WESTERN AUSTRALIAN

ASTRONOMY ALMANAC

INCLUDES FREE CD

The really useful guide to the wonders of the night sky

Highlights:

Mid January	Comet C/2005 P1 (McNaught) may be visible
March 4	Total Eclipse of the Moon
April 20	Venus visible in daytime
May 20	Venus visible in daytime
June	Two full moons
July 17	Lunar occultation of Regulus
June 18	Venus visible in daytime
August 28	Total Eclipse of the Moon
October 7	Venus visible in daytime
November 6	Venus visible in daytime

2007

PERTH OBSERVATORY

Government of Western Australia
Department of Environment and Conservation

2 0 0 7

JANUARY 2007

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3 ○	4	5	6
7	8	9	10	11 ◐	12	13
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28	29	30	31			

FEBRUARY 2007

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APRIL 2007

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MAY 2007

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JULY 2007

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29	30 ○	31				

AUGUST 2007

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SEPTEMBER 2007

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30						1
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9	10	11 ●	12	13	14	15
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23	24	25	26	27 ○	28	29

OCTOBER 2007

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3 ◐	4	5	6
7	8	9	10	11 ●	12	13
14	15	16	17	18	19 ◑	20
21	22	23	24	25	26 ○	27
28	29	30	31			

NOVEMBER 2007

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2 ◐	3
4	5	6	7	8	9	10 ●
11	12	13	14	15	16	17
18 ◑	19	20	21	22	23	24 ○
25	26	27	28	29	30	

DECEMBER 2007

Sun	Mon	Tue	Wed	Thu	Fri	Sat
30	31 ◐					1 ◐
2	3	4	5	6	7	8
9	10 ●	11	12	13	14	15
16	17 ◑	18	19	20	21	22
23	24 ○	25	26	27	28	29

● New Moon ◑ First Quarter ○ Full Moon ◐ Last Quarter

WESTERN AUSTRALIAN

ASTRONOMY ALMANAC 2007

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Information for this almanac was adapted from the following sources:

'Astronomical Almanac for the Year 2007', (US Naval Observatory/H.M. Nautical Almanac Office, Rutherford Appleton Laboratory).

'Astronomical Tables of the Sun, Moon and Planets', 2nd ed., 1995, by Jean Meeus, Willmann-Bell Inc.

'Astronomy and Astrophysics in the New Millennium', National Research Council USA, National Academy Press.

'The Cambridge Guide to the Constellations', 1995, by Michael E Bakich, Cambridge University Press.

'Eclipse! The What, Where, When, Why and How Guide to Watching Solar and Lunar Eclipses', 1997, by Philip Harrington, John Wiley & Sons, Inc.

'Explanatory Supplement to the Astronomical Almanac', 1992, ed. by P. K. Seidelmann, University Science Books, Mill Valley, California, USA.

'Frequently Asked Questions About Calendars', by Claus Tondering, 2005.

'Mathematical Astronomy Morsels', 1997, by Jean Meeus, Willmann-Bell Inc.

'More Mathematical Astronomy Morsels', 2002, by Jean Meeus, Willmann-Bell Inc.

'The Southern Sky Guide', 1993, by David Ellyard & Wil Tirion, Cambridge University Press.

'Total Eclipses: Science, Observations, Myths and Legends', 1999, by Pierre Guillermier and Serge Koutchmy, Springer – Praxis Series in Astronomy.

Heavens Above website http://www.heavens above.com

ICQ/CBAT/MPC World Wide Web pages http://cfa-www.harvard.edu/iau/

International Meteor Organization http://www.imo.net/

JPL Solar Systems Dynamics Group http://ssd.jpl.nasa.gov/

NASA National Space Science Data Center http://nssdc.gsfc.nasa.gov/planetary

Resolutions 5 and 6 adopted at IAU XXVIth General Assembly in Prague, on August 24, 2006. http://www.iau.org/Resolutions_at_GA-XXVI.340.0.html

SIMBAD database, operated at CDS, Strasbourg, France http://simbad.u-strasbg.fr/sim-fid.pl

Sky and Telescope magazine http://skyandtelescope.com/

United States Naval Observatory http://www.usno.navy.mil

US Geological Survey Planetary Nomenclature http://planetarynames.wr.usgs.gov/

ICE version 0.51, US Naval Observatory, Nautical Almanac Office

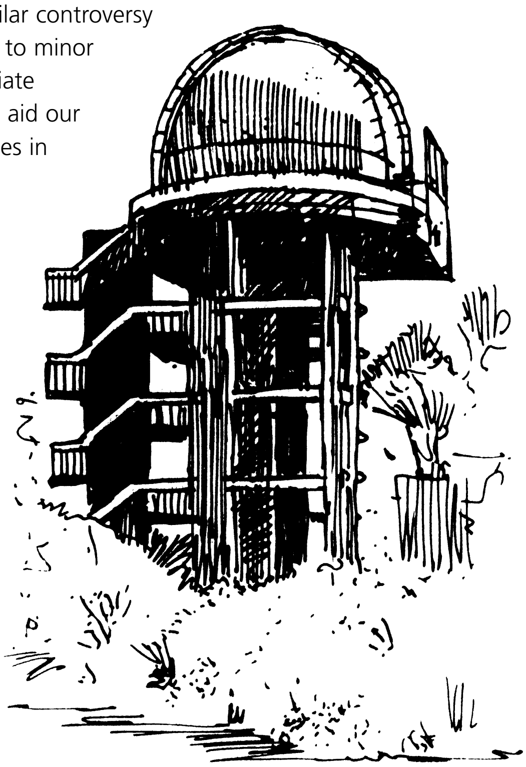
Sky Charts – Cartes du Ciel version 2.76 by Patrick Chevalley

Starry Night Pro, version 3.0.2, Sienna Software Inc.

***Front cover image**: This features the giant star-forming region in the southern sky known as the Carina Nebula (NGC3372). This image is created by combining the light from 3 different filters tracing emission from oxygen (blue), hydrogen (green), and sulphur (red). The colour is also representative of the temperature in the ionized gas: blue is relatively hot and red is cooler. The Carina Nebula is one of the most prominent features of the Southern Milky Way visible to the naked eye. Its distance from us is about 8,000 light years, and it has a diameter of over 200 light years. In normal colour images it is generally red in colour due to the fluorescent emission from of hydrogen. This emission from the gaseous nebula is caused by intense ultraviolet radiation from young, hot stars in the clusters within it. In fact, the Carina Nebula is the region nearest to the Sun where there are examples of the most massive stars known (spectral type O3), with surface temperatures 10 times and masses 100 times those of the Sun. The bright star near the centre of the image is Eta Carinae, which is one of the most massive and luminous stars known.*

Acknowledgement: Nathan Smith, University of Minnesota/NOAO/AURA/NSF

It was a case of back to the future for astronomy in 2006. The controversy concerning Pluto's redefinition from a planet to dwarf planet is not unique in astronomical history – similar controversy accompanied the redefinition of the "planets" Ceres, Pallas, Juno, Vesta, and others, to minor planets/asteroids in the mid 1800's. What is not controversial is the need for appropriate definitions, or more precisely a "taxonomical" system for planet-like objects. This will aid our understanding and facilitate advancement in this field and the never-ending discoveries in our Solar System (and the Milky Way galaxy) are forcing us in this direction. The term planet conjures images of a diverse range of astronomical objects that is as unconstructive to astronomers as a zoological garden with all enclosures labelled "animal" is to zoologists.



It is clear that the "planet-definition" debate will continue into 2007 and beyond – and well it should. The current debate has focussed on a definition applicable only to the Solar System. This is justifiable as Solar System objects are closer and thus, in principle, easier to observe and discern their characteristics. However, this limitation has not restrained controversy to date. In fact, it is easy to foresee that the debate will get more problematic as implicitly related to the definition of a planet is the definition of a moon. At one time in the current planet debate it was mooted that Charon, the large moon of Pluto (nearly half Pluto's diameter) should be classified a planet and the Pluto-Charon system should be classified a double planet. However, there are several Solar System moons larger than Pluto, including our Moon (Luna). And why should a planet definition be restricted to the Solar System – free floating objects that have too little mass to become stars have been found in the Milky Way, and convincing evidence has been found for over 200 planets orbiting near, and distant, stars.

Clearly, the "planet" debate has a long way to go and it is very likely that future observations will reveal new objects that further disorientate our preconceptions on this issue.

There is plenty to see in the night sky in 2007. Comet C/2005 P1 (McNaught) was discovered in August 2006 and current estimates suggest it may be just visible to the unaided eye, low in the WSW sky, in mid January. Please note that comet brightness is notoriously variable!

Comet C/2005 P1 (McNaught) may be visible in mid January

Two lunar eclipses are visible from WA in 2007. In the first of these only the early stages are visible because Moonset occurs before mid eclipse. The second lunar eclipse appears more promising as the Moon rises 45 minutes before mid eclipse.

TOTAL ECLIPSE of the MOON March 4 and August 28

Can you observe any celestial objects other than the Sun and Moon in the daytime? Yes, people with average eyesight should be able to detect the bright planet Venus. But you must know its position because the glare of the daytime sky severely reduces its conspicuousness. One way to overcome this is to try to observe it when it's close to the Moon. This occurs on April 20, May 20, June 18, Oct 7 and Nov 6. So on these dates use the Moon as a position reference and slowly scan around it in order to find Venus. Remember: ***Do NOT look at the Sun***.

VENUS VISIBLE in DAYTIME April 20, May 20, June 18, Oct 7 and Nov 6

In June the Moon will have Full phases on two occasions. This occurrence is not particularly rare; it recurs about every 2¼ years and depends on the time zone. For example, in 2007 Australia has two full Moons in June and New Zealand has two full moons in July. Increasingly, the second Full Moon in a month is called a 'Blue Moon' but this is a recent expression and can be traced back to a US farming almanac from about 50 years ago.

Two Full Moons in June

Remember to keep an eye to the sky. While this almanac will help you plan your observing sessions based on predicable phenomenon, the sky is full of wondrous unpredictable events that happen at any time.

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Government Astronomer for Western Australia,
Director of Perth Observatory,
and Adjunct Associate Professor, Curtin University of Technology.

***Competence** requires practice. So if you want to appreciate the night sky beyond the level of simple wonderment (which we might add is a reasonable thing in itself) then you have to practice – you have to get out and observe, and prepare yourself so that you know what you are observing.*

Here are some steps that you should take in order to gain a deeper appreciation of the night sky.

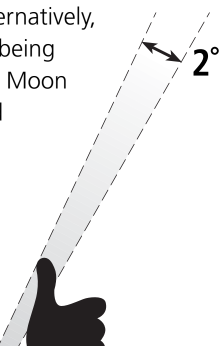
■ *Read astronomy books and other media*

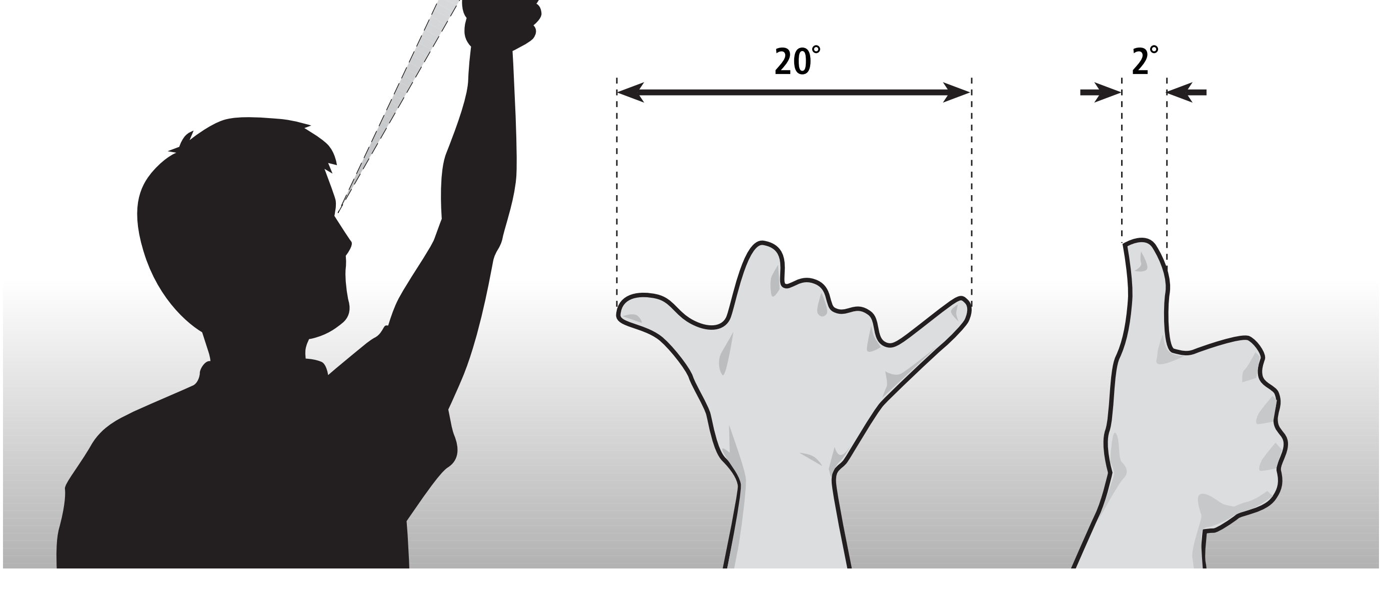
It's best to be prepared before you step outside to observe. This means obtaining some reliable background information about what there is to view, in which direction, what time it's visible and so on. This Almanac is a great place to start. It's designed to assist star viewing. Even when you are more expert you can consult it for the information that will assist your nights observing. There are also many websites, magazines, books, CDs and videos that can assist you. We have listed some useful websites in the Section *Background and General Information* that can get you started and they also have references to resources in other media.

A planisphere is a useful tool. It has a representation of the stars and constellations visible for any night of the year. Make sure you purchase the correct one for your latitude.

One important issue in becoming familiar with the sky is size. Astronomers measure distances across the sky in degrees. We all know that in a circle there are 360°. However this is rather large and not easily applicable to star viewing. There is an easy way to estimate smaller angles. Stretch out your arm in front of you. Open your hand and extend your fingers. With your arm outstretched, the angle between the tip of your thumb and tip of your little finger is about 20°. Also, the width of your thumb is about 1 to 2°. Alternatively, the Moon provides a stationary reference being about 0.˚5 across. In fact, you can use the Moon to 'calibrate' your extended arm and hand angle measuring system.

For smaller distances across the sky, 1° is divided into 60 minutes of arc, or 60'. One minute of arc is further divided into 60 seconds of arc, or 60". The Moon is approximately 0.˚5 or 30' across.





These detailed units are used in the tables of accurate positions of objects in the sky; for example, see the Section *Solar System Information*. Also note the way that astronomers write decimal angles – the symbol is always placed after its integer part, eg $^1/_2$˚ = 30' = **0.˚5**, not 0.5˚. Another system to define angular positions on the sky uses time-based units: hours, minutes and seconds. This type of unit is convenient because the sky moves one rotation about every 24 hours, similar to the Sun. In this system, one complete rotation corresponds to 24 hours (denoted 24^h) and the hour is subdivided into minutes and seconds in the conventional way. Note: This system is used for positions on the sky, for example right ascension. In order to measure positional differences the system based on degrees, arcminutes and arcseconds should be used.

■ *Join an astronomy society*

At an astronomy society you will meet a diverse range of people who have in common a great appreciation for and fascination with astronomy. The more established members are a great source of knowledge not only about the sky, but also instruments and observing sites. These societies can also provide enjoyable learning opportunities with formal and semi-formal lectures on astronomical topics, viewing nights, camps for star viewing and the like. The viewing nights also present an opportunity to learn about telescopes from the people who already own one. Some local societies are listed in the Section *Western Australian Places of Astronomical Interest*.

■ *Basic Observing*

A lot of star viewing occurs incidentally, while putting out the rubbish bin, driving home late from a trip to the country and so on. You can see some spectacular sights when you least expect it. Some of these are discussed in the Section *Background and General Information*. However, to get a deeper appreciation of the night sky you have to observe regularly.

It's also best to prepare yourself in advance. Remember -prior planning and preparation prevents poor performance.

First, you should try to find a safe and suitable site. It should be away from the glare of lights so that your eyes have the best chance to become dark adapted. It is probably best to do this in the daytime. Some astronomical societies have observatories or viewing sites out in the country that members can use. Also, if observing alone or in a small group always inform your friends and family and have some form of mobile communication in case of an emergency.

Read your almanacs and reference books, or run your computer programs to find out what's where and when, then make a list of things to see and do, set up at your observing site and get some equipment to make yourself comfortable such as a chair and blanket well before it gets dark. Also, it's advisable to wear stout shoes to protect your feet.

It also pays to inquire about the weather beforehand. You may need to dress warmly – you will probably be exposed to the breeze and this may create a wind chill factor that can make conditions cool even in summer. Also, star viewing is a rather low energy activity. This has the benefit that star viewing presents little restriction with regard to physical fitness - but keeping your body warm is an issue. If the weather is warm or still, insect repellent may be required.

Whilst star viewing is not a strenuous activity muscle strains can occur if your body is contorted in order to view through a telescope eyepiece or the like. In your planning think about what you will be doing. A simple folding chair may be very useful to minimise the risk of strain injuries.

Bring some spares. Batteries for your torch (very low power, or lens covered with red cellophane), spare cables etc, and food and drink for the humans!

Being organised means that there will be less need to rush and less possibility of mistakes or accidents during star viewing.

■ *Keep it simple*

Don't rush out to buy a telescope! There are a lot of telescopes that have been used once then never used again.

Become familiar with what is visible to the unaided eye. In fact, the eye is the best 'instrument' to view large sections of the sky such as those of constellation size. This also gives you an appreciation of the location of stars and constellations and at what season and time they are visible.

Objects that are visible with the unaided eye are the Moon and the five brightest planets, shooting stars (meteors), satellites, and more rarely, meteor showers, bright comets and auroras.

■ *Optical Instruments*

Binoculars are a good instrument to start with. They are mass produced and this means that generally their optical quality is quite good, and are relatively inexpensive.

They come in a variety of sizes. 7 x 50 binoculars are a cost effective choice. The 7 refers to their magnification and 50 is the width of the lens in millimetres.

Binoculars need to be held steady in order to minimise image shake. This can be done by leaning up against a tree, or wall, or mounting them on a tripod.

More detail is visible when using binoculars as compared to the unaided eye. This is a simple fact of physics – the wider the aperture the more detail that can be seen. Also, fainter objects become detectable using larger collecting areas; the pupil in the human eye has an aperture of about 7mm, compared to tens of millimetres for binoculars. Sights to see with binoculars include the craters of the Moon, the moons of Jupiter, bright comets (should any be around), star clusters and vistas rich in stars especially along the Milky Way.

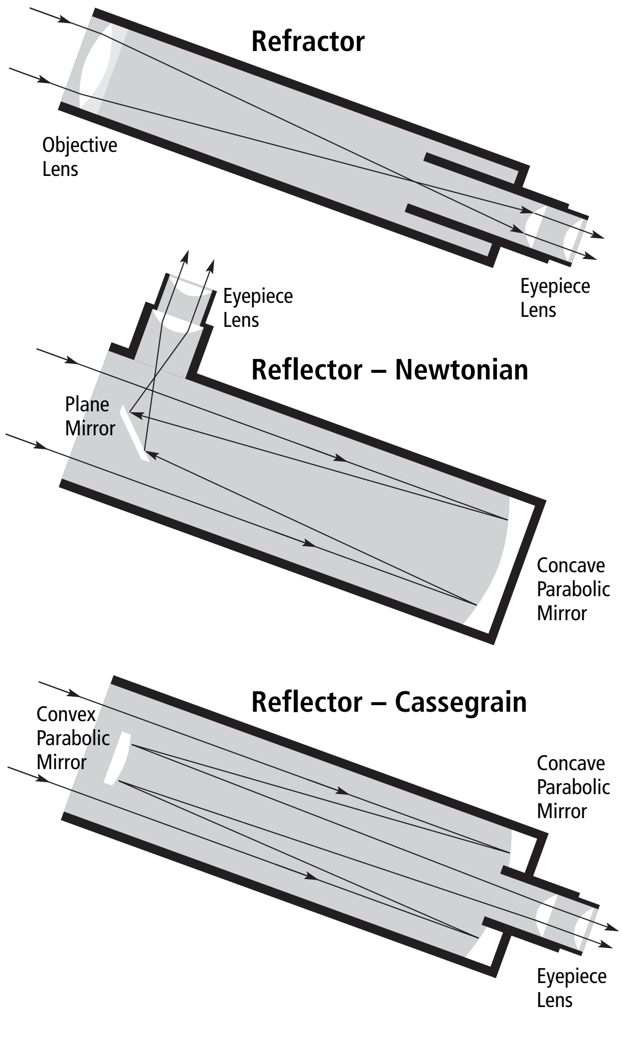
■ *Buying a telescope*

Eventually, if you've enjoyed doing all the things mentioned above you will probably want to buy your own telescope. Beware of any telescope that is advertised promoting its high magnification. These are probably built for a price, and not quality. It probably does have a high magnification, but what you will end up magnifying is the distortion in the telescope and atmosphere. Read widely about telescopes and purchase from a reputable business.

The subject of astronomical telescopes is quite large and only a very brief discussion is presented here. Telescopes come in three basic types:

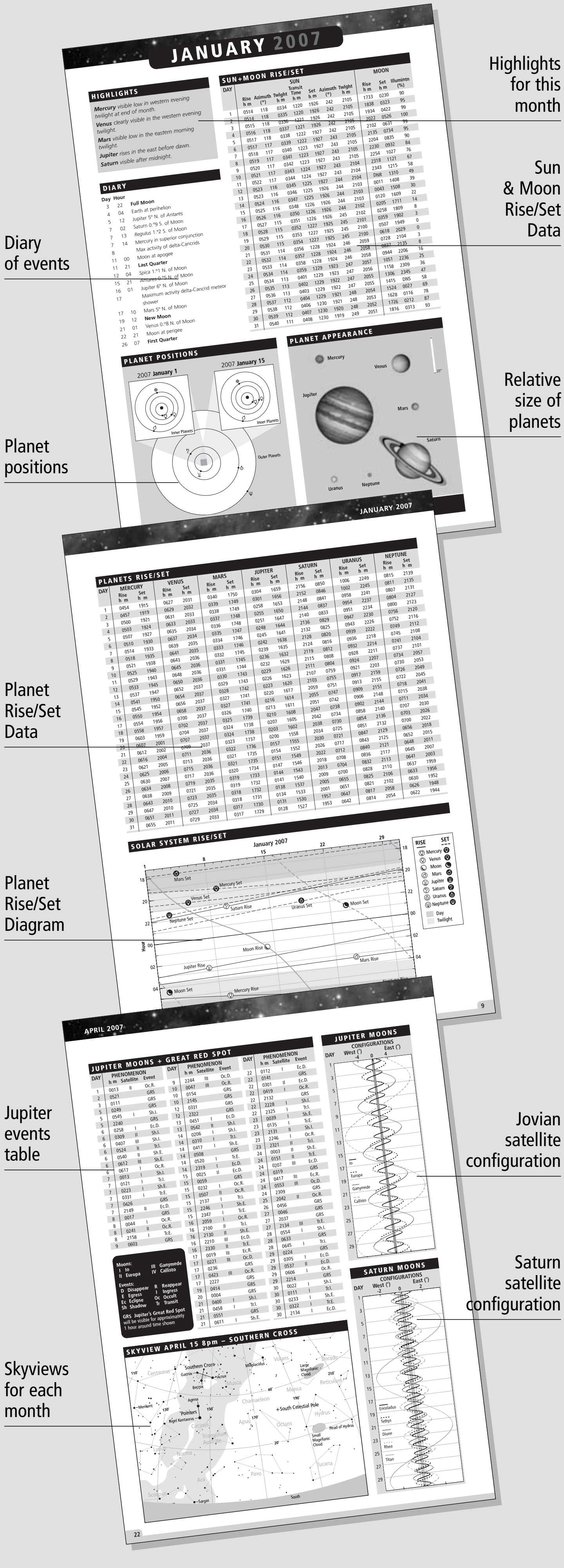
- ***refractors*** – uses lenses,
- ***reflectors*** – uses a concave mirror to focus light, and
- ***catadioptrics*** – part reflecting telescope that has a correcting lens at the top to form the image. Most catadioptrics are of the Schmidt-Cassegrain design and these are quite a popular and useful design.

A sturdy mount is necessary in order to keep the image stable. A motor drive is also very useful as it allows your telescope to track celestial objects (assuming it is aligned correctly). This eliminates the tedious task of winding knobs in order to keep objects in the field of view and allows you to concentrate on astronomy.



HOW TO USE THIS ALMANAC

***The majority** of this almanac is dedicated to the provision of detailed information about what is to be seen and where it is located for each month. Following that is a section providing details about very rare and/or unusual events. Finally, the later sections provide background and reference information relevant for this year, as well as more general astronomical information.*



Monthly Sections

Highlights for each month and a more detailed diary of events are provided in the **monthly sections**. Also, the relative size of the planets (in seconds of arc) is illustrated graphically. In order to put the previous information in context, a diagram of the inner Solar System is included for the beginning and middle of the month. The planets in the outer Solar System do not move very fast and only one plot for the middle of the month is provided for them. Detailed rise and set times for the major Solar System objects are tabulated along with other useful information such as twilight times, azimuth of sunrise and set, and the fraction of the Moon illuminated. In the table of Moonrise and set times, DNR indicates the Moon did not rise on that date, and DNS indicates the Moon did not set on that date. Note that all times are given in Western Australian Standard Times (WAST = Co-ordinated Universal Time (UTC, the modern equivalent of Greenwich Mean Time) + 8 hours) unless noted otherwise and twilight refers to astronomical twilight – the time when the Sun is 18° below the horizon and its glow is approximately equal to the background starlight. Sometimes the planets rise or set twice in one night – this is just a consequence of the planet's and Earth's orbital motions. A chart graphically summarises the rise and set times of the Sun, Moon and planets over a given month. All rise and set times are correct for observers in Perth, however graphs indicating the corrections required for observers elsewhere in WA are provided in the Section *Background and General Information*. No information is supplied for Pluto as it is no longer classified as a planet (See Section *Solar System Information – Definition of the Planets in the Solar System*).

Jupiter is the next major focus of these sections. A table is provided that indicates the time of events involving its four brightest moons Io (I), Europa (II), Ganymede (III) and Callisto (IV). The events indicated are a transit (Tr, passage of moon across Jupiter), shadow (Sh, a moon's shadow crosses the disc of Jupiter), eclipse (Ec, a moon passes into Jupiter's shadow) and occultation (Oc, a moon passes behind Jupiter). The timings associated with these events are related to the disappearance (D) and reappearance (R) of a moon after an occultation, and, ingress (I) into, and egress (E) from, Jupiter's disc associated with a transit, shadow or eclipse event. Also, the times of visibility of Jupiter's Great Red Spot (GRS) are provided. In practise, the Great Red Spot is only visible for around one hour centred on these times and is notoriously difficult to detect without stable atmospheric conditions and a decent telescope. The positions of the moons with respect to the planets Jupiter and Saturn are also illustrated graphically. Note that in these charts the thicker lines indicate that the moon is closer to Earth than the planet.

The last component of the monthly sections – the *sky views* is one of the most useful. A *sky view* is a chart showing the planet or object of interest against the background of brighter stars. These are a great aid in assisting beginners find their way around the sky. Please note that the size of the Moon in these images is larger than it should be in order to aid clarity.

Additional Sections

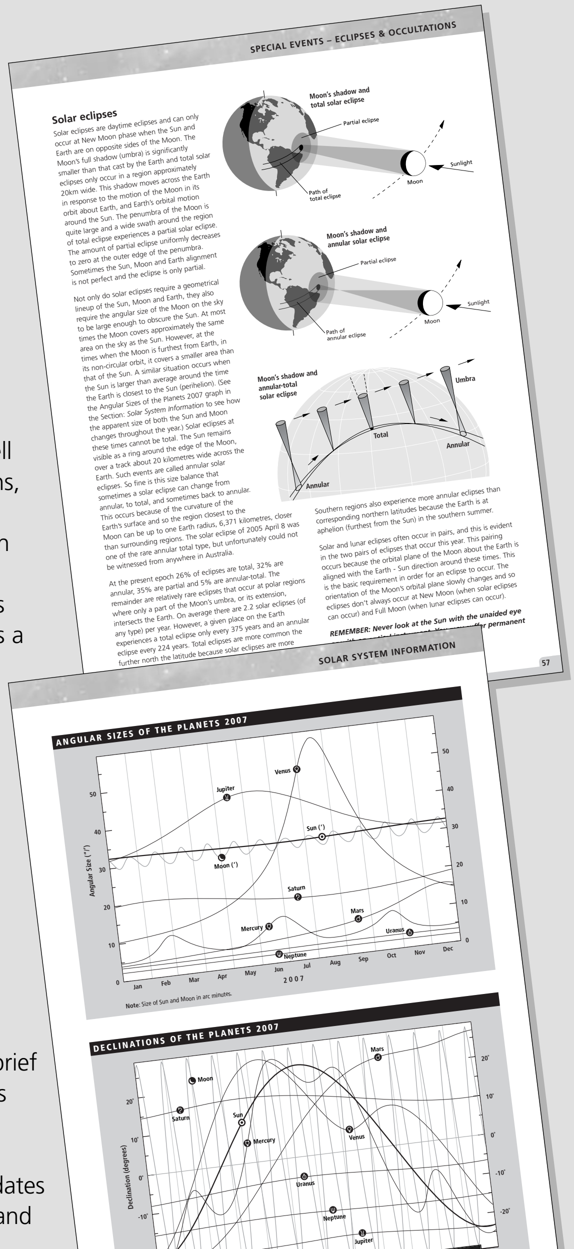
Some of the more spectacular and/or rare celestial events are discussed in the **Special Events – Eclipses & Occultations** Section. In particular, the date, time and region where the event is actually visible are provided.

