (i.e., user-interface theme) for Emu48, see "Jamie's Modification of Casey's GX II", HP Calculator Archive, ID: 6527; also available here.

- x48 files repository; latest version also here: x48-0.6.4.tar.bz2. X48 Homepage; also available here. NetBSD patches for x48 0.6.4. x48 was originally created by Eddie C. Dost in 1994, and later maintained by G. Allen Morris III.

- HP 48GX Revision R ROM, HP Calculator Archive, ID: 4368; also here: gxrom-r.zip. For Emu48, use its included 'Convert.exe' program on the foregoing ROM like so: `$ wine Convert.exe gxrom-r ROM.48G`. The same Revision R ROM formatted for x48: x48-gxrom-r.tar.gz; also available here.

- *HP 48G Series User's Guide* (Corvallis, Ore.: Hewlett-Packard Company, Edition 8, Dec. 1994), internal HP Part No. 00048-90104; also available here and here.

- *HP 48G Series Quick Start Guide* (Corvallis, Ore.: Hewlett-Packard Company, Edition 5, Jan. 1994), internal HP Part No. 00048-90105; also available here and here.

The following cross-platform, free and open-source program is able to convert between many different units of measurement:

- GNU Units, GNU Project (Free Software Foundation, Inc.); port to Microsoft Windows; Adrian Mariano, *Units Conversion* (HTML; also in PDF), the manual for GNU Units. GNU Units was originally developed by Mariano in 1996.

See also the below mathematics reference work which describes several special functions:

- Frank W. J. Olver, Adri B. Olde Daalhuis, Daniel W. Lozier, Barry I. Schneider, Ronald F. Boisvert, Charles W. Clark, Bruce R. Miller, Bonita V. Saunders, Howard S. Cohl and Marjorie A. McClain (Eds.), *NIST Digital Library of Mathematical Functions*, National Institute of Standards and Technology (NIST; US Department of Commerce), May 11, 2010, since updated; Internet Archive Wayback Machine website mirror.