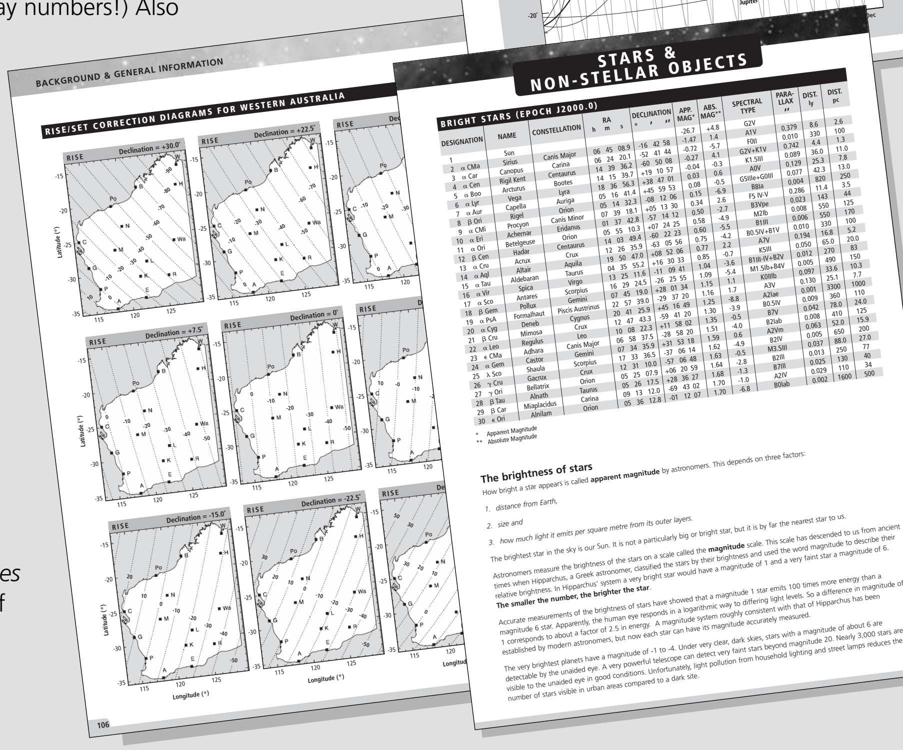
Detailed **Solar System information** is provided in the next section. This includes up-to-date physical parameters for the planets and their ever-increasing number of moons. Notes on the origin of the names of the planets and moons are also provided and give a flavour of the long history of astronomy and the creative continuation of its traditions. The positions of all the major Solar System objects are also tabulated along with the constellation in which they are located. Note that these positions refer to 0000 WAST, which corresponds to 1600 UTC. Charts of the planetary positions over the year are also included. The Moon's phases can affect observing so they are provided, along with a map that will aid identification of its major surface features, as well as some basic Moon information. More detailed graphs concerning the positions, sizes, brightness etc of the planets are also provided in order to assist the more experienced observers. A list of bright meteor showers visible from the Southern Hemisphere is tabulated in order to assist identification of any conspicuous meteors. Information about close approaches by known asteroids and comets is contained in the next group of tables. Finally, ephemerides (tables of position as a function of time) for bright comets are tabulated. Note: the brightness of comets is difficult to predict with any accuracy.

A detailed section with explanatory notes is contained in the **Stars and Non-Stellar Objects** Sections. You can't view most of these objects with the unaided eye, but they are included as a reference for those interested and the more experienced observers. The parameters provided are the most up-to-date from recent observations.

The penultimate section contains a range of **Background & General Information**. The list of websites and the extensive list of astronomical definitions will be particularly useful to beginners. The subsection concerning calendars and the like may appear quiet abstract at first glance. But contained within it is information that alludes to the complex history of our (Gregorian) calendar system, and the other calendars still in use around the world. Also, a brief explanation of the astronomical and historical basis of our time keeping systems and terminology is outlined. The list of Julian day numbers is a calendar that astronomers use. Every day has a number assigned to it, and the time interval between events can be easily calculated from the difference between the two dates in Julian day format. (Try finding the time interval between, say, 1963 April 29 and 1972 November 1 without using Julian day numbers!) Also note that astronomers have an unusual format for dates and times. Not only do they use a 24 hour clock, but they always put the most significant part first, and the least last. For example, 2pm on the 6th of July, 1990 becomes CE 1990 July 6 1400 (CE means the *Common Era*, the modern counterpart of AD). This system is also the international standard (ISO 8601). The next few pages will aid naked-eye observers interpret, what might appear at first sight to be, unusual observations. Readers are most welcome to use the observation form provided and submit recent observations that they cannot readily identify themselves.

The final Section, *Western Australian Places of Astronomical Interest*, lists a number of places you can visit for an astronomy experience, and societies to join.





JANUARY 2007

HIGHLIGHTS

***Mercury** visible low in western evening twilight at end of month.*

***Venus** clearly visible in the western evening twilight.*

***Mars** visible low in the eastern morning twilight.*

***Jupiter** rises in the east before dawn.*

***Saturn** visible after midnight.*

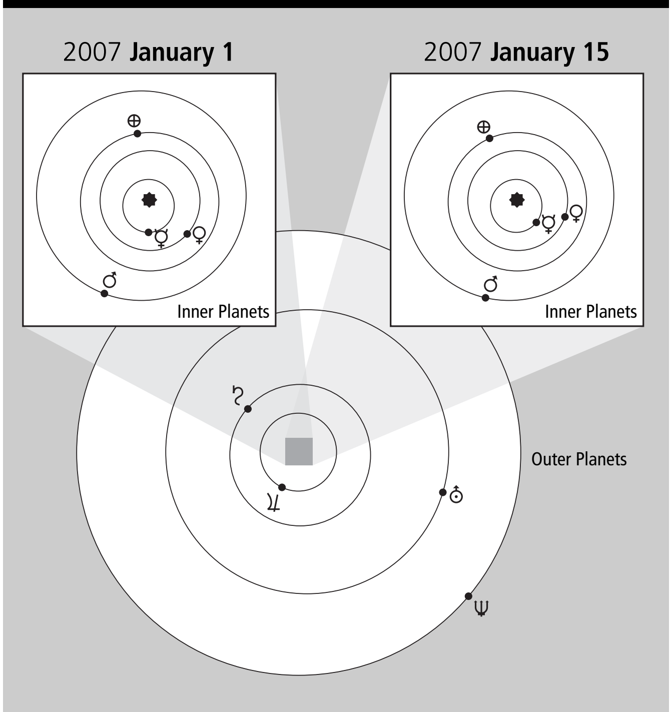
DIARY

Day	Hour	
3	22	**Full Moon**
4	04	Earth at perihelion
5	12	Jupiter 5° N. of *Antares*
7	02	Saturn 0.°9 S. of Moon
7	13	*Regulus* 1.°2 S. of Moon
7	14	Mercury in superior conjunction
8		Max activity of delta-Cancrids
11	00	Moon at apogee
11	21	**Last Quarter**
12	04	*Spica* 1.°1 N. of Moon
15	21	*Antares* 0.°5 N. of Moon
16	01	Jupiter 6° N. of Moon
17		Maximum activity delta-Cancrid meteor shower
17	10	Mars 5° N. of Moon
19	12	**New Moon**
21	01	Venus 0.°8 N. of Moon
22	21	Moon at perigee
26	07	**First Quarter**

SUN+MOON RISE/SET

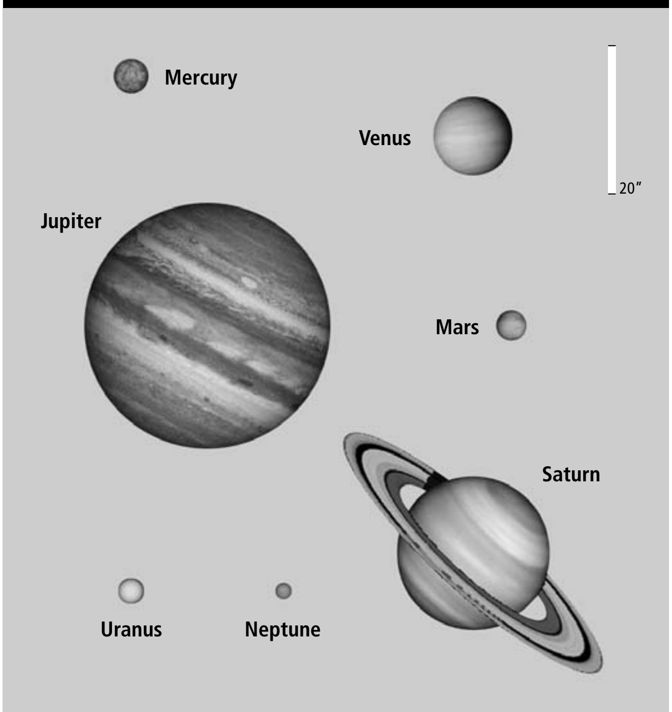
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0514	118	0334	1220	1926	242	2105	1733	0230	90
2	0514	118	0335	1220	1926	242	2105	1838	0323	95
3	0515	118	0336	1221	1926	242	2105	1934	0422	99
4	0516	118	0337	1221	1926	242	2105	2022	0526	100
5	0517	118	0338	1222	1927	242	2105	2102	0631	99
6	0517	117	0339	1222	1927	243	2105	2135	0734	95
7	0518	117	0340	1223	1927	243	2105	2204	0835	90
8	0519	117	0341	1223	1927	243	2105	2230	0932	84
9	0520	117	0342	1223	1927	243	2105	2254	1027	76
10	0521	117	0343	1224	1927	243	2104	2318	1121	67
11	0522	117	0344	1224	1927	243	2104	2343	1215	58
12	0523	116	0345	1225	1927	244	2104	DNR	1310	49
13	0523	116	0346	1225	1926	244	2103	0011	1408	39
14	0524	116	0347	1225	1926	244	2103	0043	1508	30
15	0525	116	0348	1226	1926	244	2103	0120	1609	22
16	0526	116	0350	1226	1926	244	2102	0205	1711	14
17	0527	115	0351	1226	1926	245	2102	0258	1809	8
18	0528	115	0352	1227	1925	245	2101	0359	1902	3
19	0529	115	0353	1227	1925	245	2100	0507	1949	0
20	0530	115	0354	1227	1925	245	2100	0618	2029	0
21	0531	114	0356	1228	1924	246	2059	0728	2104	3
22	0532	114	0357	1228	1924	246	2058	0837	2135	8
23	0533	114	0358	1228	1924	246	2058	0944	2206	16
24	0534	114	0359	1229	1923	247	2057	1051	2236	25
25	0534	113	0401	1229	1923	247	2056	1158	2309	36
26	0535	113	0402	1229	1922	247	2055	1306	2345	47
27	0536	113	0403	1229	1922	247	2055	1415	DNS	58
28	0537	112	0404	1229	1921	248	2054	1524	0027	69
29	0538	112	0406	1230	1921	248	2053	1628	0116	78
30	0539	112	0407	1230	1920	248	2052	1726	0212	87
31	0540	111	0408	1230	1919	249	2051	1816	0313	93

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

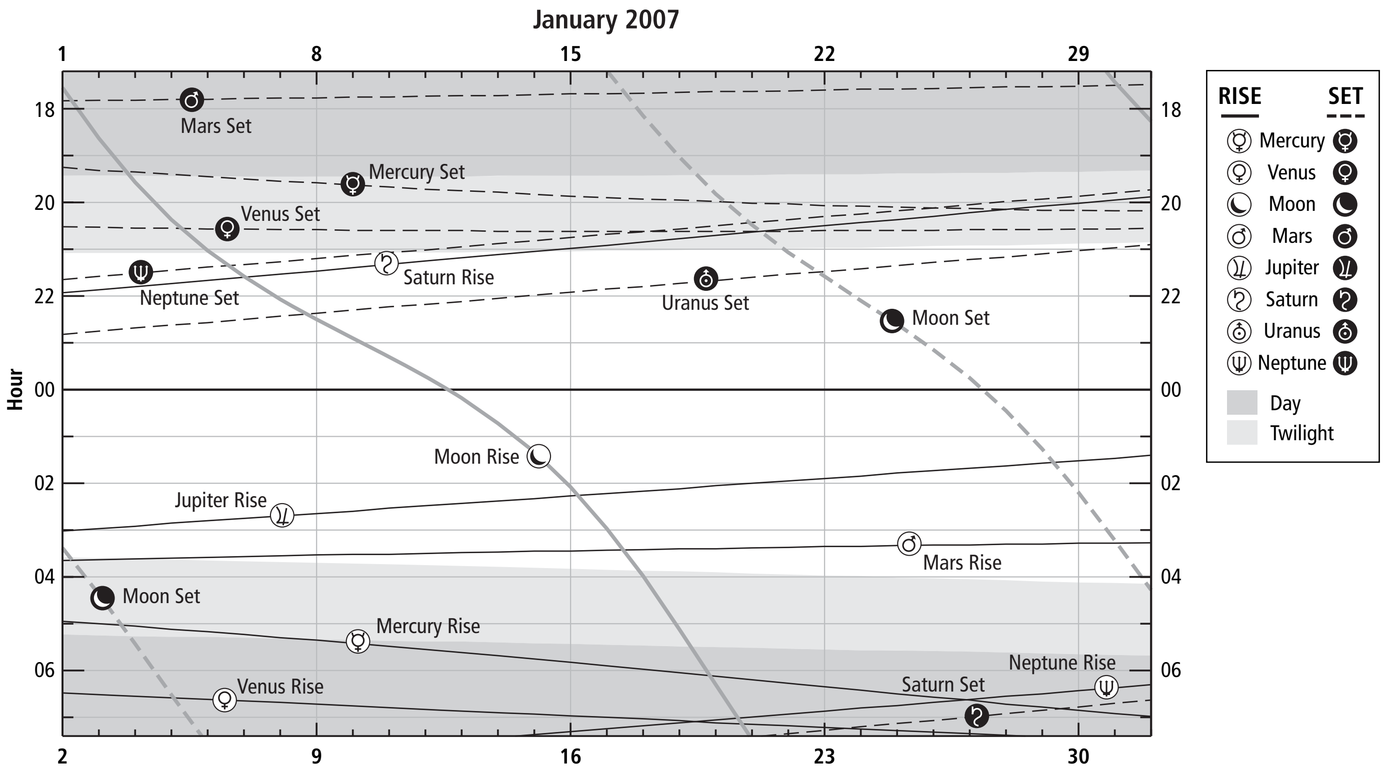


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		SATURN		URANUS		NEPTUNE	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0454	1915	0627	2031	0340	1750	0304	1659	2156	0850	1006	2249	0815	2139
2	0457	1919	0629	2032	0339	1749	0301	1656	2152	0846	1002	2245	0811	2135
3	0500	1921	0631	2033	0338	1749	0258	1653	2148	0841	0958	2241	0807	2131
4	0503	1924	0633	2033	0337	1748	0255	1650	2144	0837	0954	2237	0804	2127
5	0507	1927	0635	2034	0336	1748	0251	1647	2140	0833	0951	2234	0800	2123
6	0510	1930	0637	2034	0335	1747	0248	1644	2136	0829	0947	2230	0756	2120
7	0514	1933	0639	2035	0334	1746	0245	1641	2132	0825	0943	2226	0752	2116
8	0518	1935	0641	2035	0333	1746	0242	1638	2128	0820	0939	2222	0749	2112
9	0521	1938	0643	2036	0332	1745	0239	1635	2124	0816	0936	2218	0745	2108
10	0525	1940	0645	2036	0331	1745	0236	1632	2119	0812	0932	2214	0741	2104
11	0529	1943	0648	2036	0331	1744	0232	1629	2115	0808	0928	2211	0737	2101
12	0533	1945	0650	2036	0330	1743	0229	1626	2111	0804	0924	2207	0734	2057
13	0537	1947	0652	2037	0329	1743	0226	1623	2107	0759	0921	2203	0730	2053
14	0541	1950	0654	2037	0328	1742	0223	1620	2103	0755	0917	2159	0726	2049
15	0545	1952	0656	2037	0327	1741	0220	1617	2059	0751	0913	2155	0722	2045
16	0550	1954	0658	2037	0327	1741	0216	1614	2055	0747	0909	2151	0718	2041
17	0554	1956	0700	2037	0326	1740	0213	1611	2051	0742	0906	2148	0715	2038
18	0558	1957	0702	2037	0325	1739	0210	1608	2047	0738	0902	2144	0711	2034
19	0603	1959	0704	2037	0324	1738	0207	1605	2042	0734	0858	2140	0707	2030
20	0607	2001	0707	2037	0324	1738	0203	1602	2038	0730	0854	2136	0703	2026
21	0612	2002	0709	2037	0323	1737	0200	1558	2034	0725	0851	2132	0700	2022
22	0616	2004	0711	2036	0322	1736	0157	1555	2030	0721	0847	2129	0656	2018
23	0621	2005	0713	2036	0321	1735	0154	1552	2026	0717	0843	2125	0652	2015
24	0625	2006	0715	2036	0321	1735	0151	1549	2022	0712	0840	2121	0648	2011
25	0630	2007	0717	2036	0320	1734	0147	1546	2018	0708	0836	2117	0645	2007
26	0634	2008	0719	2035	0319	1733	0144	1543	2013	0704	0832	2113	0641	2003
27	0638	2009	0721	2035	0319	1732	0141	1540	2009	0700	0828	2110	0637	1959
28	0643	2010	0723	2035	0318	1732	0138	1537	2005	0655	0825	2106	0633	1956
29	0647	2010	0725	2034	0318	1731	0134	1533	2001	0651	0821	2102	0630	1952
30	0651	2011	0727	2034	0317	1730	0131	1530	1957	0647	0817	2058	0626	1948
31	0655	2011	0729	2033	0317	1729	0128	1527	1953	0642	0814	2054	0622	1944

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

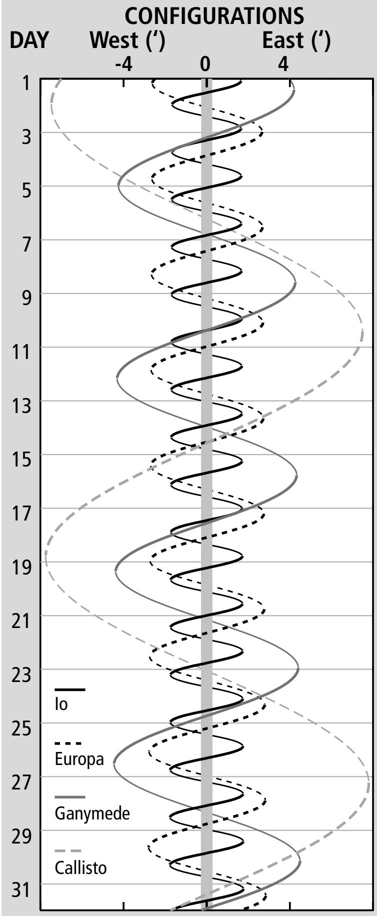
DAY	h m	Satellite	Event	Phenomenon
3	0320	III	Tr.I.	Transit Ingress
3	0508	I	Sh.I.	Shadow Ingress
4	0313		GRS	Great Red Spot
6	0451		GRS	Great Red Spot
10	0436	III	Sh.I.	Shadow Ingress
11	0358		GRS	Great Red Spot
11	0422	I	Ec.D.	Eclipse Disappear
12	0340	I	Sh.E.	Shadow Egress
12	0429	I	Tr.E.	Transit Egress
16	0305		GRS	Great Red Spot
16	0359	II	Ec.D.	Eclipse Disappear
18	0322	II	Tr.E.	Transit Egress
18	0443		GRS	Great Red Spot
19	0324	I	Sh.I.	Shadow Ingress
19	0417	I	Tr.I.	Transit Ingress
20	0348	I	Oc.R.	Occult Reappear
21	0212		GRS	Great Red Spot
21	0226	III	Oc.D.	Occult Disappear
21	0431	III	Oc.R.	Occult Reappear
23	0350		GRS	Great Red Spot
25	0334	II	Tr.I.	Transit Ingress
25	0410	II	Sh.E.	Shadow Egress
25	0527		GRS	Great Red Spot
26	0517	I	Sh.I.	Shadow Ingress
27	0236	I	Ec.D.	Eclipse Disappear
28	0156	I	Sh.E.	Shadow Egress
28	0240	III	Ec.D.	Eclipse Disappear
28	0256	I	Tr.E.	Transit Eclipse
28	0256		GRS	Great Red Spot
28	0440	III	Ec.R.	Eclipse Reappear
30	0434		GRS	Great Red Spot

Moons: I Io; II Europa; III Ganymede; IV Callisto

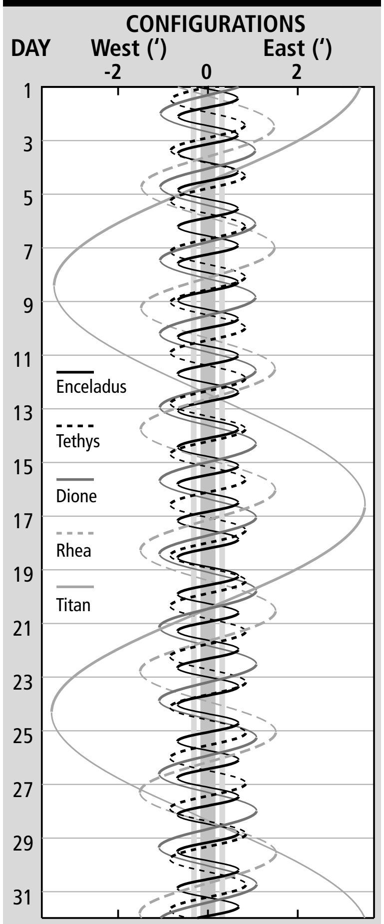
Events: D Disappear; R Reappear; E Egress; I Ingress; Ec Eclipse; Oc Occult; Sh Shadow; Tr Transit

GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

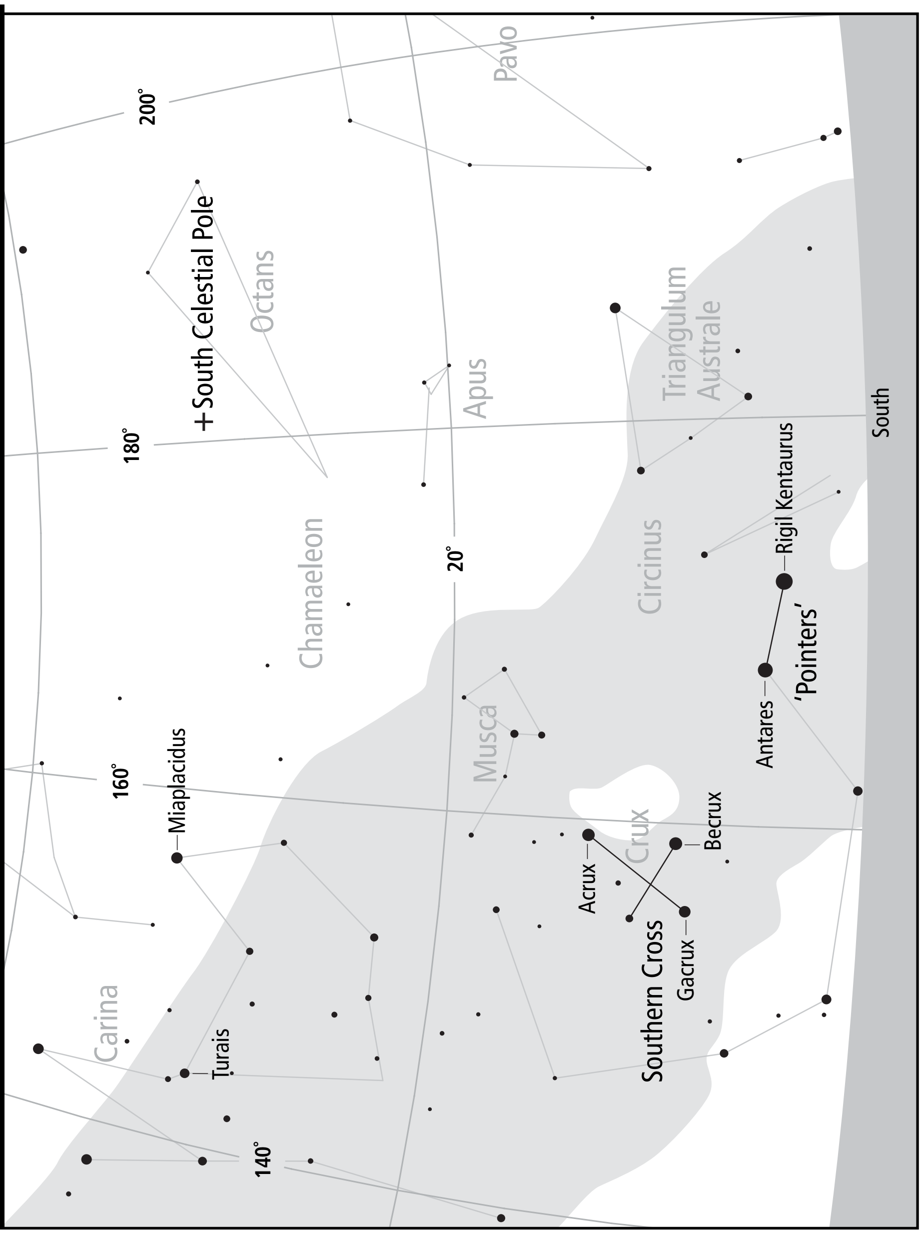
JUPITER MOONS



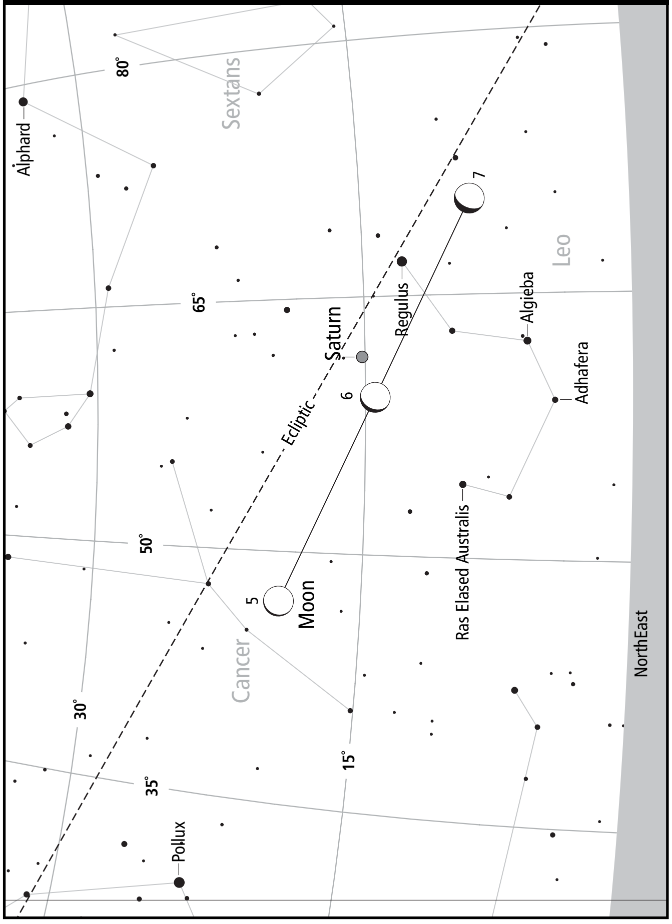
SATURN MOONS



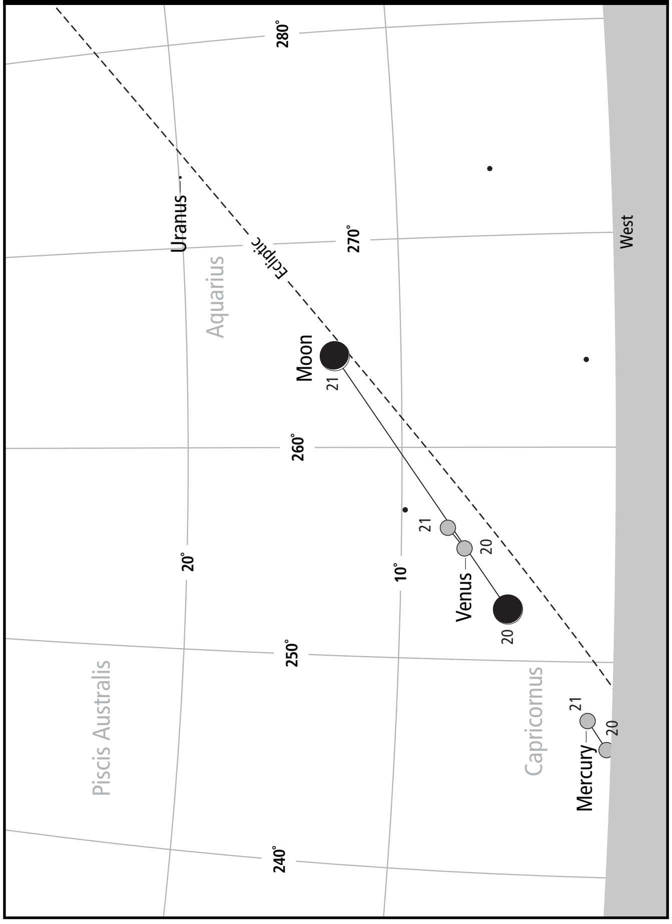
SKYVIEW JANUARY 15 8pm – SOUTHERN CROSS



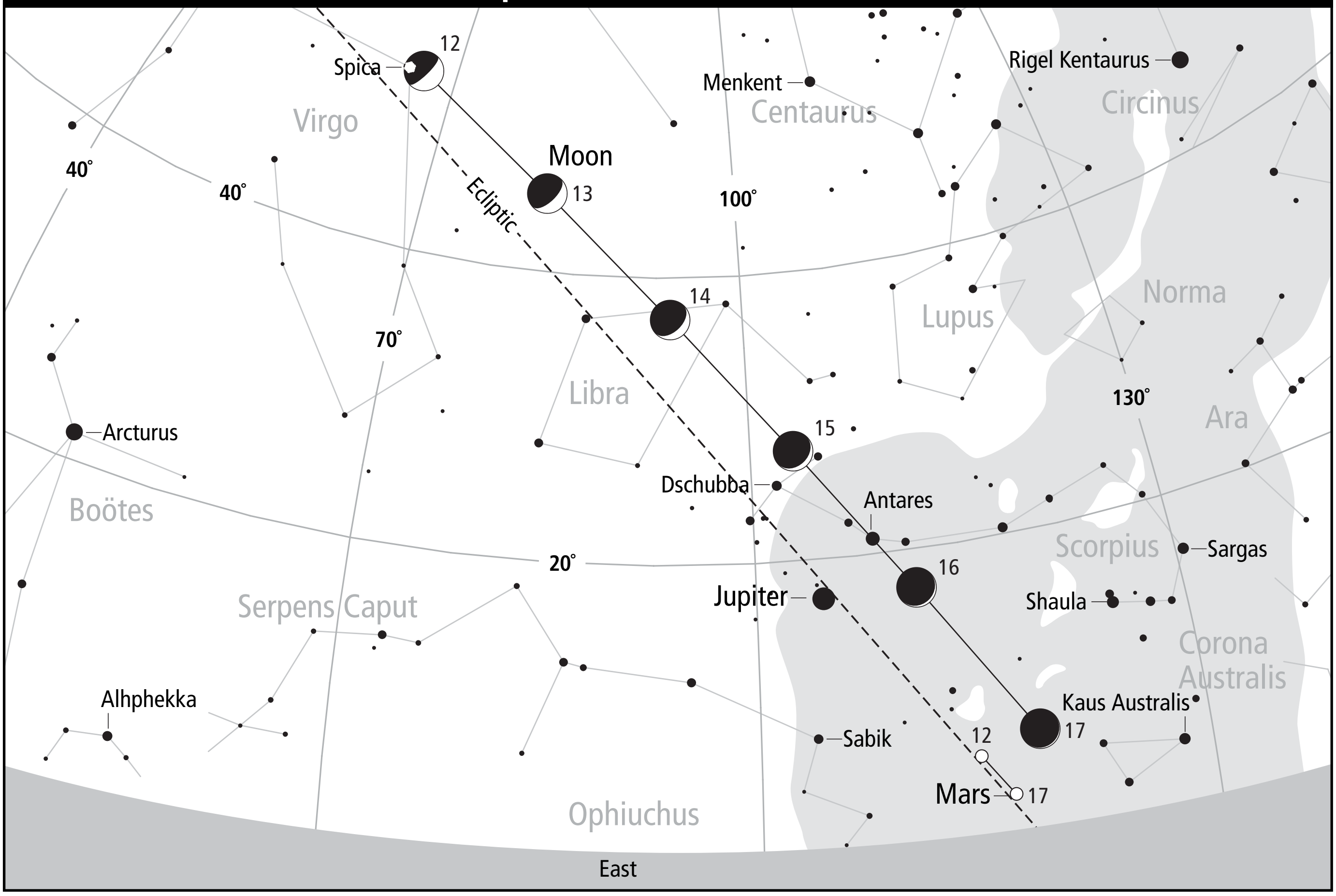
SKYVIEW 2007 JANUARY 5-7 11pm



SKYVIEW 2007 JANUARY 20-21 8pm



SKYVIEW 2007 JANUARY 12-17 8pm



HIGHLIGHTS

Mercury *visible very low in western evening twilight in first half of month.*

Venus *clearly visible in the western evening twilight.*

Mars *visible low in the eastern morning sky.*

Jupiter *rises in the east before dawn.*

Saturn *visible most of night.*

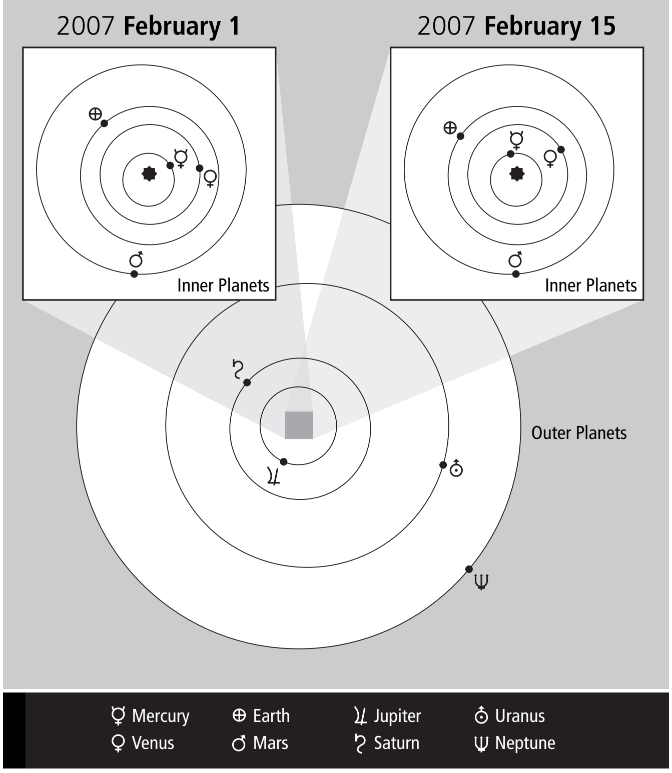
DIARY

Day	Hour	
2	14	**Full Moon**
3	07	Saturn 0.°9 S. of Moon
3	22	*Regulus* 1.°1 S. of Moon
7		Maximum activity of alpha-Centaurid meteor shower
7	21	Moon at apogee
8	01	Mercury greatest along. E. (18°)
8	12	*Spica* 1.°3 N. of Moon
9	00	Neptune in conjunction with Sun
10	18	**Last Quarter**
11	03	Saturn at opposition
12	06	*Antares* 0.°7 N. of Moon
12	18	Jupiter 6° N. of Moon
13	22	Mercury stationary
15	09	Mars 4° N. of Moon
18	00	**New Moon**
19	18	Moon at perigee
20	01	Venus 2° S. of Moon
23	13	Mercury in inferior stationary conjunction
24	16	**First Quarter**
26		Maximum activity of delta-Leonid meteor shower

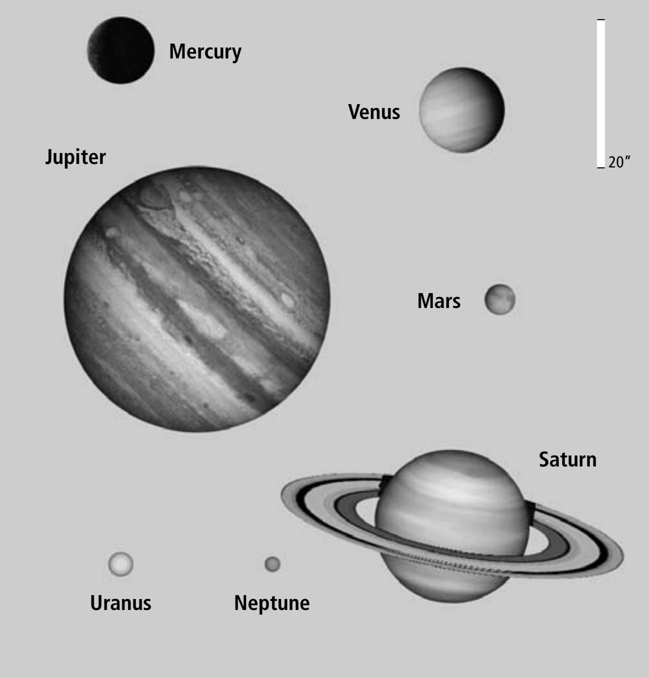
SUN+MOON RISE/SET

DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0541	111	0409	1230	1919	249	2050	1858	0417	97
2	0542	111	0411	1230	1918	249	2049	1934	0521	100
3	0543	110	0412	1230	1917	250	2048	2004	0622	100
4	0544	110	0413	1230	1917	250	2047	2031	0721	98
5	0545	110	0414	1231	1916	251	2046	2056	0817	94
6	0546	109	0416	1231	1915	251	2045	2120	0911	89
7	0547	109	0417	1231	1914	251	2044	2144	1005	83
8	0548	109	0418	1231	1913	252	2043	2211	1100	75
9	0548	108	0419	1231	1913	252	2042	2240	1156	66
10	0549	108	0420	1231	1912	252	2040	2314	1254	57
11	0550	107	0422	1231	1911	253	2039	2355	1354	48
12	0551	107	0423	1231	1910	253	2038	DNR	1455	38
13	0552	107	0424	1231	1909	254	2037	0043	1554	28
14	0553	106	0425	1231	1908	254	2036	0140	1649	20
15	0554	106	0426	1231	1907	254	2034	0244	1738	12
16	0555	105	0427	1231	1906	255	2033	0354	1821	6
17	0556	105	0429	1231	1905	255	2032	0505	1859	1
18	0556	105	0430	1231	1904	256	2031	0616	1933	0
19	0557	104	0431	1230	1903	256	2029	0727	2005	1
20	0558	104	0432	1230	1902	257	2028	0836	2036	6
21	0559	103	0433	1230	1901	257	2027	0946	2109	12
22	0600	103	0434	1230	1900	257	2026	1056	2145	21
23	0601	102	0435	1230	1859	258	2024	1206	2226	32
24	0601	102	0436	1230	1858	258	2023	1316	2313	43
25	0602	102	0437	1230	1857	259	2022	1422	DNS	54
26	0603	101	0438	1230	1856	259	2020	1522	0007	65
27	0604	101	0439	1229	1855	260	2019	1614	0106	74
28	0605	100	0440	1229	1853	260	2018	1658	0209	83

PLANET POSITIONS



PLANET APPEARANCE

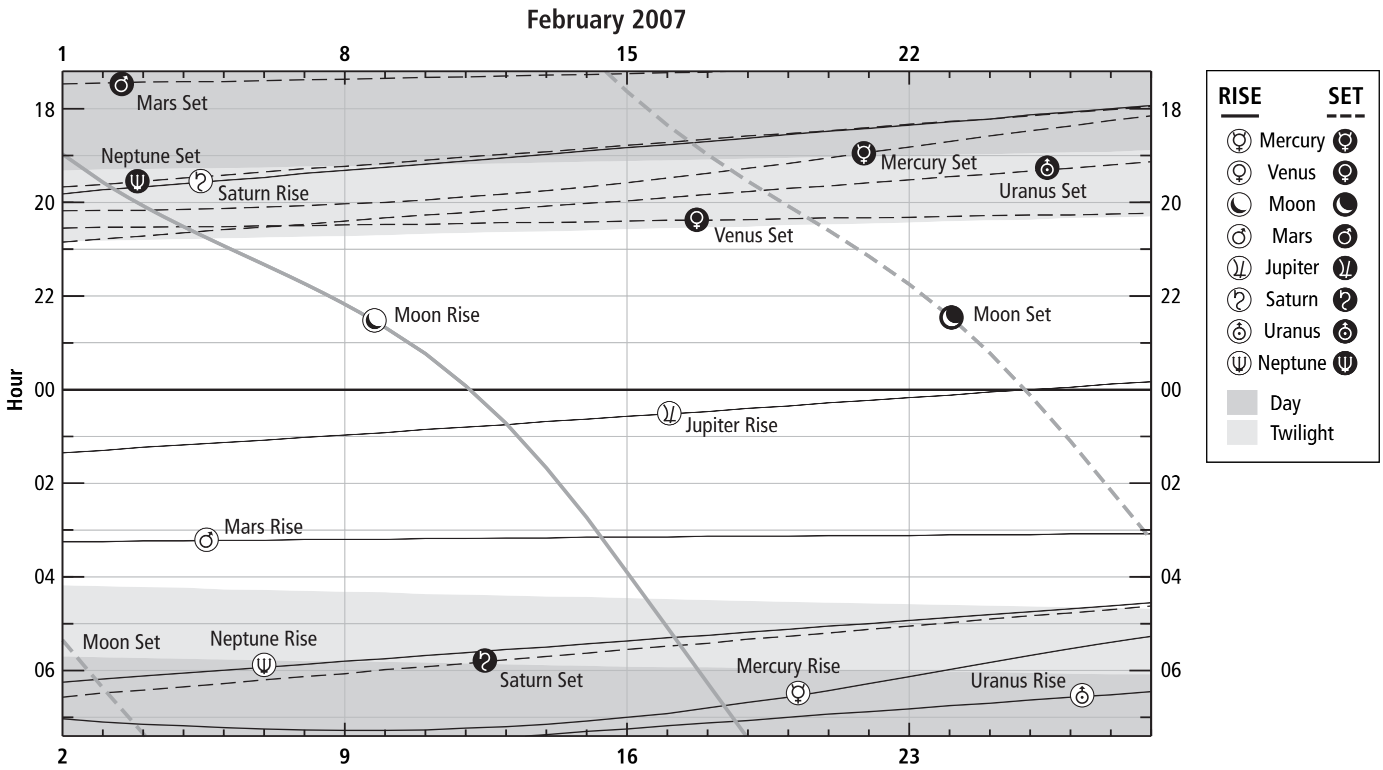


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		SATURN		URANUS		NEPTUNE	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0659	2011	0731	2033	0316	1728	0124	1524	1949	0638	0810	2051	0618	1940
2	0702	2010	0733	2032	0315	1727	0121	1521	1944	0634	0806	2047	0615	1937
3	0706	2010	0735	2032	0315	1726	0118	1518	1940	0629	0803	2043	0611	1933
4	0709	2009	0737	2031	0314	1725	0114	1514	1936	0625	0759	2039	0607	1929
5	0711	2008	0739	2031	0314	1725	0111	1511	1932	0621	0755	2035	0603	1925
6	0713	2006	0741	2030	0313	1724	0108	1508	1928	0617	0752	2032	0600	1921
7	0715	2004	0743	2030	0313	1723	0105	1505	1923	0612	0748	2028	0556	1917
8	0716	2002	0745	2029	0312	1722	0101	1502	1919	0608	0744	2024	0552	1914
9	0717	2000	0747	2028	0312	1721	0058	1458	1915	0604	0741	2020	0548	1910
10	0717	1957	0749	2028	0312	1720	0055	1455	1911	0559	0737	2016	0545	1906
11	0716	1953	0750	2027	0311	1719	0051	1452	1907	0555	0733	2013	0541	1902
12	0714	1949	0752	2026	0311	1718	0048	1449	1903	0551	0729	2009	0537	1858
13	0712	1945	0754	2026	0310	1717	0045	1445	1858	0546	0726	2005	0533	1855
14	0709	1940	0756	2025	0310	1716	0041	1442	1854	0542	0722	2001	0530	1851
15	0705	1935	0758	2024	0309	1715	0038	1439	1850	0538	0718	1958	0526	1847
16	0700	1929	0800	2023	0309	1714	0034	1435	1846	0533	0715	1954	0522	1843
17	0655	1923	0802	2023	0309	1713	0031	1432	1842	0529	0711	1950	0518	1839
18	0648	1916	0804	2022	0308	1711	0028	1429	1838	0525	0707	1946	0515	1835
19	0641	1910	0805	2021	0308	1710	0024	1425	1833	0520	0704	1942	0511	1832
20	0634	1903	0807	2020	0308	1709	0021	1422	1829	0516	0700	1939	0507	1828
21	0626	1856	0809	2020	0307	1708	0017	1419	1825	0512	0656	1935	0503	1824
22	0617	1849	0811	2019	0307	1707	0014	1415	1821	0507	0653	1931	0500	1820
23	0608	1842	0813	2018	0307	1706	0010	1412	1817	0503	0649	1927	0456	1816
24	0559	1835	0815	2017	0306	1705	0007	1408	1813	0459	0645	1924	0452	1813
25	0550	1828	0816	2016	0306	1703	0003	1405	1808	0454	0642	1920	0448	1809
26	0541	1822	0818	2016	0306	1702	0000	1402	1804	0450	0638	1916	0445	1805
26							2357							
27	0532	1815	0820	2015	0305	1701	2353	1358	1800	0446	0634	1912	0441	1801
28	0524	1809	0822	2014	0305	1700	2350	1355	1756	0442	0631	1908	0437	1757

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

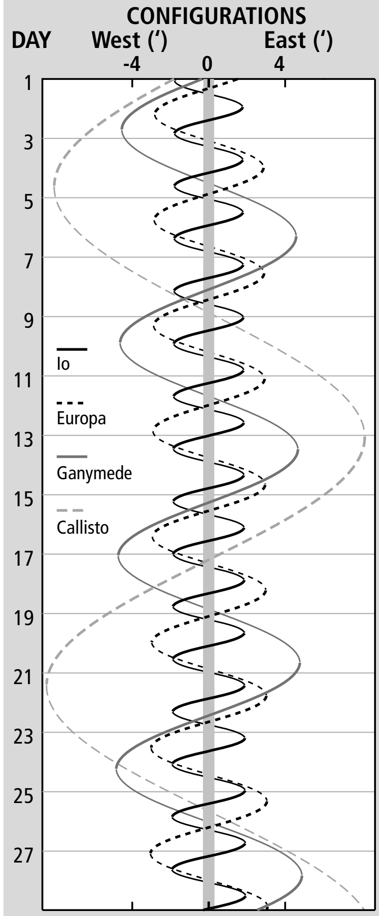
DAY	PHENOMENON h m	Sat.	Event
1	0412	II	Sh.I.
2	0203		GRS
3	0313	II	Oc.R.
3	0430	I	Ec.D.
4	0139	I	Sh.I.
4	0244	I	Tr.I.
4	0341		GRS
4	0349	I	Sh.E.
4	0454	I	Tr.E.
5	0213	I	Oc.R.
6	0519		GRS
7	0110		GRS
8	0259	III	Tr.E.
9	0248		GRS
10	0103	II	Ec.D.
11	0333	I	Sh.I.
11	0425		GRS
11	0441	I	Tr.I.
11	0543	I	Sh.E.
12	0049	II	Tr.E.
12	0051	I	Ec.D.
12	0410	I	Oc.R.
13	0121	I	Tr.E.
14	0154		GRS
15	0224	III	Sh.E.
15	0509	III	Tr.I.
16	0332		GRS
17	0339	II	Ec.D.
18	0509		GRS
18	0527	I	Sh.I.
19	0057	II	Tr.I.
19	0101		GRS
19	0106	II	Sh.E.
19	0244	I	Ec.D.
19	0327	II	Tr.E.
20	0107	I	Tr.I.
20	0205	I	Sh.E.
20	0317	I	Tr.E.
21	0035	I	Oc.R.
21	0238		GRS
22	0422	III	Sh.I.
23	0416		GRS
25	0553		GRS
26	0108	II	Sh.I.
26	0133	III	Oc.R.
26	0144		GRS
26	0334	II	Tr.I.
26	0339	II	Sh.E.
26	0437	I	Ec.D.
27	0148	I	Sh.I.
27	0302	I	Tr.I.
27	0358	I	Sh.E.
27	0512	I	Tr.E.
28	0038	II	Oc.R.
28	0230	I	Oc.R.
28	0322		GRS

Moons: I Io; II Europa; III Ganymede; IV Callisto

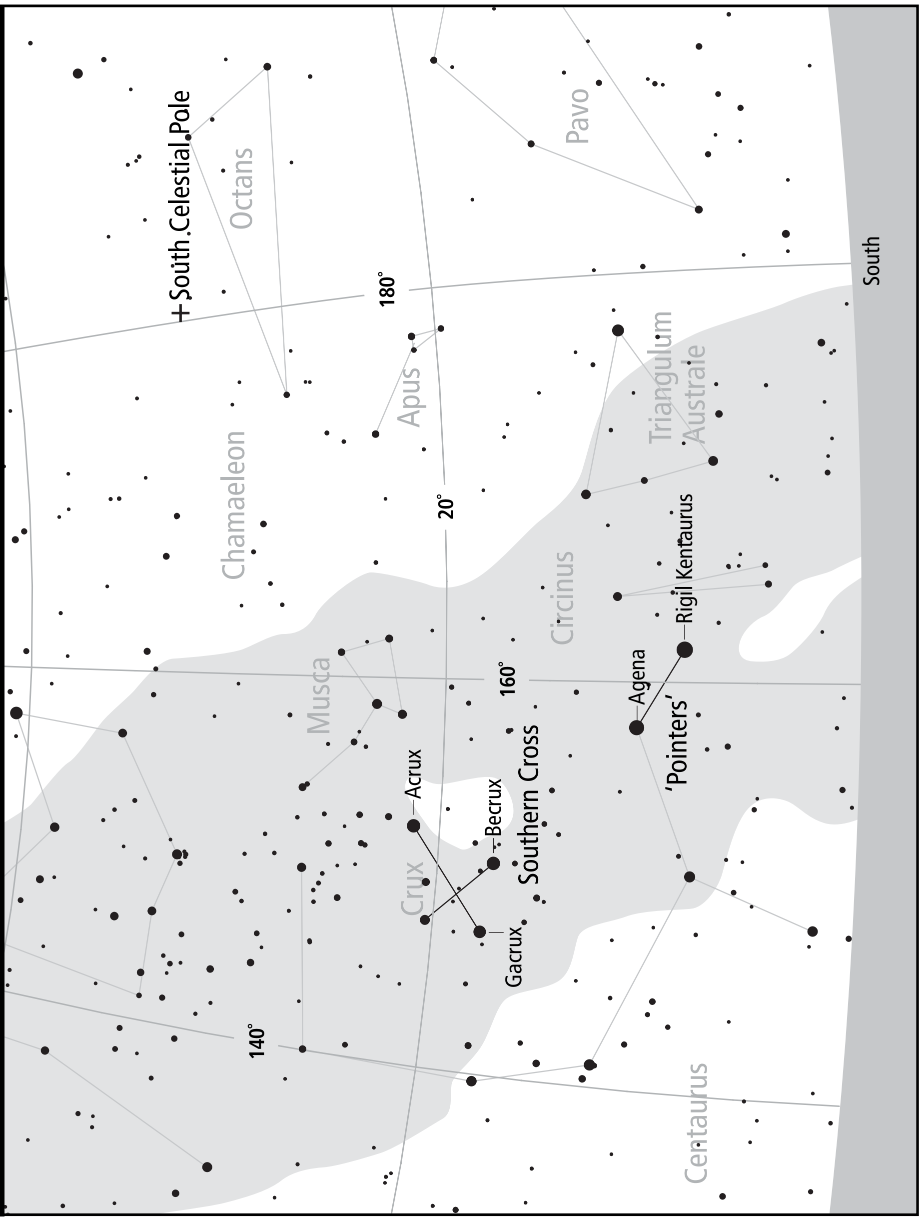
Events: D Disappear; R Reappear; E Egress; I Ingress; Ec Eclipse; Oc Occult; Sh Shadow; Tr Transit

GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

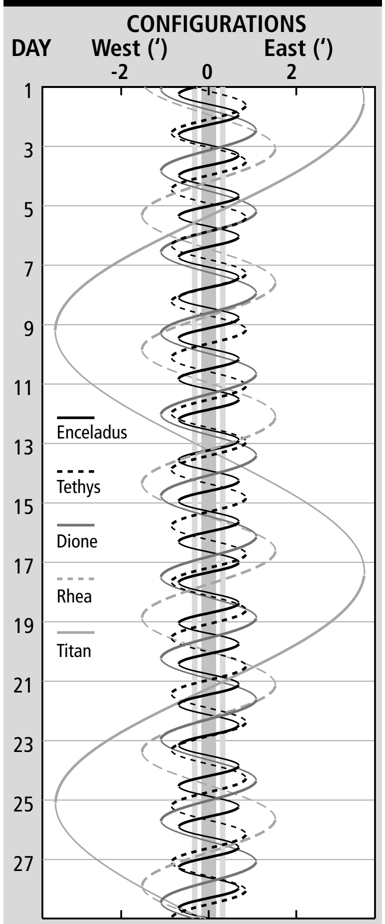
JUPITER MOONS



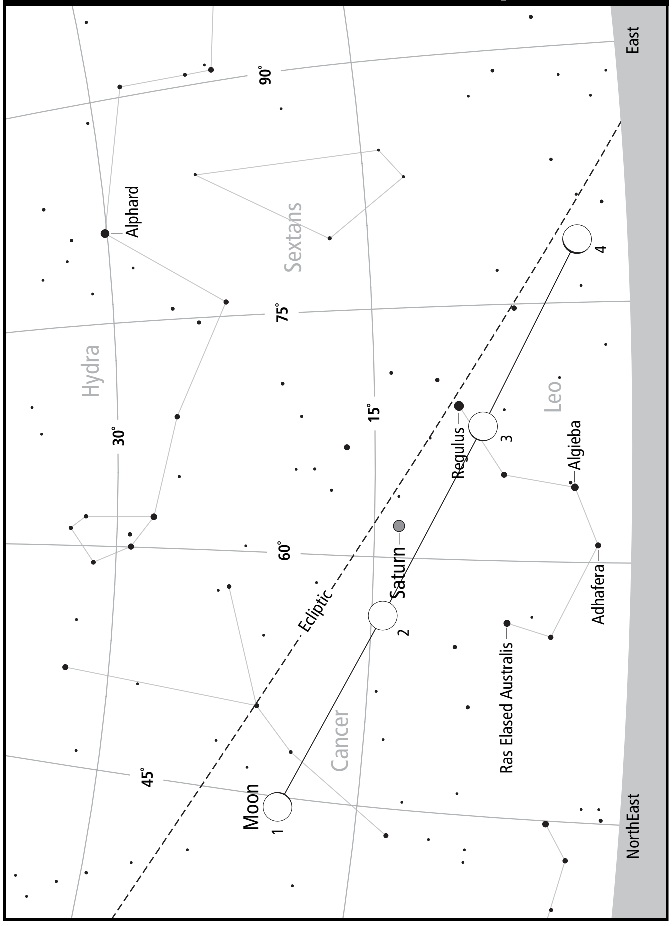
SKYVIEW FEBRUARY 15 8pm – SOUTHERN CROSS



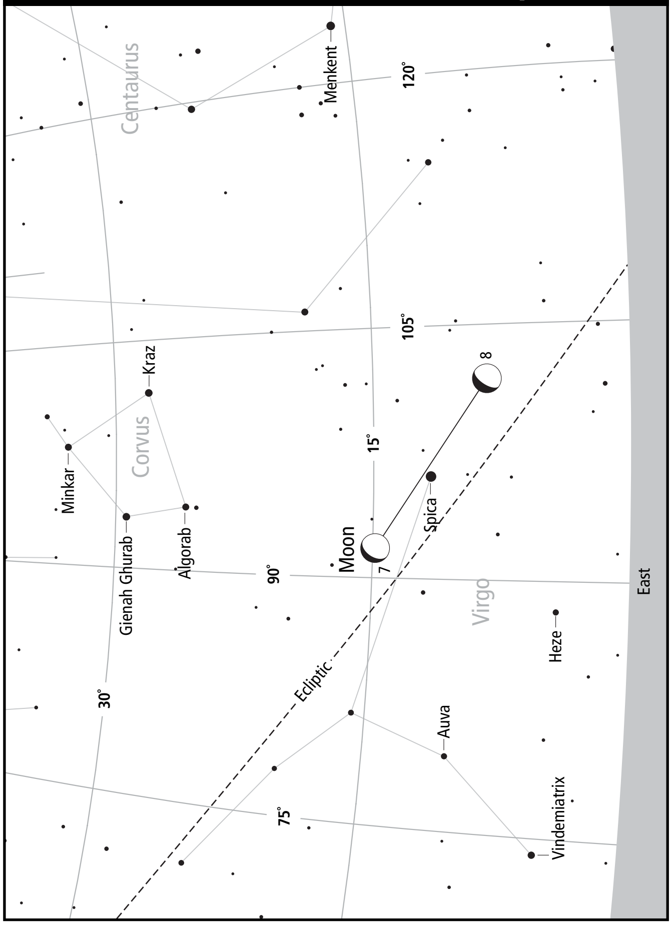
SATURN MOONS



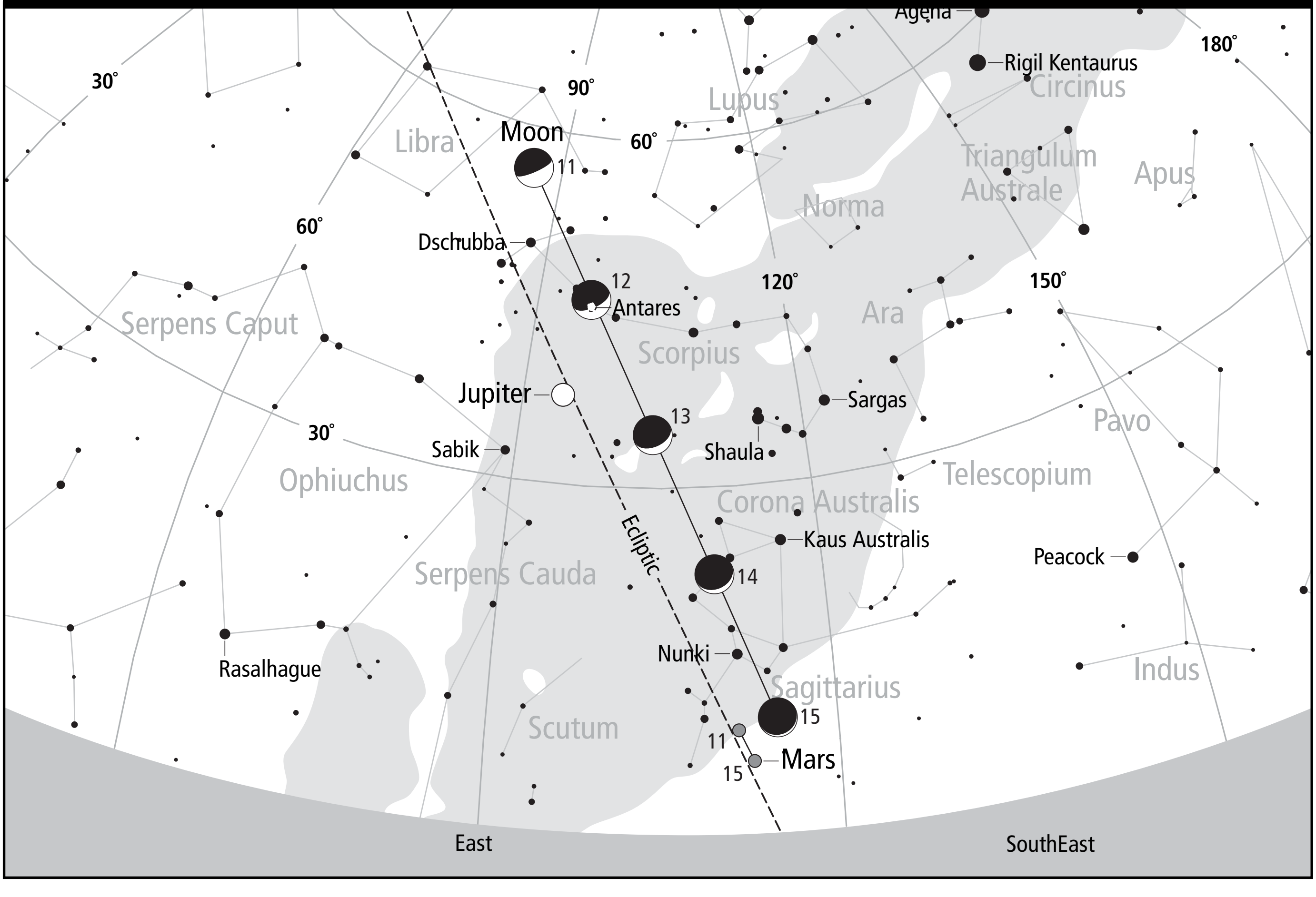
SKYVIEW 2007 FEBRUARY 1-4 9pm



SKYVIEW 2007 FEBRUARY 7-8 11pm



SKYVIEW 2007 FEBRUARY 11-16 4am



HIGHLIGHTS

Moon *start of lunar eclipse visible in morning of 4th.*

Mercury *visible low in eastern morning twilight most of month.*

Venus *clearly visible in the western evening twilight.*

Mars *visible low in the eastern late morning sky.*

Jupiter *visible after midnight and near overhead in morning twilight.*

Saturn *visible all evening and sets in the west before morning twilight.*

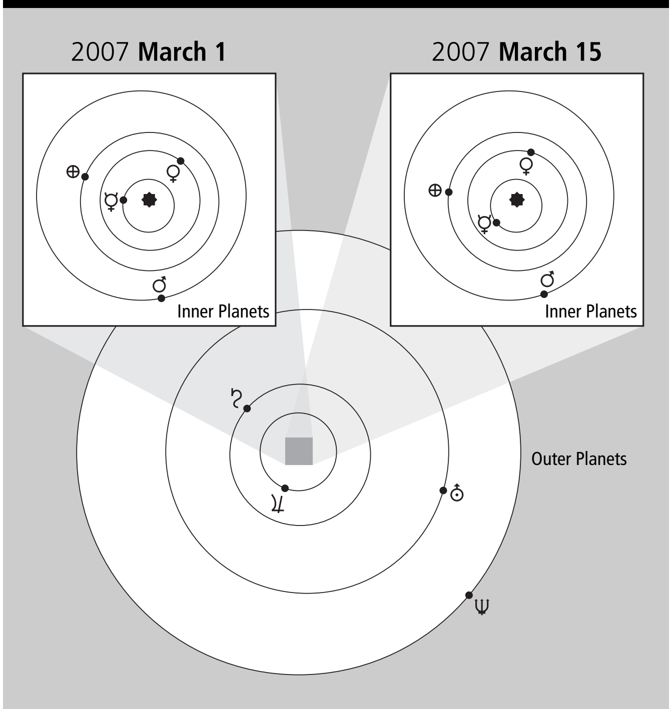
DIARY

Day	Hour	
2	10	Saturn 1.°1 S. of Moon
3	05	*Regulus* 1.°1 S. of Moon
4	07	**Full Moon** – Lunar Eclipse
6	00	Uranus in conjunction with Sun
7	12	Moon at apogee
7	18	Mercury stationary
11	14	*Antares* 0.°7 N. of Moon
12	08	Jupiter 6° N. of Moon
12	12	**Last Quarter**
14		Max activity of gamma-Normid meteors
16	09	Mars 1.°9 N. of Moon
17	11	Mercury 1.°4 N. of Moon
19	11	**New Moon**
20	03	Moon at perigee
21	08	Equinox
21	23	Venus 6° S. of Moon
22	10	Mercury greatest elongation W. (28°)
24		Max activity of Virginid meteor shower
26	02	**First Quarter**
29	12	Saturn 1.°2 S. of Moon
30	11	*Regulus* 1.°1 S. of Moon

SUN+MOON RISE/SET

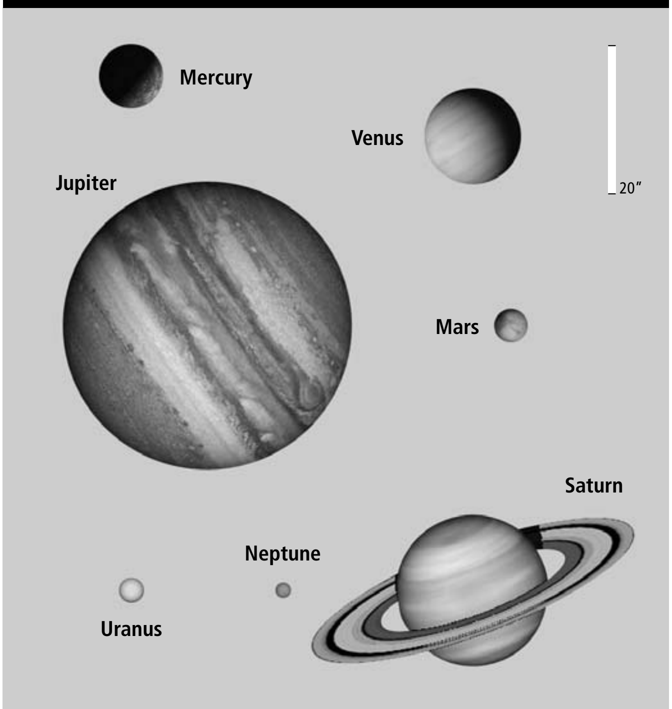
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0605	100	0441	1229	1852	260	2016	1735	0312	90
2	0606	99	0442	1229	1851	261	2015	1806	0413	95
3	0607	99	0443	1229	1850	261	2013	1833	0512	98
4	0608	98	0444	1228	1849	262	2012	1859	0609	100
5	0609	98	0445	1228	1847	262	2011	1923	0703	100
6	0609	98	0446	1228	1846	263	2009	1947	0758	97
7	0610	97	0447	1228	1845	263	2008	2013	0852	94
8	0611	97	0448	1228	1844	264	2007	2041	0948	88
9	0612	96	0449	1227	1843	264	2005	2113	1045	81
10	0612	96	0450	1227	1841	265	2004	2150	1143	74
11	0613	95	0450	1227	1840	265	2002	2234	1243	65
12	0614	95	0451	1227	1839	265	2001	2326	1341	55
13	0614	94	0452	1226	1838	266	2000	DNR	1437	45
14	0615	94	0453	1226	1836	266	1958	0025	1527	35
15	0616	93	0454	1226	1835	267	1957	0131	1612	25
16	0617	93	0455	1225	1834	267	1956	0240	1651	16
17	0617	92	0455	1225	1833	268	1954	0350	1727	9
18	0618	92	0456	1225	1831	268	1953	0501	1800	3
19	0619	91	0457	1225	1830	269	1952	0612	1832	0
20	0619	91	0458	1224	1829	269	1950	0723	1905	0
21	0620	91	0459	1224	1827	270	1949	0835	1940	4
22	0621	90	0459	1224	1826	270	1947	0948	2020	10
23	0621	90	0500	1223	1825	271	1946	1102	2107	18
24	0622	89	0501	1223	1824	271	1945	1212	2200	28
25	0623	89	0501	1223	1822	272	1943	1316	2259	38
26	0623	88	0502	1222	1821	272	1942	1411	DNS	49
27	0624	88	0503	1222	1820	272	1941	1458	0002	60
28	0625	87	0504	1222	1818	273	1939	1536	0105	69
29	0626	87	0504	1222	1817	273	1938	1609	0207	78
30	0626	86	0505	1221	1816	274	1937	1637	0306	86
31	0627	86	0506	1221	1815	274	1936	1703	0403	92

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

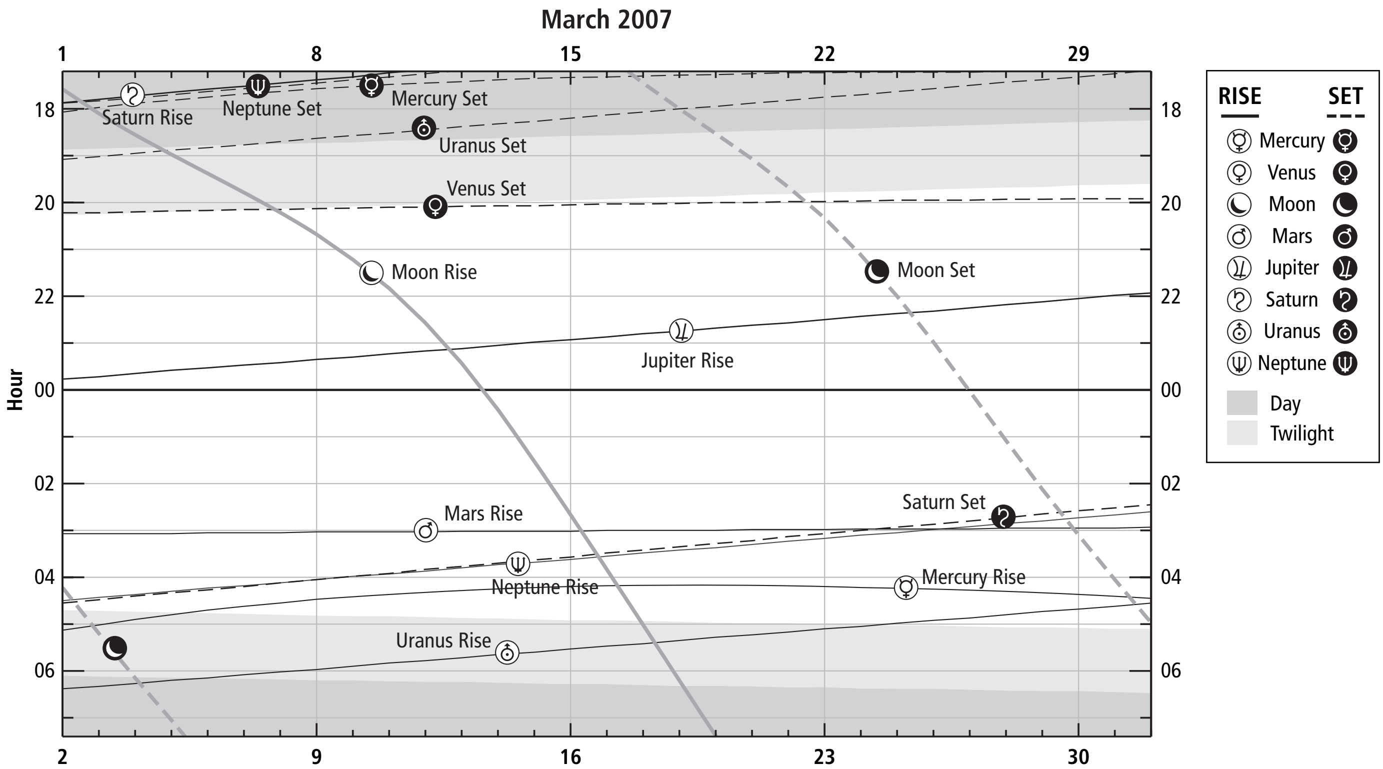


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY Rise h m	MERCURY Set h m	VENUS Rise h m	VENUS Set h m	MARS Rise h m	MARS Set h m	JUPITER Rise h m	JUPITER Set h m	SATURN Rise h m	SATURN Set h m	URANUS Rise h m	URANUS Set h m	NEPTUNE Rise h m	NEPTUNE Set h m
1	0516	1804	0824	2013	0305	1658	2346	1351	1752	0437	0627	1905	0433	1753
2	0508	1758	0825	2013	0304	1657	2343	1348	1748	0433	0623	1901	0430	1750
3	0501	1753	0827	2012	0304	1656	2339	1344	1743	0429	0620	1857	0426	1746
4	0454	1749	0829	2011	0304	1655	2335	1341	1739	0424	0616	1853	0422	1742
5	0448	1745	0831	2010	0304	1653	2332	1337	1735	0420	0612	1850	0418	1738
6	0442	1741	0833	2009	0303	1652	2328	1334	1731	0416	0609	1846	0414	1734
7	0437	1738	0834	2009	0303	1651	2325	1330	1727	0412	0605	1842	0411	1731
8	0433	1734	0836	2008	0303	1649	2321	1327	1723	0407	0601	1838	0407	1727
9	0428	1732	0838	2007	0302	1648	2318	1323	1719	0403	0558	1834	0403	1723
10	0425	1729	0840	2006	0302	1647	2314	1320	1714	0359	0554	1831	0359	1719
11	0422	1727	0842	2006	0302	1645	2310	1316	1710	0355	0550	1827	0356	1715
12	0419	1725	0844	2005	0302	1644	2307	1313	1706	0350	0547	1823	0352	1711
13	0417	1723	0845	2004	0301	1642	2303	1309	1702	0346	0543	1819	0348	1708
14	0415	1721	0847	2004	0301	1641	2259	1305	1658	0342	0539	1816	0344	1704
15	0413	1720	0849	2003	0301	1639	2256	1302	1654	0338	0536	1812	0341	1700
16	0412	1719	0851	2002	0301	1638	2252	1258	1650	0334	0532	1808	0337	1656
17	0411	1718	0853	2002	0300	1637	2248	1254	1646	0329	0528	1804	0333	1652
18	0410	1717	0855	2001	0300	1635	2245	1251	1642	0325	0525	1800	0329	1648
19	0410	1716	0856	2000	0300	1634	2241	1247	1637	0321	0521	1757	0325	1645
20	0410	1715	0858	2000	0300	1632	2237	1243	1633	0317	0517	1753	0322	1641
21	0410	1714	0900	1959	0259	1631	2234	1240	1629	0313	0514	1749	0318	1637
22	0411	1714	0902	1959	0259	1629	2230	1236	1625	0308	0510	1745	0314	1633
23	0412	1713	0904	1958	0259	1627	2226	1232	1621	0304	0506	1742	0310	1629
24	0413	1713	0906	1957	0258	1626	2222	1228	1617	0300	0503	1738	0306	1625
25	0414	1713	0907	1957	0258	1624	2219	1225	1613	0256	0459	1734	0303	1622
26	0415	1713	0909	1957	0258	1623	2215	1221	1609	0252	0455	1730	0259	1618
27	0417	1712	0911	1956	0258	1621	2211	1217	1605	0248	0452	1726	0255	1614
28	0418	1712	0913	1956	0257	1620	2207	1213	1601	0244	0448	1723	0251	1610
29	0420	1712	0915	1955	0257	1618	2203	1210	1557	0239	0444	1719	0248	1606
30	0422	1712	0917	1955	0257	1616	2159	1206	1553	0235	0441	1715	0244	1602
31	0424	1712	0919	1955	0257	1615	2156	1202	1549	0231	0437	1711	0240	1558

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

DAY	PHENOMENON h m	Satellite	Event
2	0460		GRS
3	0051		GRS
5	0031	III	Ec.R.
5	0228		GRS
5	0331	III	Oc.D.
5	0341	II	Sh.I.
5	0535	III	Oc.R.
6	0342	I	Sh.I.
6	0457	I	Tr.I.
6	0552	I	Sh.E.
7	0042	II	Ec.R.
7	0042	II	Oc.D.
7	0058	I	Ec.D.
7	0316	II	Oc.R.
7	0406		GRS
7	0423	I	Oc.R.
7	2326	I	Tr.I.
7	2357		GRS
8	0020	I	Sh.E.
8	0136	I	Tr.E.
9	0543		GRS
10	0134		GRS
12	0224	III	Ec.D.
12	0312		GRS

DAY	PHENOMENON h m	Satellite	Event
12	0428	III	Ec.R.
13	0536	I	Sh.I.
14	0043	II	Ec.D.
14	0251	I	Ec.D.
14	0317	II	Ec.R.
14	0318	II	Oc.D.
14	0449		GRS
14	0552	II	Oc.R.
15	0004	I	Sh.I.
15	0040		GRS
15	0119	I	Tr.I.
15	0214	I	Sh.E.
15	0329	I	Tr.E.
15	2324	III	Tr.E.
16	0029	II	Tr.E.
16	0045	I	Oc.R.
17	0217		GRS
19	0355		GRS
19	2346		GRS
21	0319	II	Ec.D.
21	0444	I	Ec.D.
21	0532		GRS
22	0123		GRS
22	0157	I	Sh.I.
22	0312	I	Tr.I.
22	0408	I	Sh.E.
22	0522	I	Tr.E.
22	2312	I	Ec.D.
23	0030	II	Tr.I.
23	0035	II	Sh.E.
23	0115	III	Tr.I.
23	0236	I	Oc.R.
23	0259	II	Tr.E.
23	0316	III	Tr.E.
23	2236	I	Sh.E.
23	2350	I	Tr.E.

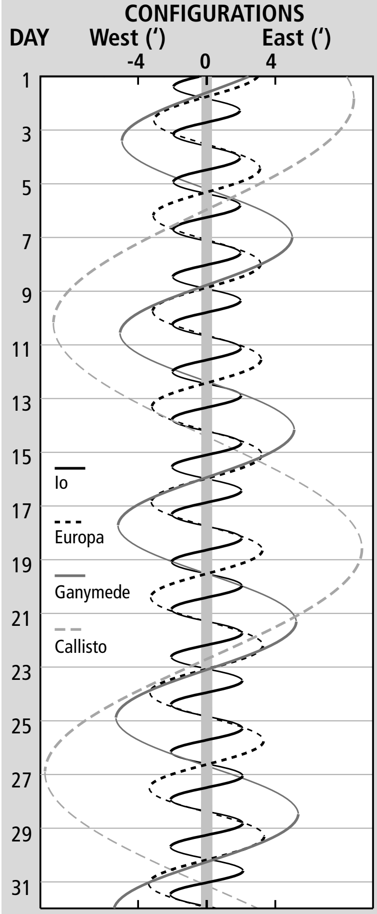
DAY	PHENOMENON h m	Satellite	Event
24	0300		GRS
24	2251		GRS
26	0438		GRS
27	0029		GRS
28	0555	II	Ec.D.
28	0615		GRS
29	0206		GRS
29	0351	I	Sh.I.
29	0503	I	Tr.I.
29	0601	I	Sh.E.
30	0010	III	Sh.I.
30	0036	II	Sh.I.
30	0105	I	Ec.D.
30	0214	III	Sh.E.
30	0258	II	Tr.I.
30	0307	II	Sh.E.
30	0427	I	Oc.R.
30	0504	III	Tr.I.
30	0528	II	Tr.E.
30	2219	I	Sh.I.
30	2331	I	Tr.I.
31	0030	I	Sh.E.
31	0141	I	Tr.E.
31	0343		GRS
31	2254	I	Oc.R.
31	2334		GRS

Moons:
I Io — III Ganymede
II Europa — IV Callisto

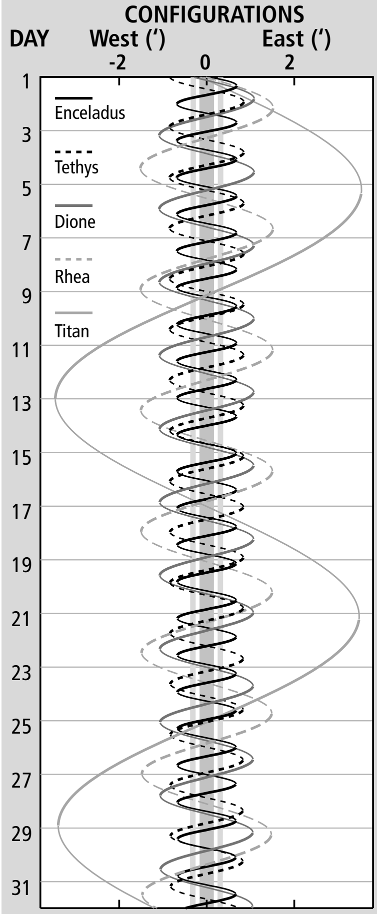
Events:
D Disappear — R Reappear
E Egress — I Ingress
Ec Eclipse — Oc Occult
Sh Shadow — Tr Transit

GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

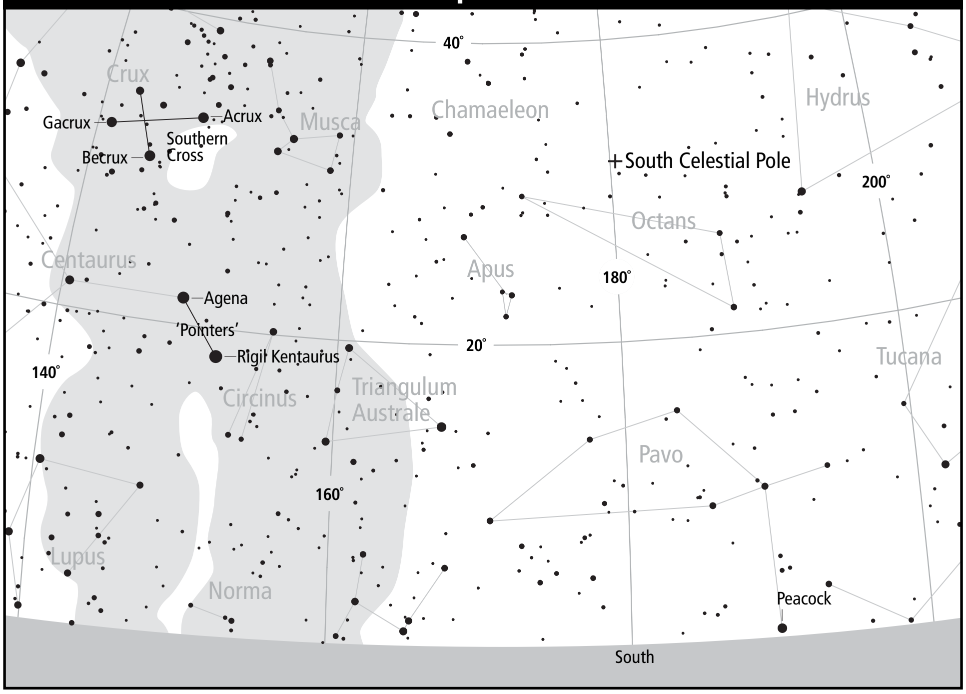
JUPITER MOONS



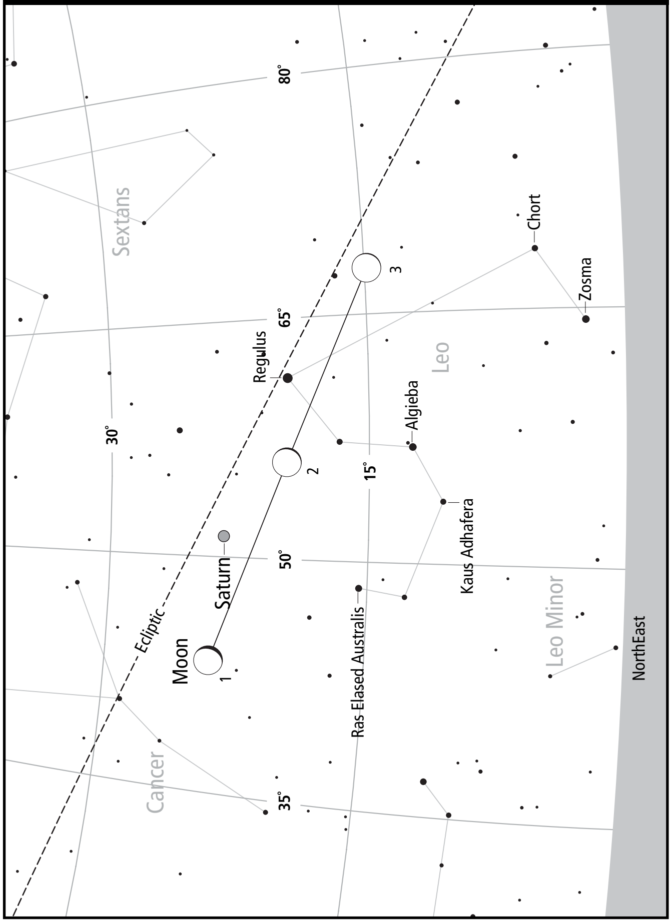
SATURN MOONS



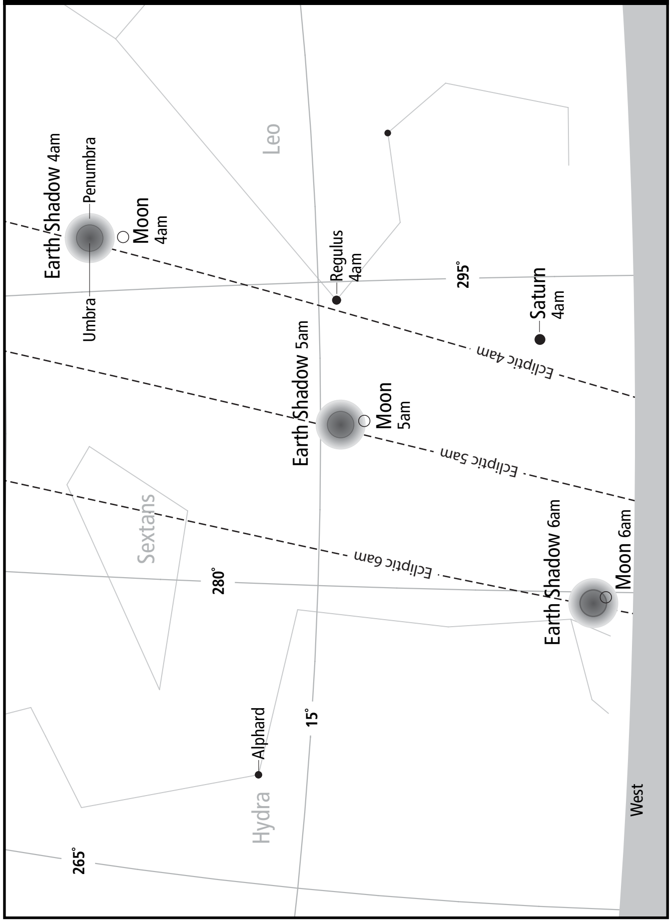
SKYVIEW 2007 MARCH 15 8pm



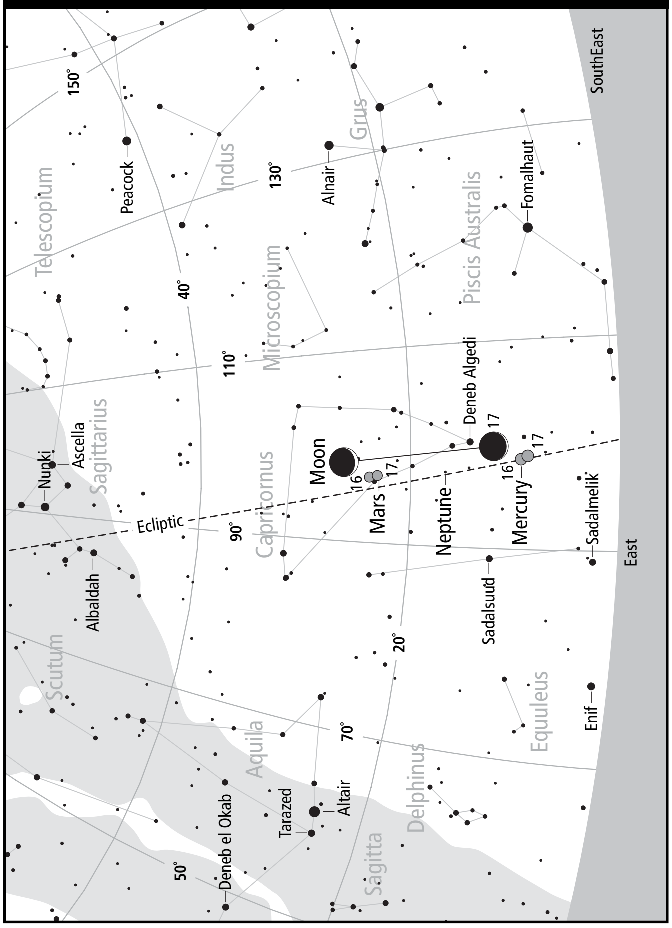
SKYVIEW 2007 MARCH 1-3 8pm



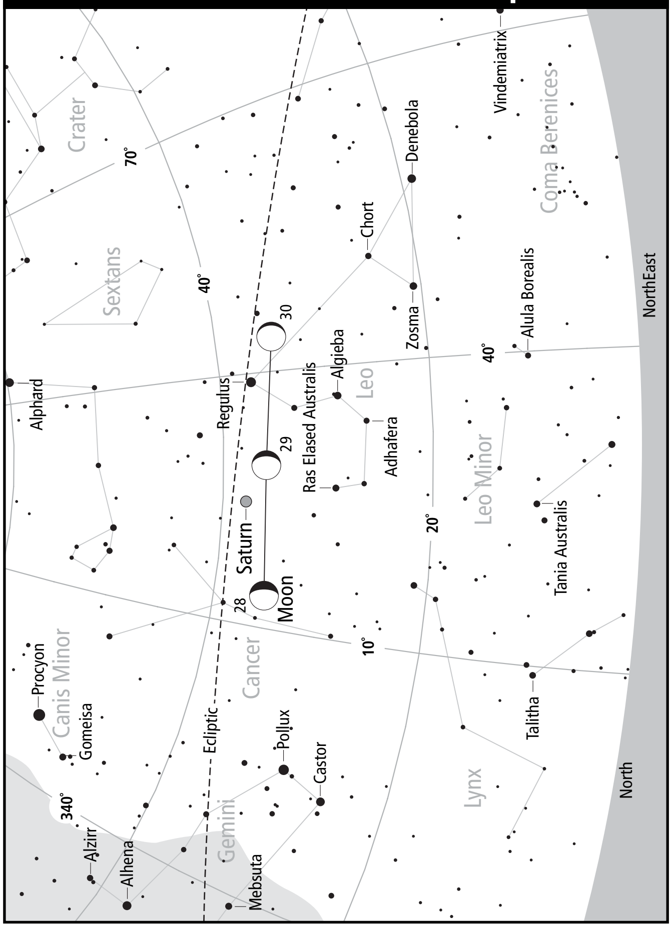
SKYVIEW 2007 MARCH 4 4-6am



SKYVIEW 2007 MARCH 16-17 5am



SKYVIEW 2007 MARCH 28-30 8pm



APRIL 2007

HIGHLIGHTS

***Mercury** visible very low in eastern morning twilight in the first half of month.*

***Venus** clearly visible in the western evening twilight.*

***Mars** visible low in the east before dawn.*

***Jupiter** rises mid evening and visible high in sky.*

***Saturn** visible most of evening and sets in the west after midnight by mid month.*

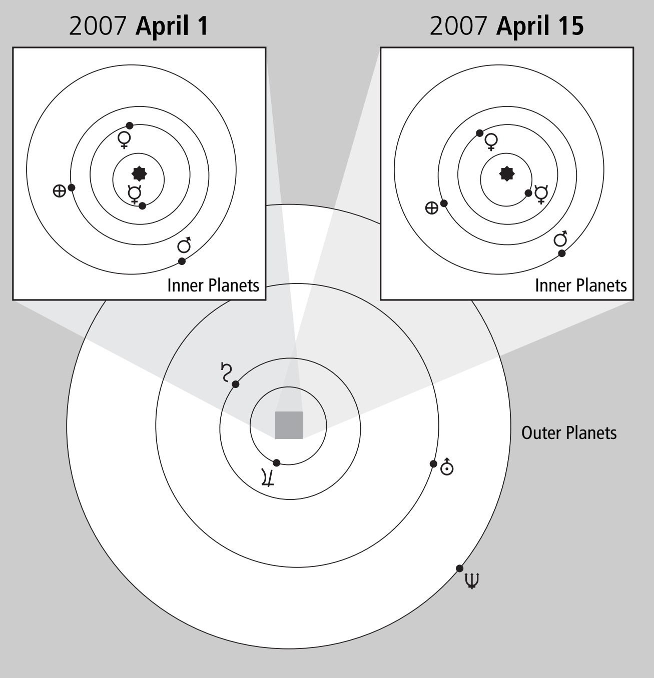
DIARY

Day	Hour	
3	01	**Full Moon**
3	17	Moon at apogee
6	10	Jupiter stationary
7	21	*Antares* 0.°6 N. of Moon
8	17	Jupiter 6° N. of Moon
11	02	**Last Quarter**
14	10	Mars 0.°5 S. of Moon
16	19	Mercury 5° S. of Moon.
17	14	Moon at perigee
17	20	**New Moon**
20	09	Saturn stationary
20	16	Venus 3° S. of Moon
21	20	Venus 7° N. of *Aldebaran*
23		Maximum activity of pi-Puppids meteors
24	15	**First Quarter**
25	18	Saturn 1.°1 S. of Moon
26	17	*Regulus* 1.°0 S. of Moon
30	19	Moon at apogee

SUN+MOON RISE/SET

DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0628	85	0506	1221	1813	275	1934	1727	0458	96
2	0628	85	0507	1220	1812	275	1933	1752	0552	99
3	0629	85	0508	1220	1811	276	1932	1817	0646	100
4	0630	84	0508	1220	1810	276	1931	1844	0741	99
5	0630	84	0509	1219	1808	277	1929	1914	0838	97
6	0631	83	0510	1219	1807	277	1928	1950	0936	92
7	0632	83	0510	1219	1806	277	1927	2031	1035	86
8	0632	82	0511	1219	1805	278	1926	2119	1133	79
9	0633	82	0512	1218	1803	278	1924	2215	1229	71
10	0634	81	0512	1218	1802	279	1923	2316	1320	61
11	0634	81	0513	1218	1801	279	1922	DNR	1406	51
12	0635	81	0514	1218	1800	280	1921	0022	1446	40
13	0636	80	0514	1217	1759	280	1920	0129	1522	30
14	0636	80	0515	1217	1757	281	1919	0238	1555	20
15	0637	79	0515	1217	1756	281	1918	0346	1626	12
16	0638	79	0516	1217	1755	281	1917	0456	1658	5
17	0638	78	0517	1216	1754	282	1915	0608	1732	1
18	0639	78	0517	1216	1753	282	1914	0722	1811	0
19	0640	78	0518	1216	1752	283	1913	0837	1856	2
20	0640	77	0519	1216	1751	283	1912	0952	1948	7
21	0641	77	0519	1215	1749	283	1911	1101	2047	15
22	0642	76	0520	1215	1748	284	1910	1202	2150	24
23	0642	76	0520	1215	1747	284	1909	1254	2256	33
24	0643	76	0521	1215	1746	285	1908	1336	2359	44
25	0644	75	0522	1215	1745	285	1907	1411	DNS	54
26	0644	75	0522	1215	1744	285	1906	1441	0100	64
27	0645	74	0523	1214	1743	286	1906	1507	0157	73
28	0646	74	0523	1214	1742	286	1905	1532	0253	81
29	0646	74	0524	1214	1741	287	1904	1556	0347	88
30	0647	73	0524	1214	1740	287	1903	1621	0441	93

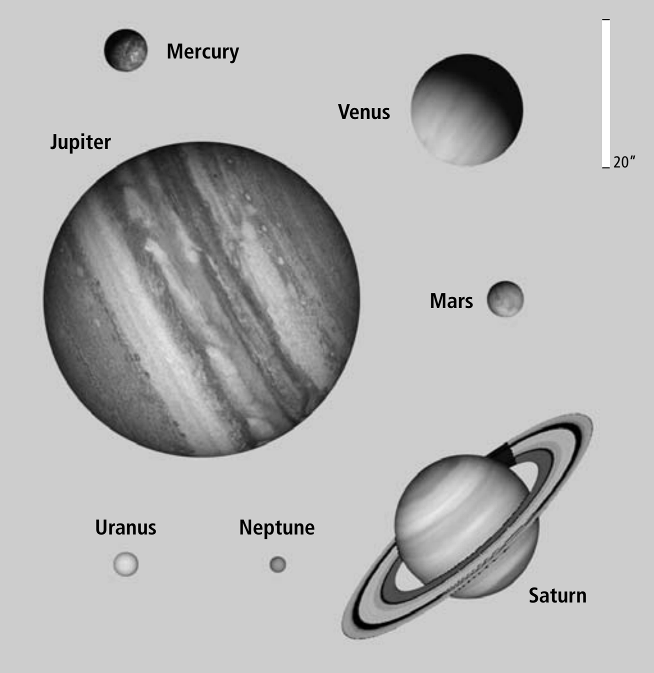
PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus

♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE



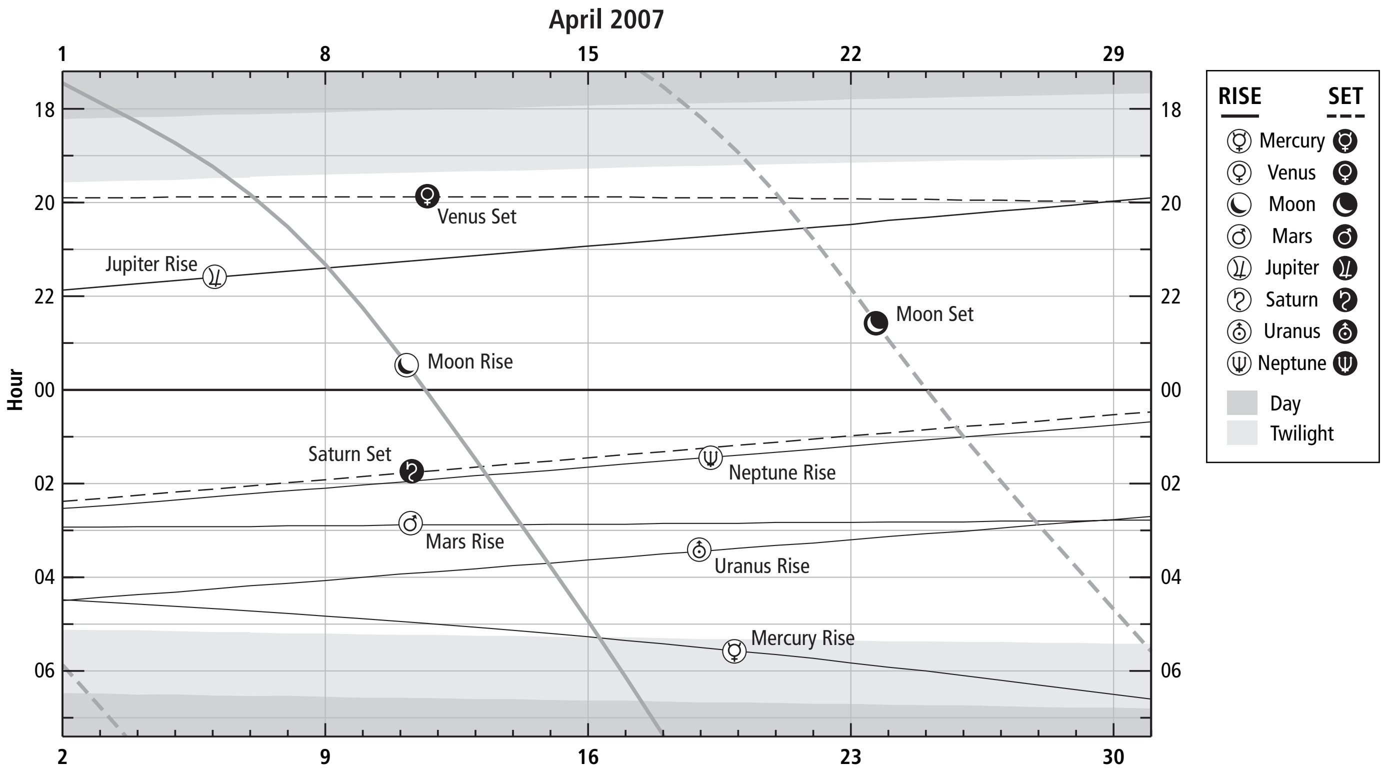
1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)

Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY Rise h m	MERCURY Set h m	VENUS Rise h m	VENUS Set h m	MARS Rise h m	MARS Set h m	JUPITER Rise h m	JUPITER Set h m	SATURN Rise h m	SATURN Set h m	URANUS Rise h m	URANUS Set h m	NEPTUNE Rise h m	NEPTUNE Set h m
1	0427	1712	0921	1954	0256	1613	2152	1158	1545	0227	0433	1708	0236	1555
2	0429	1712	0922	1954	0256	1611	2148	1154	1541	0223	0430	1704	0232	1551
3	0432	1712	0924	1954	0256	1610	2144	1150	1537	0219	0426	1700	0229	1547
4	0434	1712	0926	1953	0255	1608	2140	1146	1533	0215	0422	1656	0225	1543
5	0437	1712	0928	1953	0255	1606	2136	1142	1529	0211	0419	1652	0221	1539
6	0440	1713	0930	1953	0255	1605	2132	1139	1524	0207	0415	1649	0217	1535
7	0443	1713	0932	1953	0255	1603	2128	1135	1520	0203	0411	1645	0213	1532
8	0446	1713	0934	1953	0254	1601	2124	1131	1516	0159	0408	1641	0209	1528
9	0450	1713	0935	1953	0254	1600	2120	1127	1512	0155	0404	1637	0206	1524
10	0453	1714	0937	1953	0254	1558	2116	1123	1508	0151	0400	1633	0202	1520
11	0457	1714	0939	1953	0253	1556	2112	1119	1505	0147	0356	1630	0158	1516
12	0500	1714	0941	1953	0253	1555	2108	1115	1501	0143	0353	1626	0154	1512
13	0504	1715	0943	1953	0253	1553	2104	1111	1457	0139	0349	1622	0150	1508
14	0508	1715	0945	1953	0253	1551	2100	1107	1453	0135	0345	1618	0147	1504
15	0512	1716	0946	1953	0252	1549	2056	1103	1449	0131	0342	1614	0143	1501
16	0516	1716	0948	1953	0252	1548	2052	1058	1445	0127	0338	1611	0139	1457
17	0521	1717	0950	1954	0252	1546	2048	1054	1441	0123	0334	1607	0135	1453
18	0525	1717	0952	1954	0251	1544	2044	1050	1437	0119	0330	1603	0131	1449
19	0530	1718	0953	1954	0251	1542	2040	1046	1433	0115	0327	1559	0127	1445
20	0535	1719	0955	1954	0251	1540	2036	1042	1429	0111	0323	1555	0124	1441
21	0539	1720	0957	1955	0250	1539	2032	1038	1425	0107	0319	1552	0120	1437
22	0544	1721	0959	1955	0250	1537	2028	1034	1421	0103	0316	1548	0116	1434
23	0550	1722	1000	1956	0250	1535	2023	1030	1417	0059	0312	1544	0112	1430
24	0555	1723	1002	1956	0249	1533	2019	1025	1413	0055	0308	1540	0108	1426
25	0600	1724	1003	1957	0249	1531	2015	1021	1409	0051	0304	1536	0104	1422
26	0606	1725	1005	1957	0249	1529	2011	1017	1405	0047	0301	1533	0100	1418
27	0612	1727	1006	1958	0248	1528	2007	1013	1401	0044	0257	1529	0057	1414
28	0618	1728	1008	1958	0248	1526	2003	1009	1358	0040	0253	1525	0053	1410
29	0624	1730	1009	1959	0248	1524	1958	1004	1354	0036	0249	1521	0049	1406
30	0630	1732	1011	2000	0247	1522	1954	1000	1350	0032	0246	1517	0045	1402

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

DAY	PHENOMENON h m	Satellite	Event
1	0013	II	Oc.R.
2	0521		GRS
3	0111		GRS
5	0249		GRS
5	0545	I	Sh.I.
5	2240		GRS
6	0258	I	Ec.D.
6	0309	II	Sh.I.
6	0407	III	Sh.I.
6	0524	II	Tr.I.
6	0540	II	Sh.E.
6	0612	III	Sh.E.
6	0617	I	Oc.R.
7	0013	I	Sh.I.
7	0121	I	Tr.I.
7	0223	I	Sh.E.
7	0331	I	Tr.E.
7	0426		GRS
7	2149	II	Ec.D.
8	0017		GRS
8	0044	I	Oc.R.
8	0241	II	Oc.R.
8	2158	I	Tr.E.
9	0603		GRS

DAY	PHENOMENON h m	Satellite	Event
9	2244	III	Oc.D.
10	0047	III	Oc.R.
10	0154		GRS
10	2145		GRS
12	0331		GRS
12	2322		GRS
13	0451	I	Ec.D.
13	0542	II	Sh.I.
14	0206	I	Sh.I.
14	0310	I	Tr.I.
14	0417	I	Sh.E.
14	0508		GRS
14	0520	I	Tr.E.
14	2319	I	Ec.D.
15	0025	II	Ec.D.
15	0059		GRS
15	0232	I	Oc.R.
15	0507	II	Oc.R.
15	2137	I	Tr.I.
15	2246	I	Sh.E.
15	2347	I	Tr.E.
16	2059	I	Oc.R.
16	2100	II	Tr.I.
16	2130	II	Sh.E.
16	2210	III	Ec.D.
16	2330	II	Tr.E.
17	0019	III	Ec.R.
17	0221	III	Oc.D.
17	0236		GRS
17	0423	III	Oc.R.
17	2227		GRS
19	0414		GRS
20	0004		GRS
21	0400	I	Sh.I.
21	0458	I	Tr.I.
21	0551		GRS
21	0611	I	Sh.E.

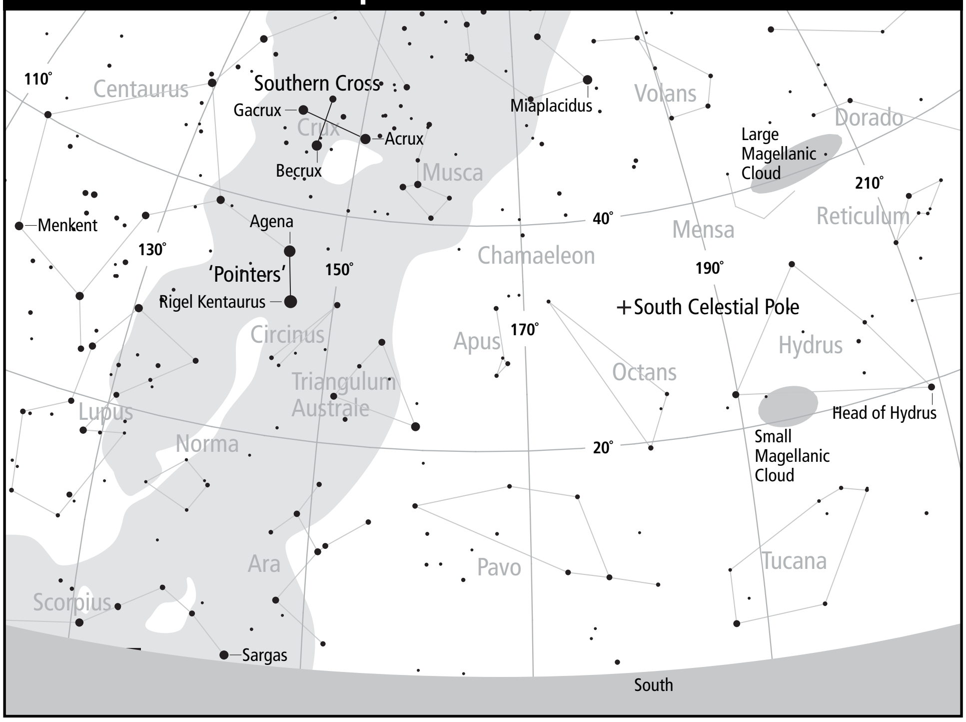
DAY	PHENOMENON h m	Satellite	Event
22	0112	I	Ec.D.
22	0141		GRS
22	0301	II	Ec.D.
22	0419	I	Oc.R.
22	2132		GRS
22	2228	I	Sh.I.
22	2325	I	Tr.I.
23	0039	I	Sh.E.
23	0135	I	Tr.E.
23	2131	II	Sh.I.
23	2246	I	Oc.R.
23	2321	II	Tr.I.
24	0003	II	Sh.E.
24	0151	II	Tr.E.
24	0207	III	Ec.D.
24	0319		GRS
24	0417	III	Ec.R.
24	0553	III	Oc.D.
24	2309		GRS
25	2042	II	Oc.R.
26	0456		GRS
27	0046		GRS
27	2037		GRS
27	2134	III	Tr.E.
28	0554	I	Sh.I.
28	0633		GRS
28	0645	I	Tr.I.
29	0224		GRS
29	0305	I	Ec.D.
29	0537	II	Ec.D.
29	0606	I	Oc.R.
29	2214		GRS
30	0022	I	Sh.I.
30	0111	I	Tr.I.
30	0233	I	Sh.E.
30	0322	I	Tr.E.
30	2134	I	Ec.D.

Moons:
I Io — III Ganymede
II Europa — IV Callisto

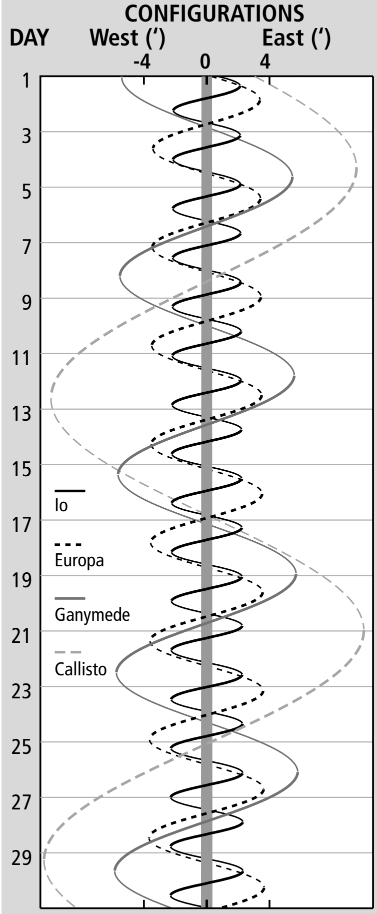
Events:
D Disappear — R Reappear
E Egress — I Ingress
Ec Eclipse — Oc Occult
Sh Shadow — Tr Transit

GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

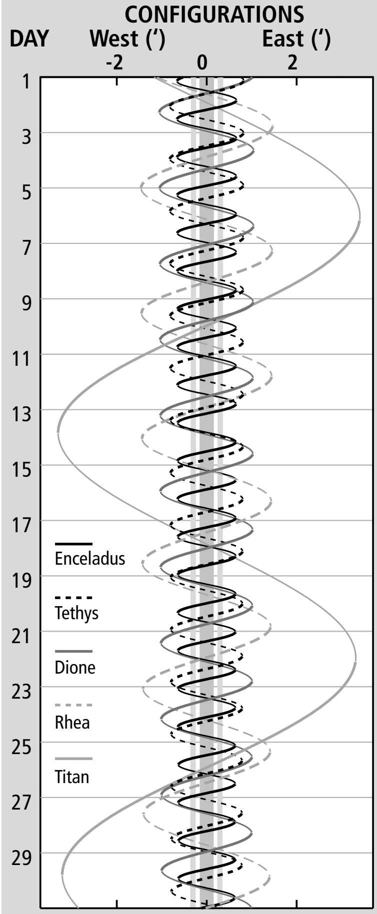
SKYVIEW APRIL 15 8pm – SOUTHERN CROSS



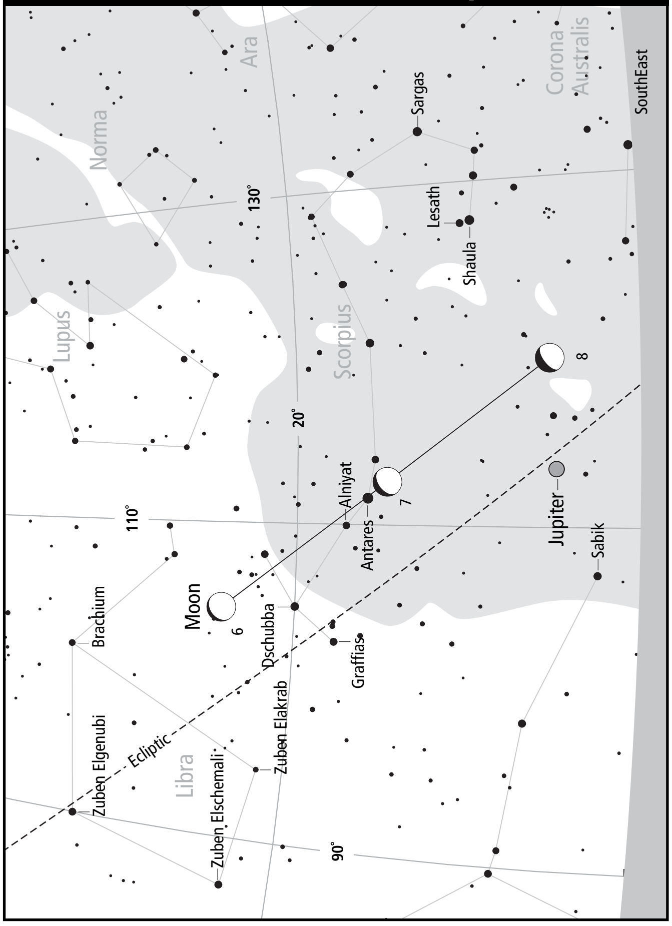
JUPITER MOONS



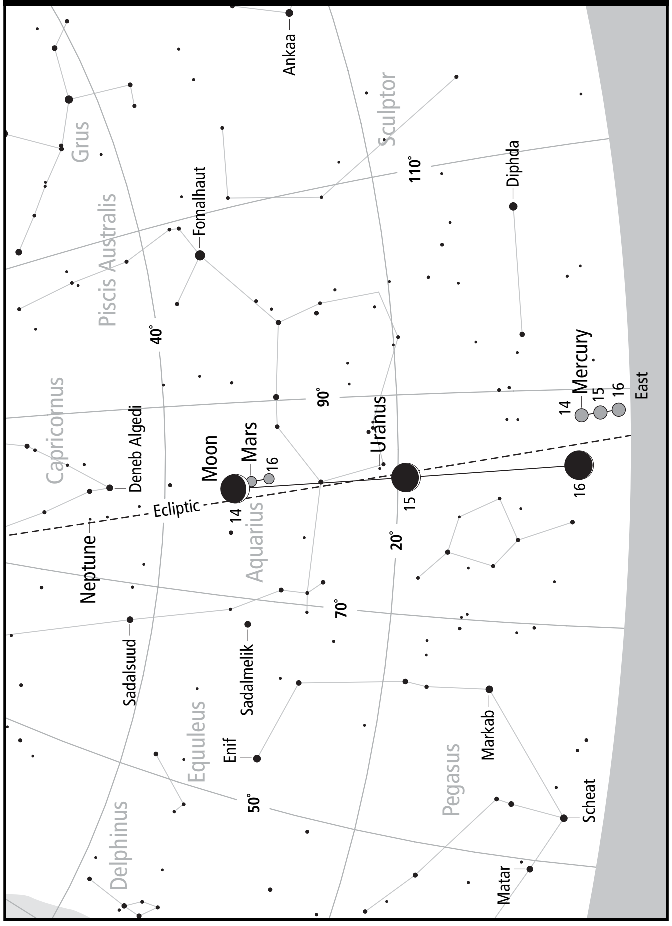
SATURN MOONS



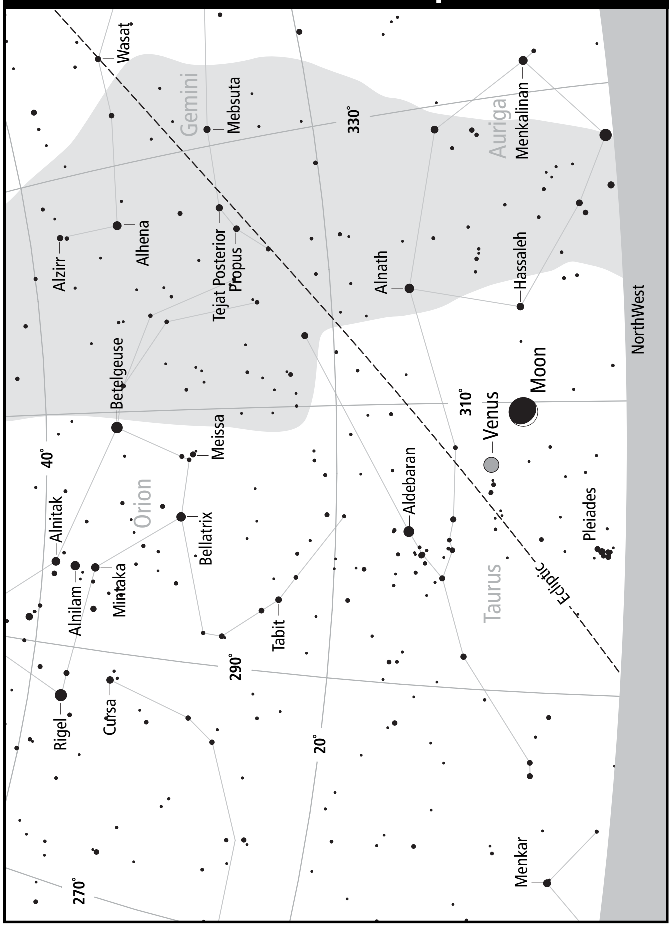
SKYVIEW 2007 APRIL 6-8 10pm



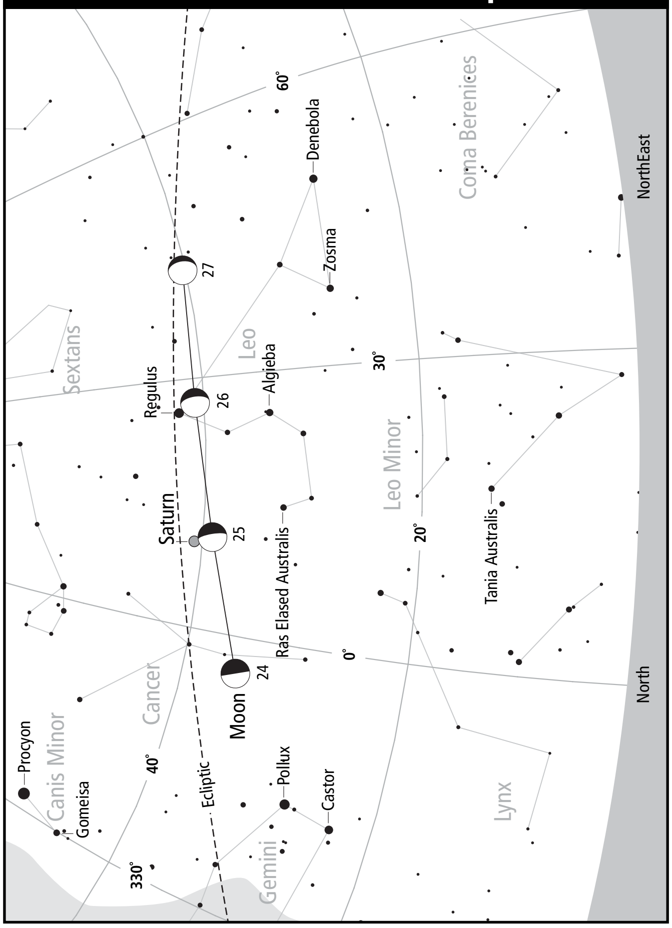
SKYVIEW 2007 APRIL 14-15 5.30am



SKYVIEW 2007 APRIL 20 7pm



SKYVIEW 2007 APRIL 24-27 7pm



MAY 2007

HIGHLIGHTS

Mercury *visible very low in western evening twilight in second half of month.*

Venus *clearly visible in the NW in the early evening, may be visible in day near Moon on 20th.*

Mars *visible low in the east before dawn.*

Jupiter *visible nearly all night.*

Saturn *visible most of evening in the NW sky.*

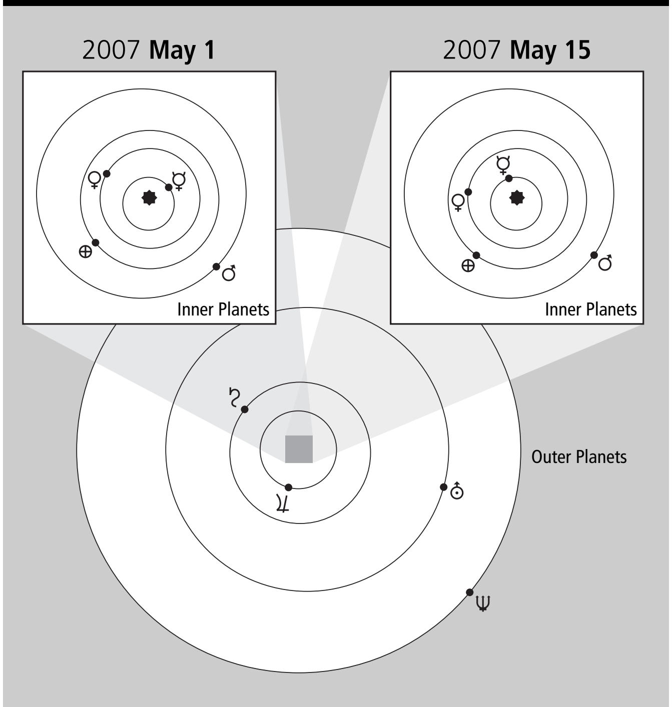
DIARY

Day	Hour	
2	18	**Full Moon**
3	12	Mercury in superior conjunction
5		Maximum activity of eta-Aquarid meteor shower
5	02	*Antares* 0.°5 N. of Moon
5	20	Jupiter 6° N. of Moon
10	12	**Last Quarter**
13	09	Mars 3° S. of Moon
15	23	Moon at perigee
17	03	**New Moon**
17	05	Mercury 7° N. of *Aldebaran*
18	08	Mercury 3° S. of Moon
19		Maximum activity of Sagittarid meteor shower
20	09	Venus 1.°7 S. of Moon
23	03	Saturn 0.°8 S. of Moon
24	00	*Regulus* 0.°7 N. of Moon
24	05	**First Quarter**
25	14	Neptune stationary
28	06	Moon at apogee
31	03	Venus 4° S. of *Pollux*

SUN+MOON RISE/SET

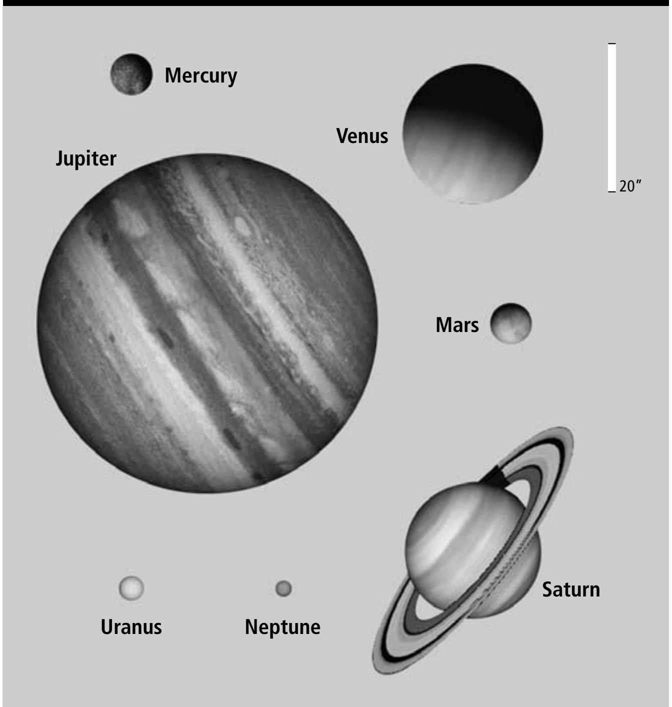
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0648	73	0525	1214	1739	287	1902	1647	0535	97
2	0649	73	0526	1214	1738	288	1901	1717	0632	99
3	0649	72	0526	1214	1737	288	1901	1751	0729	100
4	0650	72	0527	1213	1737	288	1900	1830	0828	98
5	0651	72	0527	1213	1736	289	1859	1916	0927	95
6	0651	71	0528	1213	1735	289	1858	2010	1024	90
7	0652	71	0528	1213	1734	289	1858	2109	1116	84
8	0653	70	0529	1213	1733	290	1857	2212	1203	75
9	0653	70	0530	1213	1732	290	1856	2317	1244	66
10	0654	70	0530	1213	1732	290	1855	DNR	1320	56
11	0655	70	0531	1213	1731	291	1855	0023	1353	45
12	0655	69	0531	1213	1730	291	1854	0129	1424	34
13	0656	69	0532	1213	1729	291	1854	0236	1454	23
14	0657	69	0532	1213	1729	292	1853	0344	1526	14
15	0658	68	0533	1213	1728	292	1853	0455	1602	7
16	0658	68	0534	1213	1727	292	1852	0609	1643	2
17	0659	68	0534	1213	1727	292	1852	0725	1732	0
18	0700	67	0535	1213	1726	293	1851	0838	1829	1
19	0700	67	0535	1213	1726	293	1851	0945	1932	5
20	0701	67	0536	1213	1725	293	1850	1043	2039	11
21	0702	67	0536	1213	1725	293	1850	1130	2146	19
22	0702	66	0537	1213	1724	294	1849	1209	2249	28
23	0703	66	0537	1213	1724	294	1849	1241	2349	38
24	0703	66	0538	1213	1723	294	1849	1309	DNS	48
25	0704	66	0538	1213	1723	294	1848	1335	0046	58
26	0705	66	0539	1214	1722	295	1848	1359	0141	67
27	0705	65	0539	1214	1722	295	1848	1424	0235	76
28	0706	65	0540	1214	1721	295	1847	1450	0329	83
29	0707	65	0540	1214	1721	295	1847	1518	0425	90
30	0707	65	0541	1214	1721	295	1847	1551	0522	95
31	0708	65	0541	1214	1720	295	1847	1629	0621	98

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

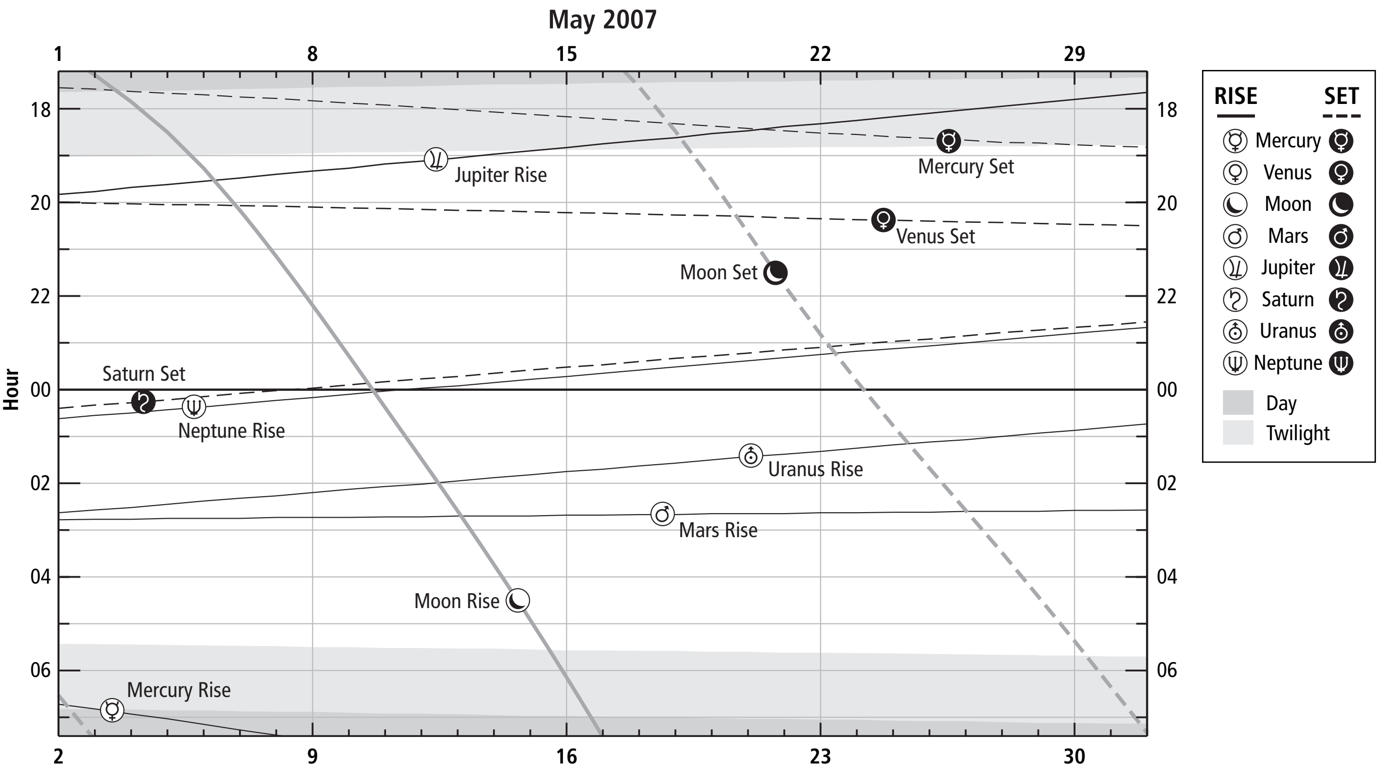


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		SATURN		URANUS		NEPTUNE	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0636	1733	1012	2000	0247	1520	1950	0956	1346	0028	0242	1513	0041	1359
2	0643	1735	1014	2001	0247	1518	1946	0952	1342	0024	0238	1510	0037	1355
3	0649	1738	1015	2002	0246	1517	1941	0947	1338	0020	0234	1506	0033	1351
4	0656	1740	1016	2003	0246	1515	1937	0943	1334	0017	0231	1502	0030	1347
5	0702	1742	1018	2003	0245	1513	1933	0939	1331	0013	0227	1458	0026	1343
6	0709	1745	1019	2004	0245	1511	1929	0934	1327	0009	0223	1454	0022	1339
7	0716	1747	1020	2005	0245	1509	1924	0930	1323	0005	0219	1450	0018	1335
8	0723	1750	1021	2006	0244	1507	1920	0926	1319	0001	0216	1447	0014	1331
8										2358				
9	0729	1753	1022	2007	0244	1505	1916	0921	1315	2354	0212	1443	0010	1327
10	0736	1755	1023	2008	0244	1503	1911	0917	1311	2350	0208	1439	0006	1323
11	0743	1758	1024	2009	0243	1502	1907	0913	1307	2346	0204	1435	0002	1320
11													2358	
12	0749	1801	1025	2010	0243	1500	1903	0908	1304	2343	0201	1431	2355	1316
13	0755	1804	1026	2011	0242	1458	1858	0904	1300	2339	0157	1427	2351	1312
14	0801	1807	1027	2012	0242	1456	1854	0859	1256	2335	0153	1424	2347	1308
15	0807	1810	1027	2013	0242	1454	1850	0855	1252	2331	0149	1420	2343	1304
16	0813	1813	1028	2014	0241	1452	1845	0851	1248	2328	0145	1416	2339	1300
17	0818	1816	1029	2015	0241	1450	1841	0846	1245	2324	0142	1412	2335	1256
18	0823	1819	1029	2016	0240	1448	1837	0842	1241	2320	0138	1408	2331	1252
19	0828	1822	1030	2017	0240	1446	1832	0837	1237	2317	0134	1404	2327	1248
20	0833	1825	1030	2018	0239	1444	1828	0833	1233	2313	0130	1400	2323	1244
21	0837	1828	1031	2020	0239	1443	1823	0828	1230	2309	0126	1357	2319	1240
22	0841	1831	1031	2021	0239	1441	1819	0824	1226	2306	0123	1353	2315	1236
23	0844	1833	1032	2022	0238	1439	1815	0819	1222	2302	0119	1349	2311	1233
24	0847	1836	1032	2023	0238	1437	1810	0815	1218	2258	0115	1345	2308	1229
25	0850	1838	1032	2024	0237	1435	1806	0810	1215	2255	0111	1341	2304	1225
26	0853	1840	1032	2025	0237	1433	1801	0806	1211	2251	0107	1337	2300	1221
27	0855	1843	1032	2026	0236	1431	1757	0802	1207	2247	0104	1333	2256	1217
28	0857	1844	1032	2027	0236	1429	1752	0757	1203	2244	0100	1330	2252	1213
29	0858	1846	1032	2028	0236	1427	1748	0753	1200	2240	0056	1326	2248	1209
30	0859	1848	1032	2029	0235	1425	1744	0748	1156	2237	0052	1322	2244	1205
31	0900	1849	1032	2030	0235	1423	1739	0744	1152	2233	0048	1318	2240	1201

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

DAY	PHENOMENON h m	Sat.	Event
1	0004	II	Sh.I.
1	0032	I	Oc.R.
1	0140	II	Tr.I.
1	0237	II	Sh.E.
1	0401		GRS
1	0410	II	Tr.E.
1	0604	III	Ec.D.
1	2102	I	Sh.E.
1	2149	I	Tr.E.
1	2351		GRS
2	2303	II	Oc.R.
3	0538		GRS
4	0128		GRS
4	1959	III	Sh.I.
4	2119		GRS
4	2208	III	Sh.E.
4	2301	III	Tr.I.
5	0101	III	Tr.E.
6	0305		GRS
6	0459	I	Ec.D.
6	2256		GRS
7	0216	I	Sh.I.
7	0257	I	Tr.I.
7	0427	I	Sh.E.
7	0508	I	Tr.E.
7	2327	I	Ec.D.
8	0218	I	Oc.R.
8	0237	II	Sh.I.
8	0357	II	Tr.I.

DAY	PHENOMENON h m	Sat.	Event
8	0442		GRS
8	0510	II	Sh.E.
8	0628	II	Tr.E.
8	2044	I	Sh.I.
8	2124	I	Tr.I.
8	2256	I	Sh.E.
8	2334	I	Tr.E.
9	0033		GRS
9	2024		GRS
9	2044	I	Oc.R.
9	2131	II	Ec.D.
10	0122	II	Oc.R.
10	0619		GRS
11	0210		GRS
11	1936	II	Tr.E.
11	2201		GRS
11	2357	III	Sh.I.
12	0207	III	Sh.E.
12	0224	III	Tr.I.
12	0424	III	Tr.E.
13	0347		GRS
13	0652	I	Ec.D.
13	2338		GRS
14	0410	I	Sh.I.
14	0443	I	Tr.I.
14	0621	I	Sh.E.
14	0653	I	Tr.E.
14	1929		GRS
15	0120	I	Ec.D.

DAY	PHENOMENON h m	Sat.	Event
15	0402	I	Oc.R.
15	0511	II	Sh.I.
15	0524		GRS
15	0613	II	Tr.I.
15	2238	I	Sh.I.
15	2309	I	Tr.I.
16	0050	I	Sh.E.
16	0115		GRS
16	0119	I	Tr.E.
16	1949	I	Ec.D.
16	2106		GRS
16	2228	I	Oc.R.
17	0007	II	Ec.D.
17	0339	II	Oc.R.
17	1918	I	Sh.E.
17	1946	I	Tr.E.
18	0252		GRS
18	1921	II	Tr.I.
18	2101	II	Sh.E.
18	2151	II	Tr.E.
18	2243		GRS
19	0354	III	Sh.I.
19	0544	III	Tr.I.
19	0606	III	Sh.E.
20	0429		GRS
21	0020		GRS
21	0604	I	Sh.I.
21	0627	I	Tr.I.
21	2011		GRS
22	0314	I	Ec.D.
22	0546	I	Oc.R.
22	0606		GRS
22	2130	III	Oc.R.
23	0032	I	Sh.I.
23	0053	I	Tr.I.
23	0157		GRS
23	0244	I	Sh.E.
23	0304	I	Tr.E.

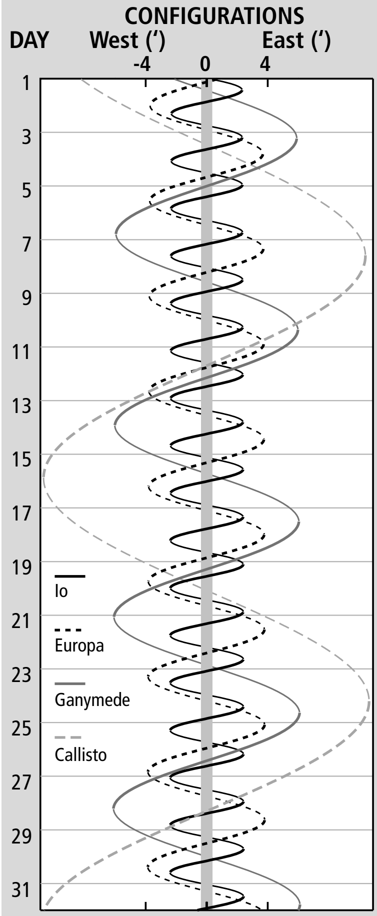
DAY	PHENOMENON h m	Sat.	Event
23	2142	I	Ec.D.
23	2148		GRS
24	0012	I	Oc.R.
24	0243	II	Ec.D.
24	0556	II	Oc.R.
24	1901	I	Sh.I.
24	1919	I	Tr.I.
24	2112	I	Sh.E.
24	2130	I	Tr.E.
25	0334		GRS
25	2101	II	Sh.I.
25	2135	II	Tr.I.
25	2325		GRS
25	2335	II	Sh.E.
26	0006	II	Tr.E.
26	1915		GRS
27	0511		GRS
27	1904	II	Oc.R.
28	0102		GRS
28	2052		GRS
29	0508	I	Ec.D.
29	0648		GRS
29	2156	III	Ec.D.
30	0048	III	Oc.R.
30	0226	I	Sh.I.
30	0237	I	Tr.I.
30	0239		GRS
30	0438	I	Sh.E.
30	0448	I	Tr.E.
30	2229		GRS
30	2336	I	Ec.D.
31	0156	I	Oc.R.
31	0520	II	Ec.D.
31	2055	I	Sh.I.
31	2103	I	Tr.I.
31	2307	I	Sh.E.
31	2314	I	Tr.E.

Moons: I Io; II Europa; III Ganymede; IV Callisto

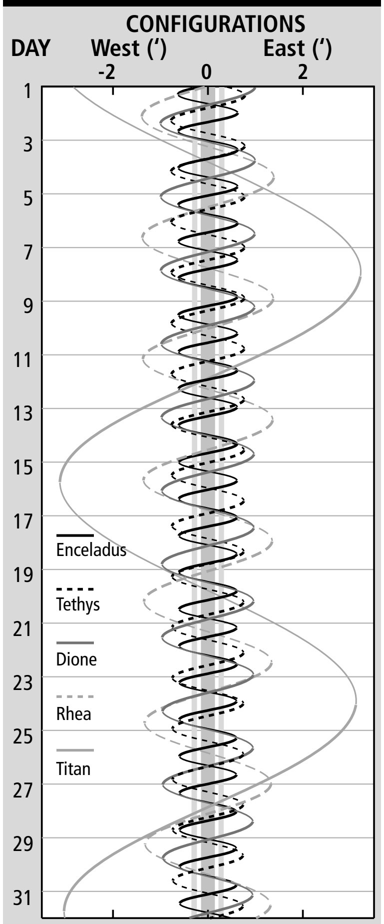
Events: D Disappear; R Reappear; E Egress; I Ingress; Ec Eclipse; Oc Occult; Sh Shadow; Tr Transit

GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

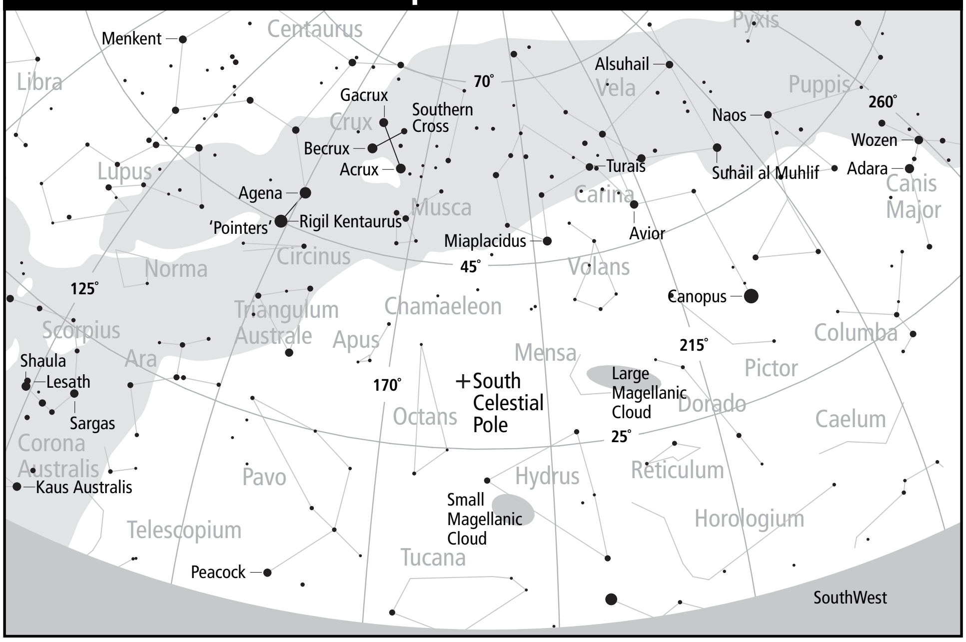
JUPITER MOONS



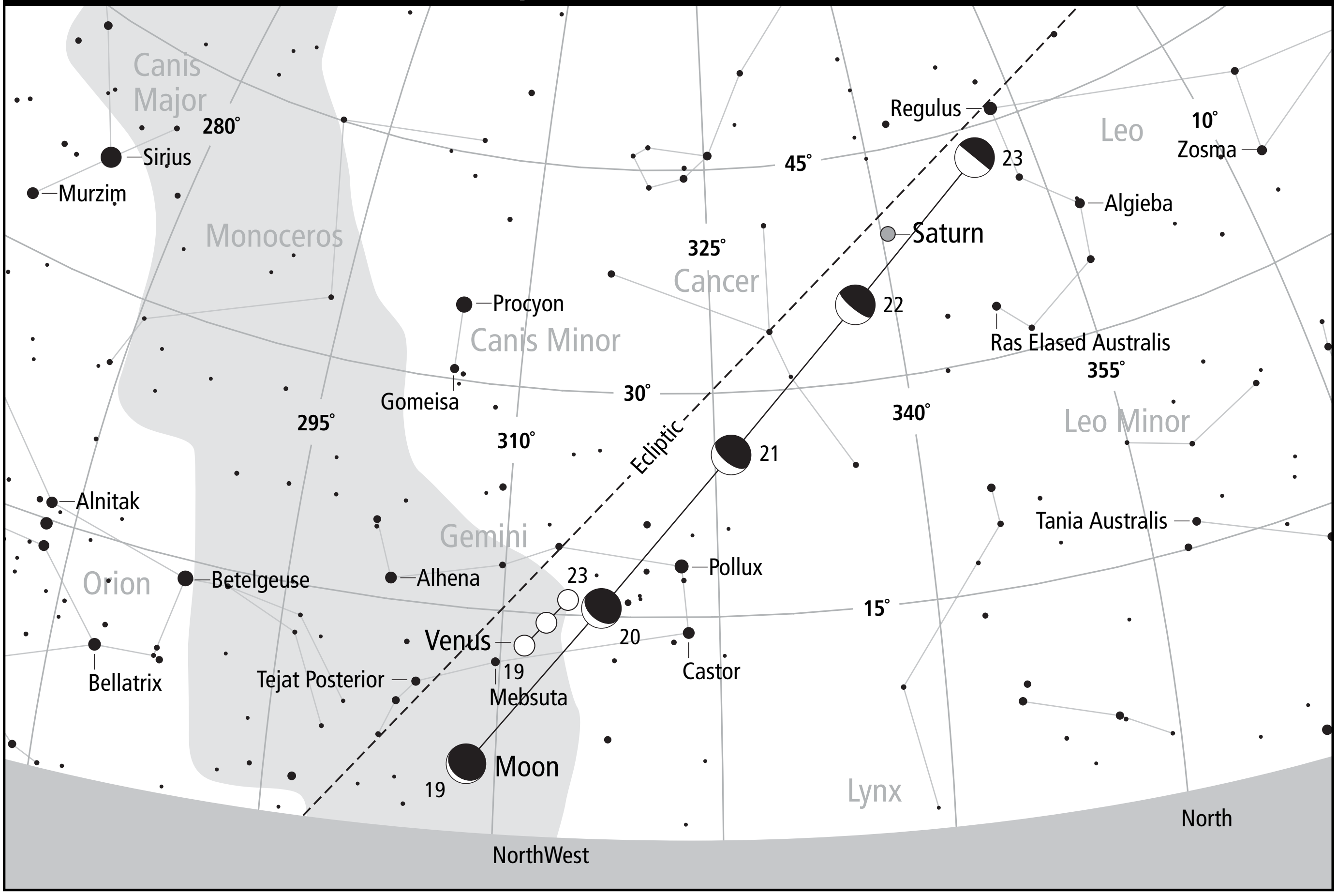
SATURN MOONS



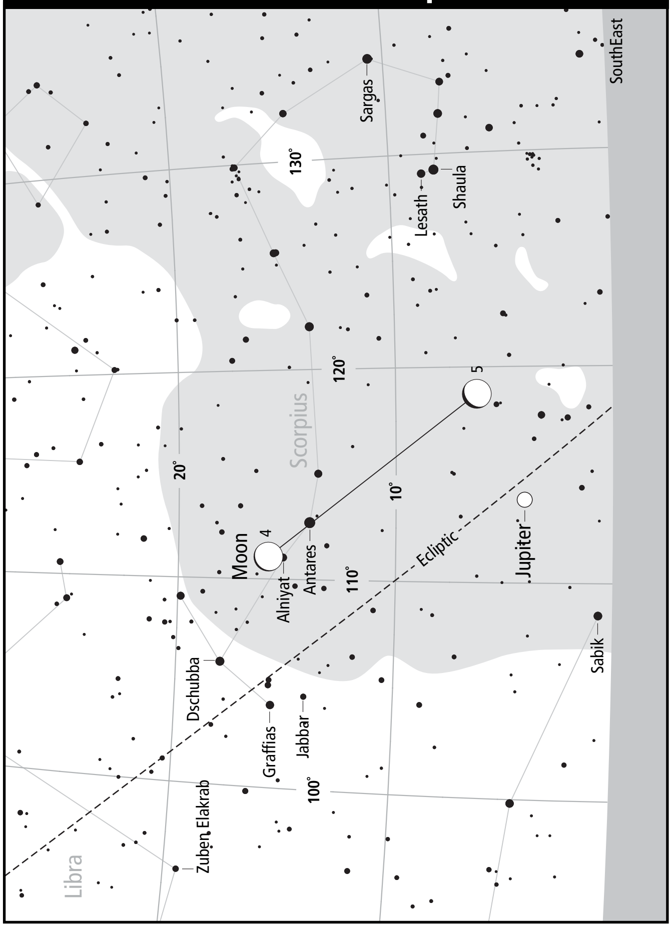
SKYVIEW 2007 MAY 15 8pm



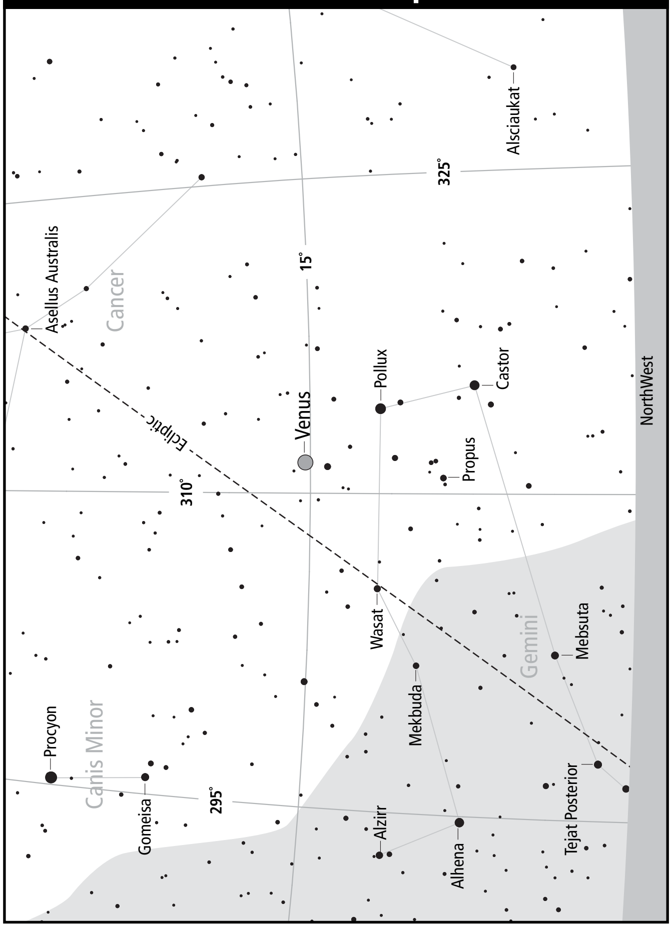
SKYVIEW 2007 FEBRUARY 19-23 7pm



SKYVIEW 2007 MAY 4-5 8pm



SKYVIEW 2007 MAY 31 7pm



JUNE 2007

HIGHLIGHTS

Moon *two Full Moon phases, 1st and 30th.*
Mercury *visible very low in western evening twilight in first half of month.*
Venus *clearly visible in the NW in the early evening*
Mars *visible in the eastern before dawn.*
Jupiter *visible nearly all night.*
Saturn *visible in the early evening in the NW sky.*

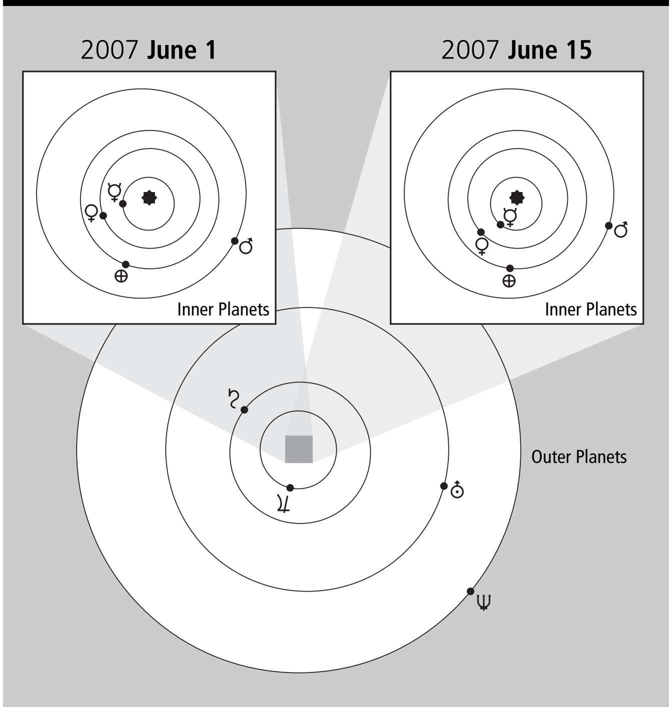
DIARY

Day	Hour	
1	09	*Antares* 0.°4 N. of Moon
1	09	**Full Moon**
1	20	Jupiter 6° N. of Moon
2	18	Mercury greatest elongation E. (23°)
6	07	Jupiter at opposition
8	20	**Last Quarter**
9	11	Venus greatest elongation E. (45°)
11	06	Mars 5° S. of Moon
13	01	Moon at perigee
15	11	**New Moon**
16	00	Mercury stationary
16	17	Mercury 0.°6 S. of Moon
18	23	Venus 0.°6 S. of Moon
19	16	Saturn 0.°4 S. of Moon
20	08	*Regulus* 0.°4 S. of Moon
22	02	Solstice
22	21	**First Quarter**
24	07	Uranus stationary
24	22	Moon at apogee
28	16	*Antares* 0.°5 N. of Moon
28	22	Jupiter 6° N. of Moon
29	03	Mercury in inferior conjunction
30	22	**Full Moon**

SUN+MOON RISE/SET

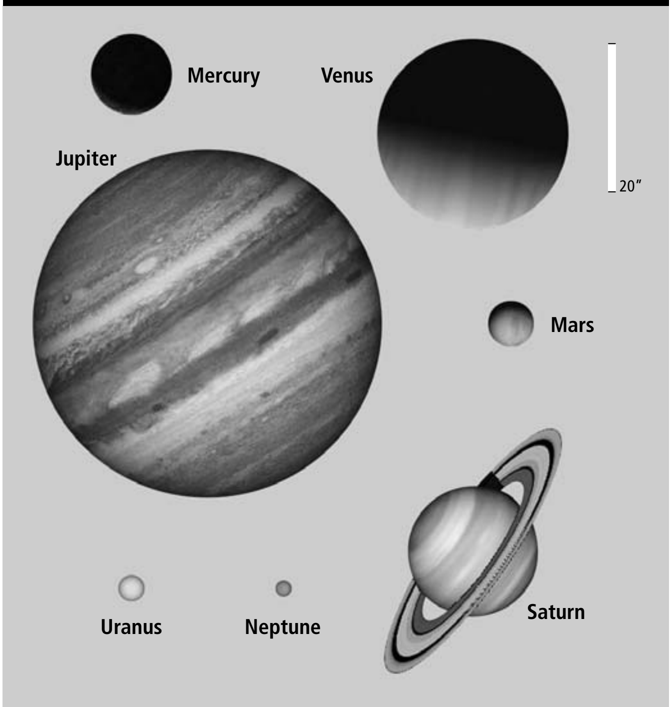
DAY	SUN Rise h m	SUN Azimuth (°)	SUN Twlght h m	SUN Transit Time h m	SUN Set h m	SUN Azimuth (°)	SUN Twlght h m	MOON Rise h m	MOON Set h m	MOON Illumintn (%)
1	0708	64	0542	1214	1720	296	1847	1713	0720	100
2	0709	64	0542	1214	1720	296	1847	1805	0818	99
3	0709	64	0543	1215	1720	296	1846	1903	0913	97
4	0710	64	0543	1215	1720	296	1846	2006	1001	93
5	0710	64	0544	1215	1719	296	1846	2110	1044	87
6	0711	64	0544	1215	1719	296	1846	2216	1121	79
7	0711	64	0544	1215	1719	297	1846	2320	1154	70
8	0712	63	0545	1216	1719	297	1846	DNR	1225	59
9	0712	63	0545	1216	1719	297	1846	0025	1254	48
10	0713	63	0546	1216	1719	297	1846	0130	1325	37
11	0713	63	0546	1216	1719	297	1846	0238	1358	26
12	0714	63	0546	1216	1719	297	1846	0348	1435	16
13	0714	63	0547	1217	1719	297	1846	0501	1519	9
14	0714	63	0547	1217	1719	297	1846	0615	1611	3
15	0715	63	0547	1217	1719	297	1846	0725	1712	0
16	0715	63	0548	1217	1719	297	1847	0827	1819	1
17	0715	63	0548	1217	1719	297	1847	0920	1927	3
18	0716	63	0548	1218	1719	297	1847	1003	2033	8
19	0716	63	0549	1218	1720	297	1847	1039	2136	15
20	0716	63	0549	1218	1720	297	1847	1109	2235	23
21	0717	63	0549	1218	1720	297	1847	1136	2332	32
22	0717	63	0549	1218	1720	297	1848	1201	DNS	42
23	0717	63	0550	1219	1720	297	1848	1226	0027	51
24	0717	63	0550	1219	1721	297	1848	1251	0121	61
25	0717	63	0550	1219	1721	297	1848	1319	0216	70
26	0717	63	0550	1219	1721	297	1849	1350	0313	78
27	0718	63	0550	1220	1722	297	1849	1426	0411	85
28	0718	63	0550	1220	1722	297	1849	1508	0510	91
29	0718	63	0550	1220	1722	297	1850	1557	0609	96
30	0718	63	0550	1220	1723	297	1850	1654	0706	99

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

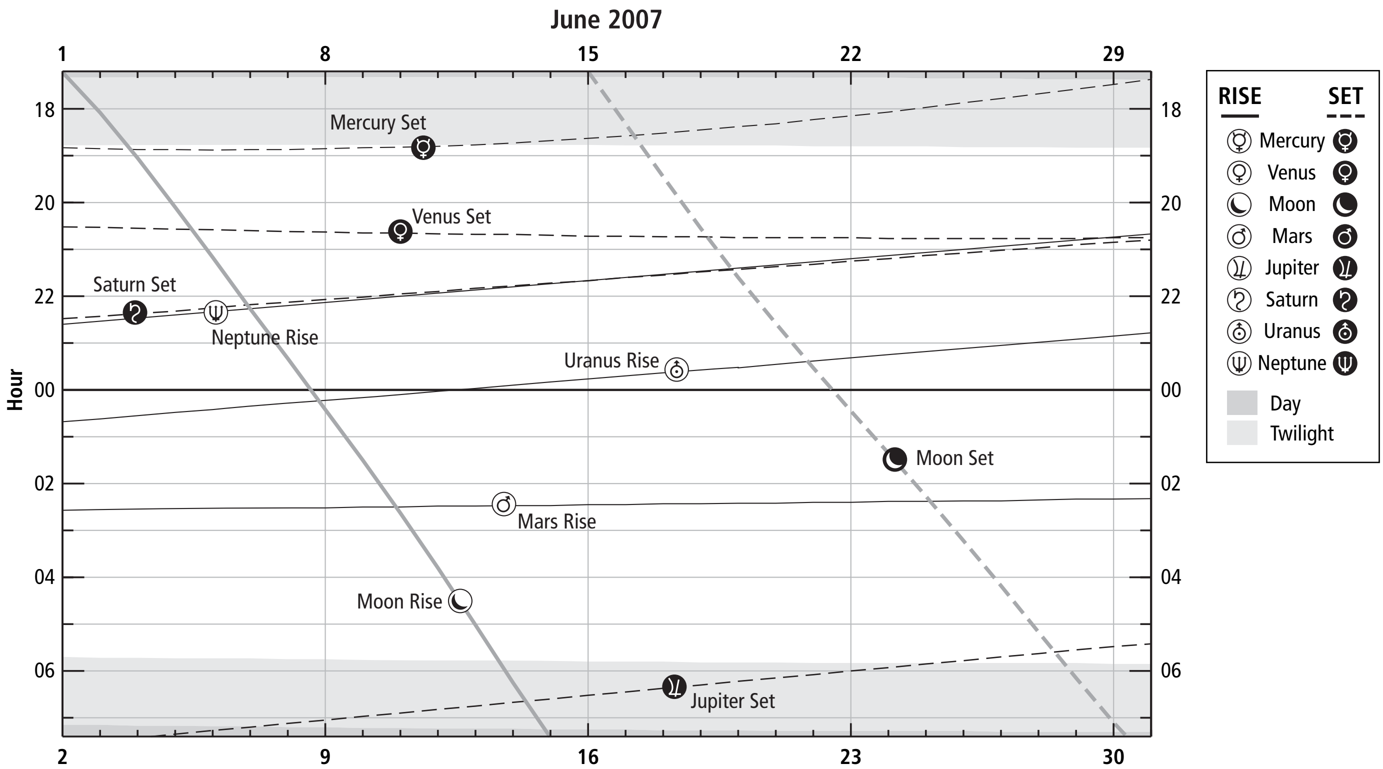


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY Rise h m	MERCURY Set h m	VENUS Rise h m	VENUS Set h m	MARS Rise h m	MARS Set h m	JUPITER Rise h m	JUPITER Set h m	SATURN Rise h m	SATURN Set h m	URANUS Rise h m	URANUS Set h m	NEPTUNE Rise h m	NEPTUNE Set h m
1	0901	1850	1032	2031	0234	1422	1735	0739	1148	2229	0044	1314	2236	1157
2	0901	1851	1031	2032	0234	1420	1730	0735	1145	2226	0041	1310	2232	1153
3	0900	1852	1031	2033	0233	1418	1726	0730	1141	2222	0037	1306	2228	1149
4	0900	1852	1030	2034	0233	1416	1721	0726	1137	2219	0033	1302	2224	1145
5	0859	1853	1030	2035	0232	1414	1717	0721	1134	2215	0029	1259	2220	1141
6	0858	1852	1029	2036	0232	1412	1713	0716	1130	2211	0025	1255	2216	1137
7	0856	1852	1029	2037	0231	1410	1708	0712	1126	2208	0021	1251	2212	1133
8	0854	1851	1028	2038	0231	1408	1704	0707	1122	2204	0017	1247	2208	1130
9	0852	1850	1027	2039	0231	1406	1659	0703	1119	2201	0013	1243	2204	1126
10	0849	1849	1027	2039	0230	1404	1655	0658	1115	2157	0010	1239	2200	1122
11	0846	1848	1026	2040	0230	1403	1650	0654	1111	2154	0006	1235	2156	1118
12	0843	1846	1025	2041	0229	1401	1646	0649	1108	2150	0002	1231	2152	1114
12											2358			
13	0839	1844	1024	2041	0229	1359	1641	0645	1104	2147	2354	1227	2148	1110
14	0835	1841	1023	2042	0228	1357	1637	0640	1100	2143	2350	1223	2144	1106
15	0830	1838	1022	2043	0228	1355	1633	0636	1057	2140	2346	1220	2140	1102
16	0826	1835	1021	2043	0227	1353	1628	0631	1053	2136	2342	1216	2136	1058
17	0821	1831	1019	2044	0227	1351	1624	0627	1049	2133	2338	1212	2132	1054
18	0815	1827	1018	2044	0226	1349	1619	0622	1046	2129	2335	1208	2128	1050
19	0810	1823	1017	2045	0226	1348	1615	0618	1042	2126	2331	1204	2124	1046
20	0804	1819	1015	2045	0225	1346	1611	0613	1038	2122	2327	1200	2120	1042
21	0758	1814	1014	2045	0225	1344	1606	0609	1035	2119	2323	1156	2116	1038
22	0752	1809	1012	2045	0224	1342	1602	0605	1031	2115	2319	1152	2112	1034
23	0745	1804	1011	2046	0224	1340	1557	0600	1027	2112	2315	1148	2108	1030
24	0738	1758	1009	2046	0223	1338	1553	0556	1024	2108	2311	1144	2104	1026
25	0732	1752	1007	2046	0223	1336	1549	0551	1020	2105	2307	1140	2100	1022
26	0725	1747	1005	2046	0222	1335	1544	0547	1017	2101	2303	1136	2056	1018
27	0718	1741	1003	2046	0222	1333	1540	0542	1013	2058	2259	1132	2052	1014
28	0711	1735	1001	2046	0221	1331	1536	0538	1009	2054	2255	1128	2048	1010
29	0704	1729	0959	2045	0220	1329	1531	0533	1006	2051	2251	1125	2044	1006
30	0658	1722	0957	2045	0220	1327	1527	0529	1002	2048	2247	1121	2040	1002

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

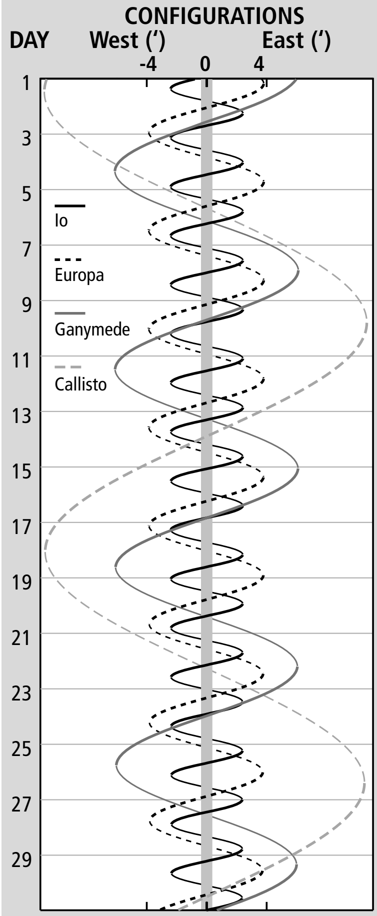
DAY	PHENOMENON h m	Sat.	Event	DAY	PHENOMENON h m	Sat.	Event	DAY	PHENOMENON h m	Sat.	Event	DAY	PHENOMENON h m	Sat.	Event
1	0416		GRS	8	0101	I	Sh.E.	15	0242	I	Tr.E.	23	2107	I	Sh.I.
1	2022	I	Oc.R.	8	0457		GRS	15	0256	I	Sh.E.	23	2203		GRS
1	2335	II	Sh.I.	8	1955	I	Oc.D.	15	0539		GRS	23	2209	III	Tr.I.
1	2349	II	Tr.I.	8	2210	I	Ec.R.	15	2139	I	Oc.D.	23	2253	I	Tr.E.
2	0006		GRS	9	0048		GRS	16	0004	I	Ec.R.	23	2319	I	Sh.E.
2	0209	II	Sh.E.	9	0203	II	Tr.I.	16	0130		GRS	23	2347	III	Sh.I.
2	0220	II	Tr.E.	9	0210	II	Sh.I.	16	0417	II	Tr.I.	24	0015	III	Tr.E.
2	1957		GRS	9	0434	II	Tr.E.	16	0444	II	Sh.I.	24	0204	III	Sh.E.
3	0553		GRS	9	0444	II	Sh.E.	16	1852	III	Tr.I.	24	2027	I	Ec.R.
3	2119	II	Oc.R.	9	1924	I	Tr.E.	16	1857	I	Tr.I.	25	0133	II	Oc.D.
4	0143		GRS	9	1930	I	Sh.E.	16	1912	I	Sh.I.	25	0350		GRS
4	2134		GRS	9	2039		GRS	16	1948	III	Sh.I.	25	0502	II	Ec.R.
5	0701	I	Ec.D.	10	0635		GRS	16	2056	III	Tr.E.	25	2341		GRS
6	0154	III	Ec.D.	10	2102	II	Oc.D.	16	2108	I	Tr.E.	26	1931		GRS
6	0320		GRS	10	2350	II	Ec.R.	16	2121		GRS	26	1939	II	Tr.I.
6	0410	III	Ec.R.	11	0225		GRS	16	2124	I	Sh.E.	26	2037	II	Sh.I.
6	0421	I	Sh.I.	11	2216		GRS	16	2204	III	Sh.E.	26	2212	II	Tr.E.
6	0421	I	Tr.I.	13	0402		GRS	17	2317	II	Oc.D.	26	2311	II	Sh.E.
6	0632	I	Tr.E.	13	0516	III	Oc.D.	18	0226	II	Ec.R.	27	0527		GRS
6	0632	I	Sh.E.	13	0605	I	Tr.I.	18	0307		GRS	28	0118		GRS
6	2311		GRS	13	0615	I	Sh.I.	18	2258		GRS	28	2109		GRS
7	0129	I	Oc.D.	13	2353		GRS	19	1849		GRS	29	0401	I	Tr.I.
7	0341	I	Ec.R.	14	0313	I	Oc.D.	19	1956	II	Tr.E.	29	0433	I	Sh.I.
7	1902		GRS	14	0535	I	Ec.R.	19	2036	II	Sh.E.	30	0108	I	Oc.D.
7	2247	I	Tr.I.	14	1944		GRS	20	0445		GRS	30	0255		GRS
7	2249	I	Sh.I.	15	0031	I	Tr.I.	21	0035		GRS	30	0353	I	Ec.R.
8	0058	I	Tr.E.	15	0044	I	Sh.I.	21	0457	I	Oc.D.	30	2227	I	Tr.I.
								21	2026		GRS	30	2246		GRS
								22	0216	I	Tr.I.	30	2302	I	Sh.I.
								22	0238	I	Sh.I.				
								22	0427	I	Tr.E.				
								22	0450	I	Sh.E.				
								22	2323	I	Oc.D.				
								23	0158	I	Ec.R.				
								23	0213		GRS				
								23	2042	I	Tr.I.				

Moons: I Io; II Europa; III Ganymede; IV Callisto

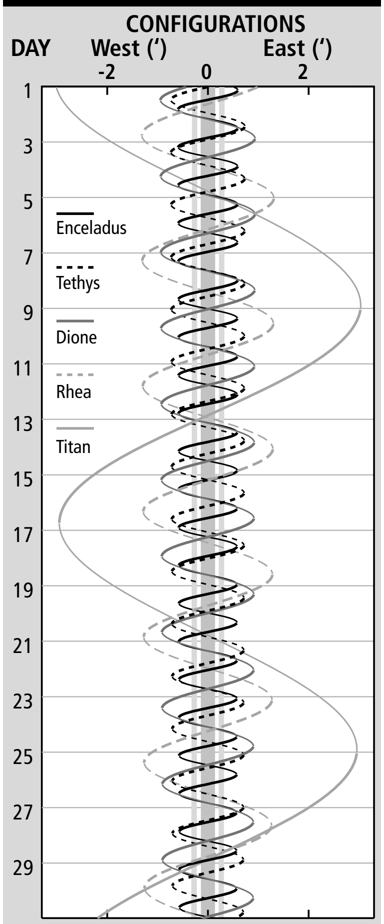
Events: D Disappear; E Egress; Ec Eclipse; Sh Shadow; R Reappear; I Ingress; Oc Occult; Tr Transit

GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

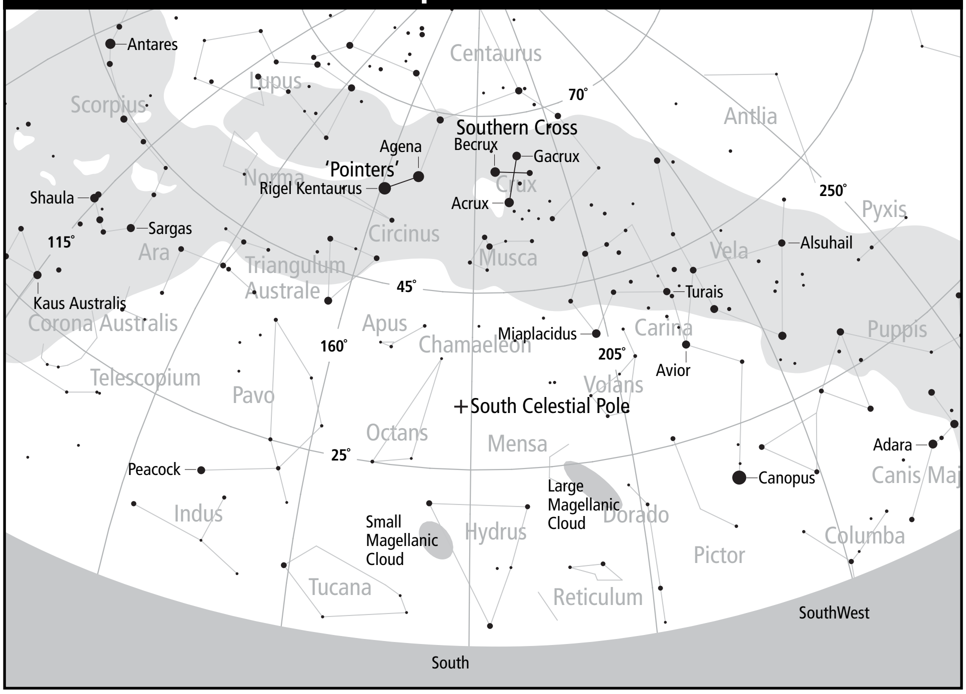
JUPITER MOONS



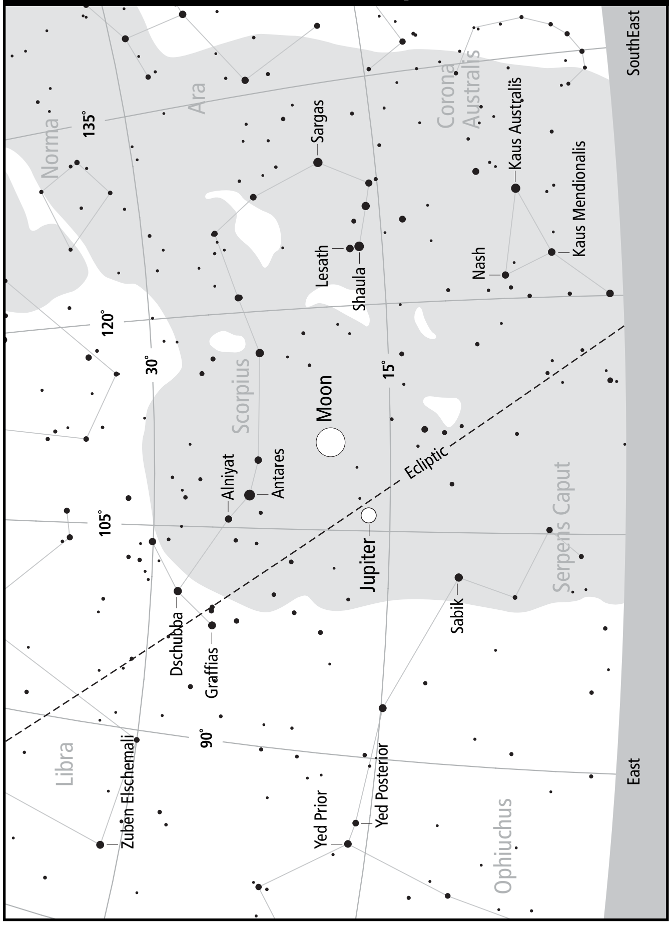
SATURN MOONS



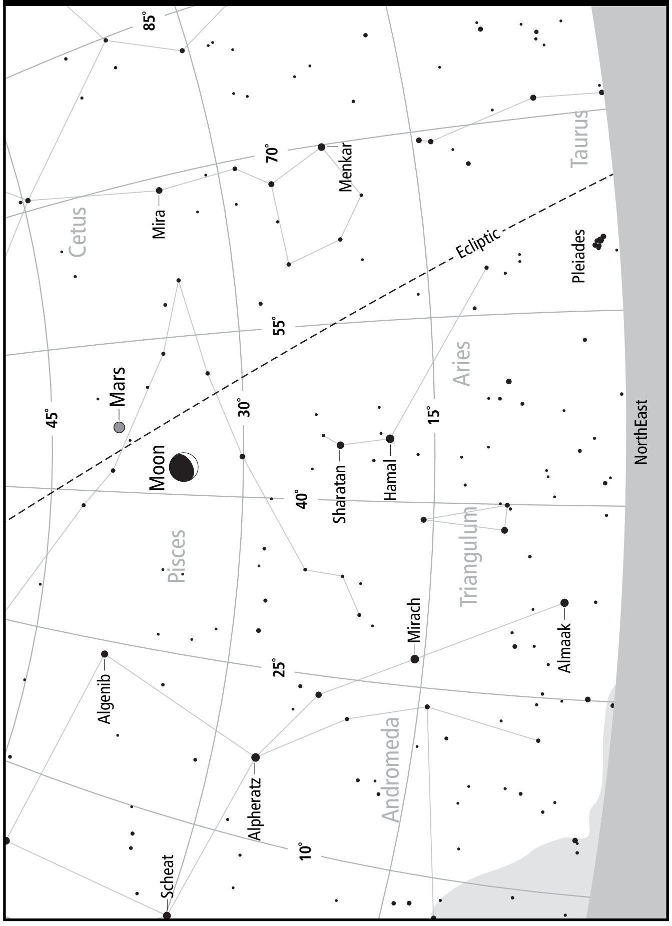
SKYVIEW 2007 JUNE 15 8pm



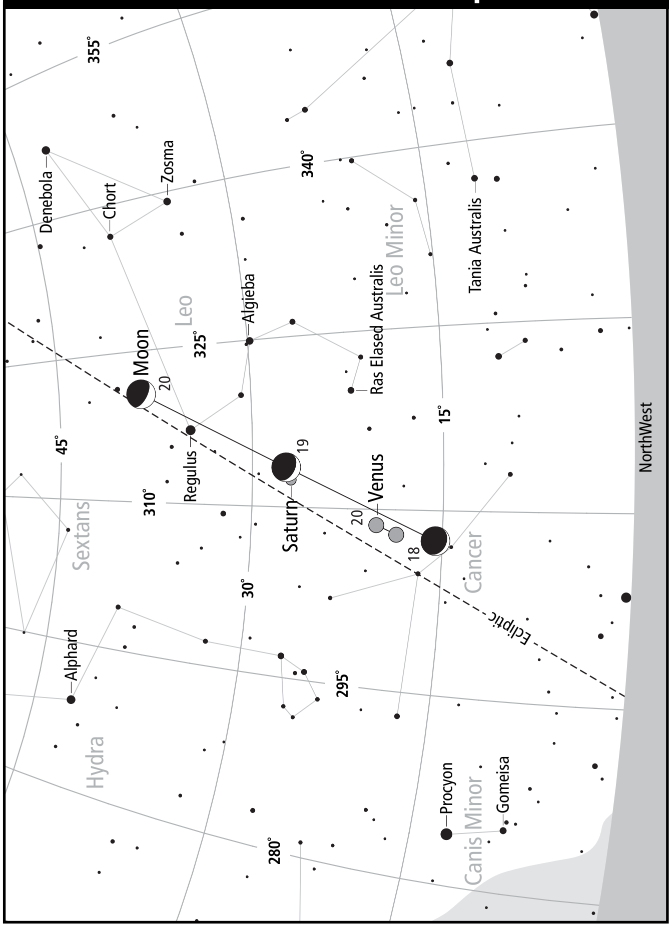
SKYVIEW 2007 JUNE 1 7pm



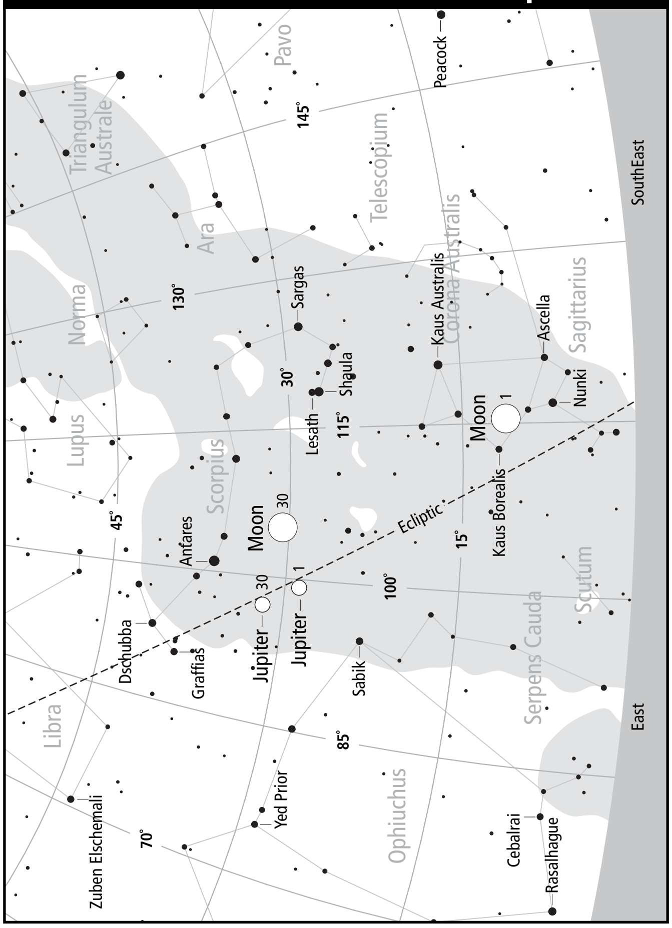
SKYVIEW 2007 JUNE 11 6am



SKYVIEW 2007 JUNE 18-20 7pm



SKYVIEW 2007 JUNE 1 and 30 8pm



JULY 2007

HIGHLIGHTS

MERCURY *visible low in eastern morning twilight late in month.*

VENUS *clearly visible in the NW in the early evening, conjunction with Saturn best view on 1st.*

MARS *visible in the NE before dawn.*

JUPITER *visible all evening.*

SATURN *visible in the early evening in the NW sky.*

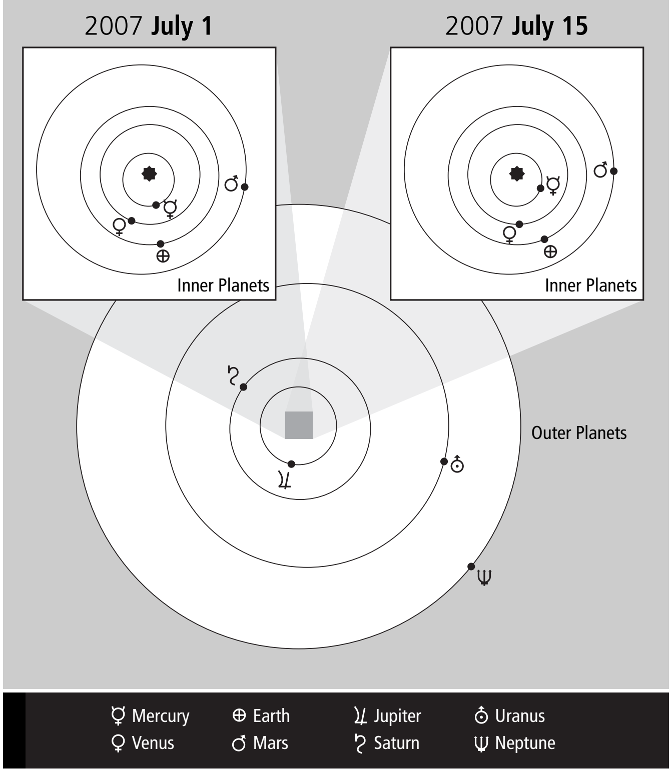
DIARY

Day	Hour	
2	09	Venus 0.°8 S. of Saturn
7	08	Earth at aphelion
8	01	**Last Quarter**
9		Max activity of Pegasid meteor shower
9	23	Mars 6° S. of Moon
10	06	Moon at perigee
10	10	Mercury stationary
12	22	Venus greatest illuminated extent
13		Max activity of July Phoenicids meteors
14	20	**New Moon**
16	23	Venus 2° S. of *Regulus*
17	07	Saturn 0.°04 N. of Moon
17	18	Venus 3° S. of Moon
17	19	*Regulus* 0.°3 S. of Moon
20	23	Mercury greatest elongation W. (20°)
22	14	**First Quarter**
22	17	Moon at apogee
25	21	Venus stationary
26	00	*Antares* 0.°6 N. of Moon
26	02	Jupiter 6° N. of Moon
27		Max activity of Piscis Austrinid meteors
27		Max activity of delta-Aquarid S. meteors
29		Max activity of alpha-Capricornid meteors
30	09	**Full Moon**

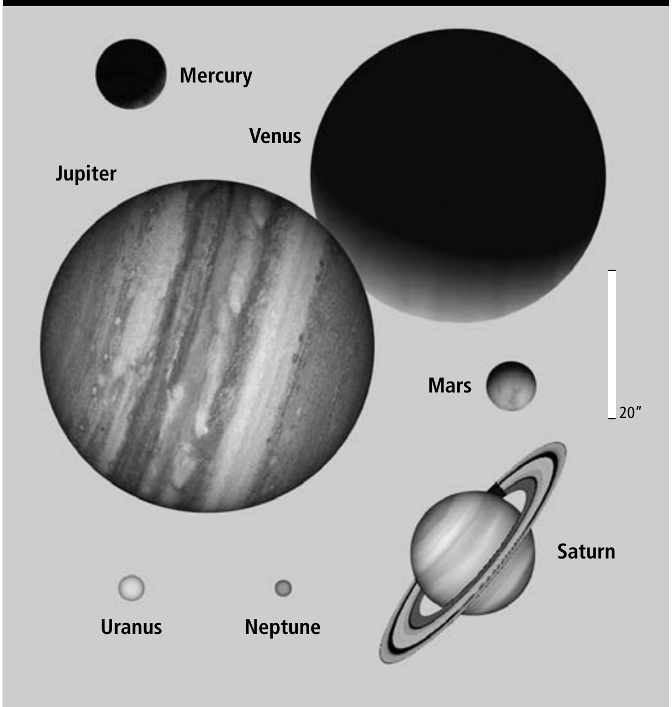
SUN+MOON RISE/SET

DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0718	63	0551	1220	1723	297	1850	1757	0757	100
2	0718	63	0551	1221	1723	297	1851	1902	0842	99
3	0718	63	0551	1221	1724	297	1851	2008	0922	95
4	0718	63	0551	1221	1724	297	1851	2114	0956	89
5	0718	63	0551	1221	1725	297	1852	2218	1028	82
6	0717	63	0551	1221	1725	296	1852	2323	1057	72
7	0717	64	0550	1221	1726	296	1852	DNR	1127	62
8	0717	64	0550	1222	1726	296	1853	0029	1158	51
9	0717	64	0550	1222	1727	296	1853	0136	1233	39
10	0717	64	0550	1222	1727	296	1854	0246	1313	28
11	0717	64	0550	1222	1728	296	1854	0358	1401	18
12	0716	64	0550	1222	1728	296	1855	0508	1457	10
13	0716	64	0550	1222	1729	295	1855	0613	1600	4
14	0716	65	0549	1222	1729	295	1855	0709	1708	1
15	0715	65	0549	1223	1730	295	1856	0756	1815	0
16	0715	65	0549	1223	1730	295	1856	0835	1920	2
17	0715	65	0549	1223	1731	295	1857	0908	2022	5
18	0714	65	0548	1223	1732	294	1857	0936	2120	11
19	0714	66	0548	1223	1732	294	1858	1002	2216	18
20	0713	66	0548	1223	1733	294	1858	1027	2311	26
21	0713	66	0547	1223	1733	294	1859	1052	DNS	35
22	0712	66	0547	1223	1734	294	1859	1119	0006	44
23	0712	67	0547	1223	1735	293	1900	1148	0102	54
24	0711	67	0546	1223	1735	293	1900	1222	0200	63
25	0711	67	0546	1223	1736	293	1901	1301	0258	72
26	0710	67	0545	1223	1736	293	1901	1347	0358	80
27	0710	68	0545	1223	1737	292	1902	1442	0455	88
28	0709	68	0544	1223	1738	292	1902	1542	0549	94
29	0708	68	0544	1223	1738	292	1903	1648	0637	98
30	0708	68	0543	1223	1739	291	1903	1755	0719	100
31	0707	69	0542	1223	1740	291	1904	1902	0756	99

PLANET POSITIONS



PLANET APPEARANCE

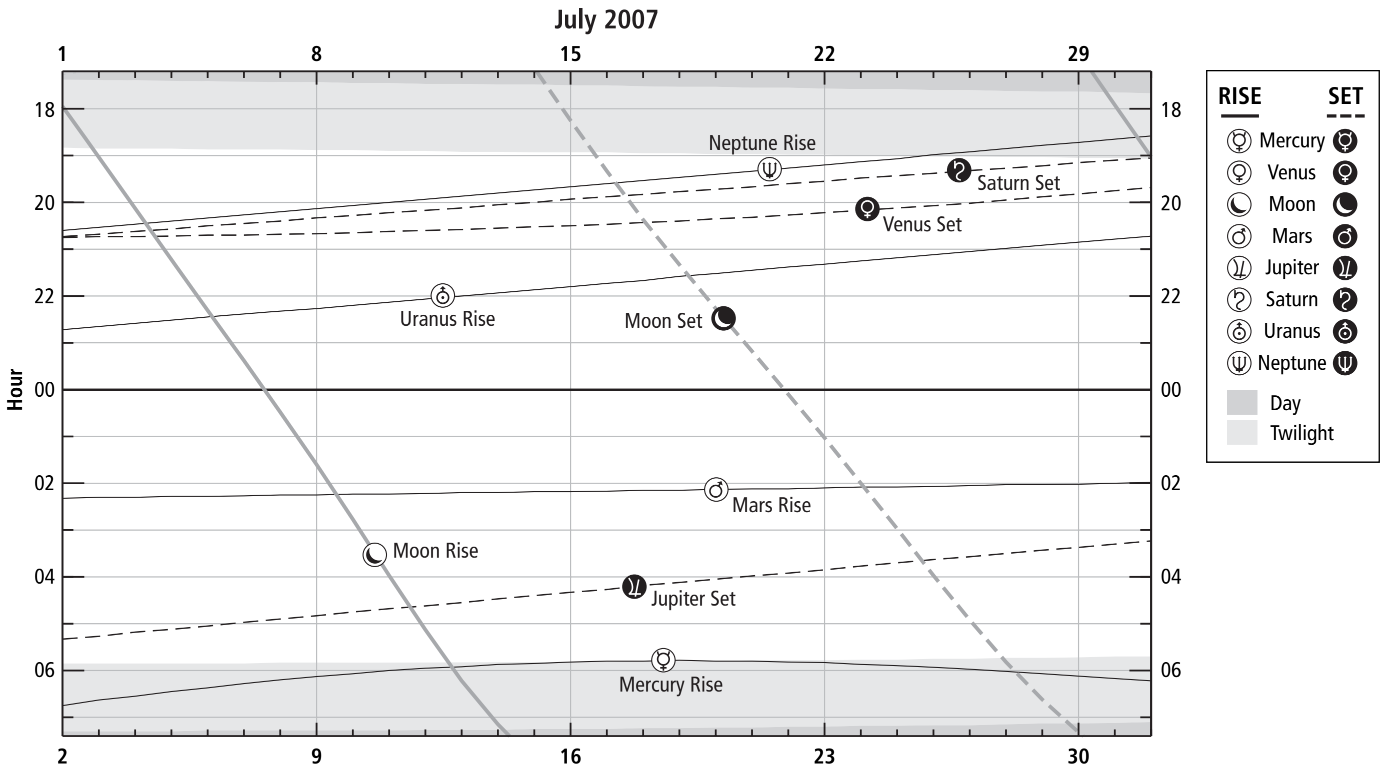


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY Rise h m	MERCURY Set h m	VENUS Rise h m	VENUS Set h m	MARS Rise h m	MARS Set h m	JUPITER Rise h m	JUPITER Set h m	SATURN Rise h m	SATURN Set h m	URANUS Rise h m	URANUS Set h m	NEPTUNE Rise h m	NEPTUNE Set h m
1	0651	1716	0955	2045	0219	1325	1523	0525	0958	2044	2243	1117	2036	0958
2	0645	1710	0953	2044	0219	1323	1518	0520	0955	2041	2239	1113	2032	0954
3	0638	1704	0950	2044	0218	1322	1514	0516	0951	2037	2235	1109	2028	0950
4	0633	1659	0948	2043	0218	1320	1510	0511	0948	2034	2231	1105	2024	0946
5	0627	1653	0946	2042	0217	1318	1505	0507	0944	2030	2227	1101	2020	0942
6	0622	1648	0943	2042	0217	1316	1501	0503	0940	2027	2223	1057	2016	0938
7	0617	1643	0940	2041	0216	1314	1457	0458	0937	2024	2219	1053	2012	0934
8	0612	1638	0938	2040	0215	1313	1452	0454	0933	2020	2216	1049	2008	0930
9	0608	1633	0935	2039	0215	1311	1448	0450	0930	2017	2212	1045	2004	0926
10	0604	1629	0932	2037	0214	1309	1444	0445	0926	2013	2208	1041	2000	0922
11	0600	1625	0929	2036	0214	1307	1440	0441	0922	2010	2204	1037	1956	0918
12	0557	1621	0926	2035	0213	1305	1435	0437	0919	2007	2200	1033	1952	0914
13	0555	1618	0923	2033	0212	1304	1431	0433	0915	2003	2156	1029	1948	0910
14	0552	1615	0919	2031	0212	1302	1427	0428	0912	2000	2152	1025	1944	0906
15	0551	1612	0916	2030	0211	1300	1423	0424	0908	1956	2148	1021	1940	0902
16	0549	1610	0913	2028	0211	1258	1419	0420	0904	1953	2144	1017	1936	0858
17	0548	1608	0909	2026	0210	1257	1414	0416	0901	1950	2140	1013	1932	0854
18	0548	1606	0906	2024	0209	1255	1410	0411	0857	1946	2135	1009	1928	0850
19	0547	1605	0902	2021	0209	1253	1406	0407	0854	1943	2131	1005	1924	0846
20	0548	1604	0858	2019	0208	1251	1402	0403	0850	1940	2127	1001	1920	0842
21	0548	1604	0854	2016	0207	1250	1358	0359	0846	1936	2123	0957	1916	0838
22	0549	1604	0850	2013	0207	1248	1354	0355	0843	1933	2119	0953	1912	0834
23	0550	1604	0846	2010	0206	1246	1349	0351	0839	1929	2115	0949	1908	0830
24	0552	1605	0841	2007	0205	1244	1345	0346	0836	1926	2111	0945	1904	0826
25	0554	1606	0837	2004	0205	1243	1341	0342	0832	1923	2107	0941	1859	0822
26	0556	1608	0833	2001	0204	1241	1337	0338	0829	1919	2103	0937	1855	0818
27	0558	1610	0828	1957	0203	1239	1333	0334	0825	1916	2059	0933	1851	0814
28	0601	1613	0823	1953	0202	1238	1329	0330	0821	1913	2055	0929	1847	0810
29	0604	1615	0818	1949	0202	1236	1325	0326	0818	1909	2051	0925	1843	0806
30	0607	1619	0813	1945	0201	1234	1321	0322	0814	1906	2047	0921	1839	0802
31	0610	1622	0808	1941	0200	1232	1317	0318	0811	1903	2043	0917	1835	0758

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

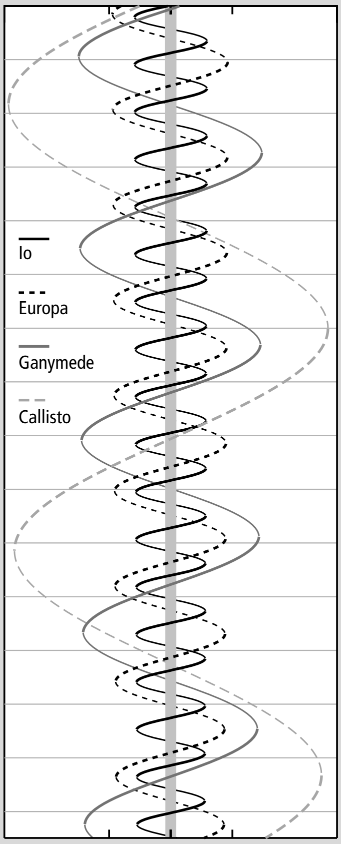
DAY	PHENOMENON h m	Sat.	Event
1	0038	I	Tr.E.
1	0113	I	Sh.E.
1	0129	III	Tr.I.
1	0336	III	Tr.E.
1	0346	III	Sh.I.
1	1934	I	Oc.D.
1	2221	I	Ec.R.
2	0351	II	Oc.D.
2	0432		GRS
2	1905	I	Tr.E.
2	1942	I	Sh.E.
3	0023		GRS
3	2014		GRS
3	2156	II	Tr.I.
3	2312	II	Sh.I.
4	0029	II	Tr.E.
4	0146	II	Sh.E.
4	2007	III	Ec.R.
5	0200		GRS
5	2057	II	Ec.R.
5	2151		GRS
7	0253	I	Oc.D.
7	0338		GRS
7	2329		GRS
8	0013	I	Tr.I.
8	0056	I	Sh.I.
8	0224	I	Tr.E.
8	0308	I	Sh.E.
8	0451	III	Tr.I.
8	1920		GRS
8	2120	I	Oc.D.
9	0016	I	Ec.R.
9	1925	I	Sh.I.
9	2051	I	Tr.E.
9	2136	I	Sh.E.
10	0106		GRS
10	2057		GRS
11	0015	II	Tr.I.
11	0147	II	Sh.I.
11	0248	II	Tr.E.
11	0422	II	Sh.E.
11	2050	III	Oc.R.
11	2147	III	Ec.D.
12	0007	III	Ec.R.
12	0243		GRS
12	1919	II	Oc.D.
12	2234		GRS
12	2333	II	Ec.R.
14	0421		GRS
15	0012		GRS
15	0200	I	Tr.I.
15	0251	I	Sh.I.
15	0411	I	Tr.E.
15	2003		GRS
15	2307	I	Oc.D.
16	0211	I	Ec.R.
16	2027	I	Tr.I.
16	2120	I	Sh.I.
16	2238	I	Tr.E.
16	2331	I	Sh.E.
17	0149		GRS
17	2040	I	Ec.R.
17	2140		GRS
18	0235	II	Tr.I.
18	2207	III	Oc.D.
19	0020	III	Oc.R.
19	0146	III	Ec.D.
19	0327		GRS
19	2141	II	Oc.D.
19	2318		GRS
20	0209	II	Ec.R.
20	1908		GRS
21	2016	II	Sh.E.
22	0055		GRS
22	0348	I	Tr.I.
22	2046		GRS
23	0055	I	Oc.D.
23	2216	I	Tr.I.
23	2315	I	Sh.I.
24	0026	I	Tr.E.
24	0126	I	Sh.E.
24	0233		GRS
24	1922	I	Oc.D.
24	2224		GRS
24	2234	I	Ec.R.
25	1955	I	Sh.E.
26	0139	III	Oc.D.
27	0001		GRS
27	0004	II	Oc.D.
27	1952		GRS
28	2018	II	Sh.I.
28	2044	II	Tr.E.
28	2252	II	Sh.E.
29	0139		GRS
29	1942	III	Sh.I.
29	2130		GRS
29	2203	III	Sh.E.
30	0244	I	Oc.D.
31	0005	I	Tr.I.
31	0110	I	Sh.I.
31	0216	I	Tr.E.
31	0316		GRS
31	2111	I	Oc.D.
31	2307		GRS

Moons: I Io; II Europa; III Ganymede; IV Callisto

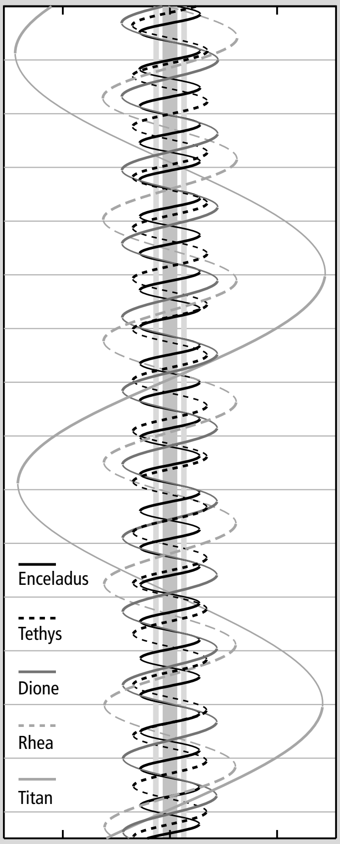
Events: D Disappear; R Reappear; E Egress; I Ingress; Ec Eclipse; Oc Occult; Sh Shadow; Tr Transit

GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

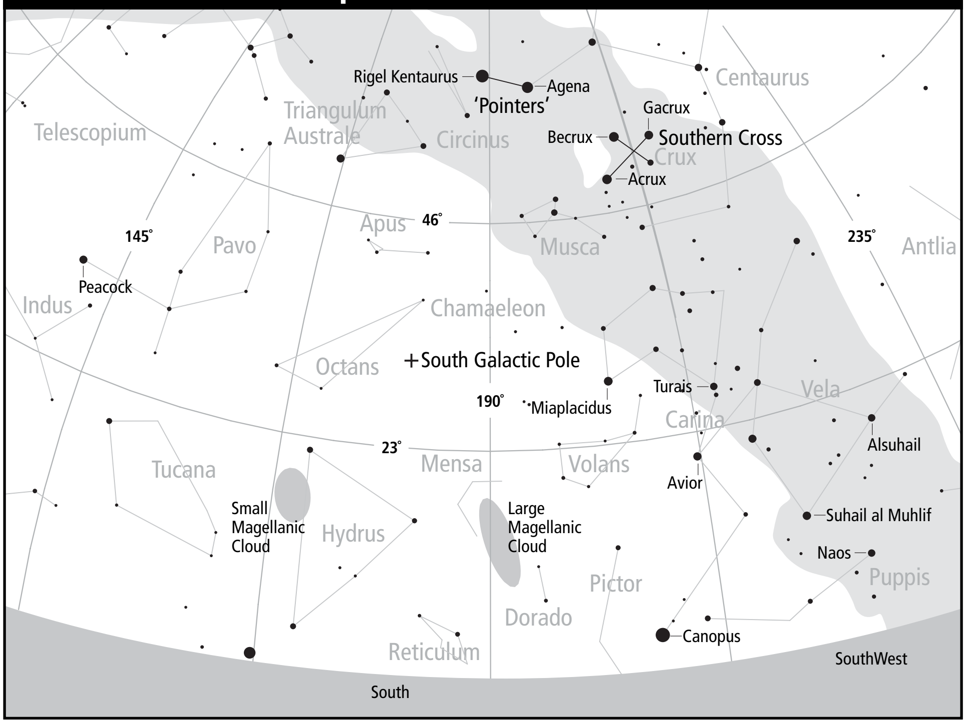
JUPITER MOONS



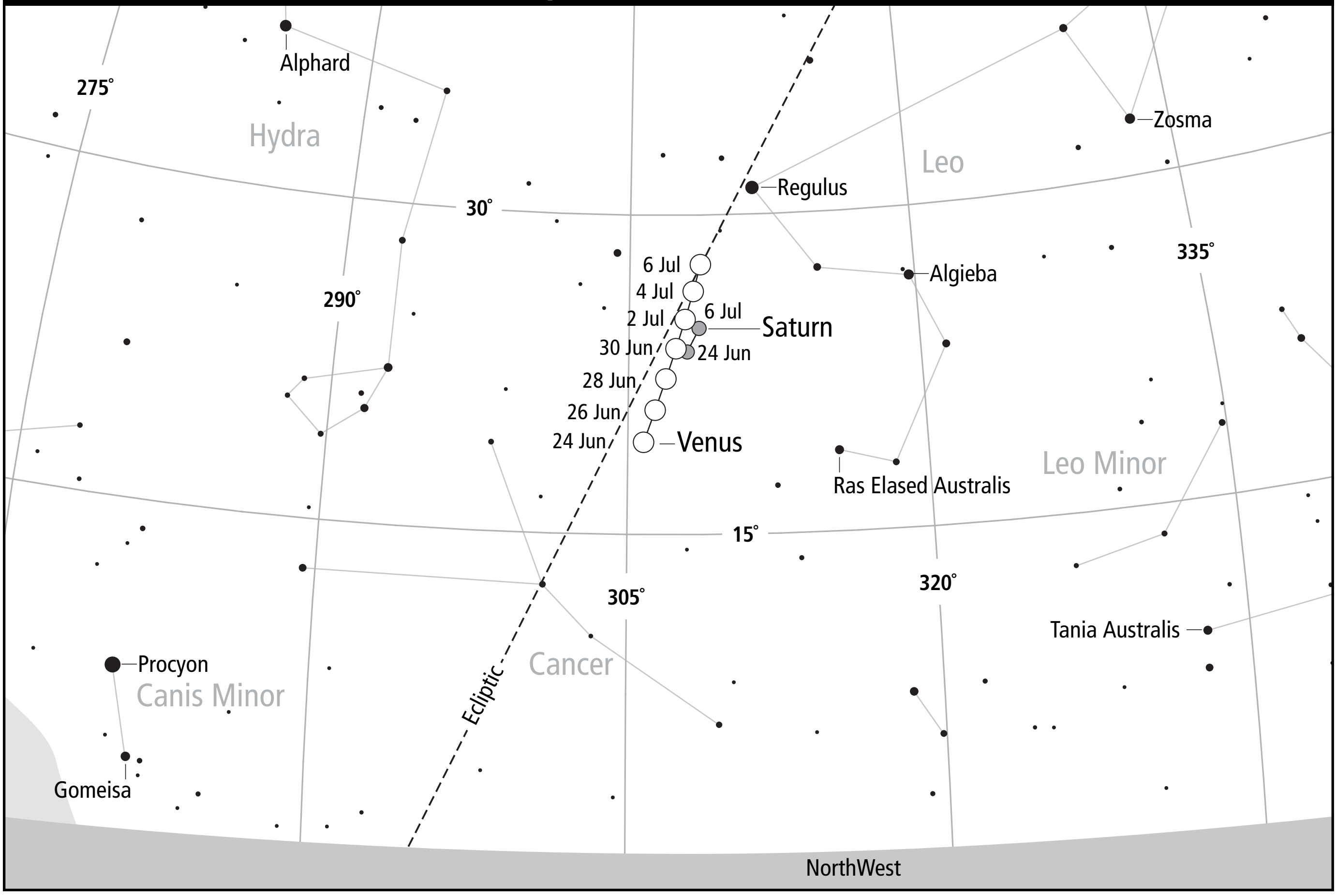
SATURN MOONS



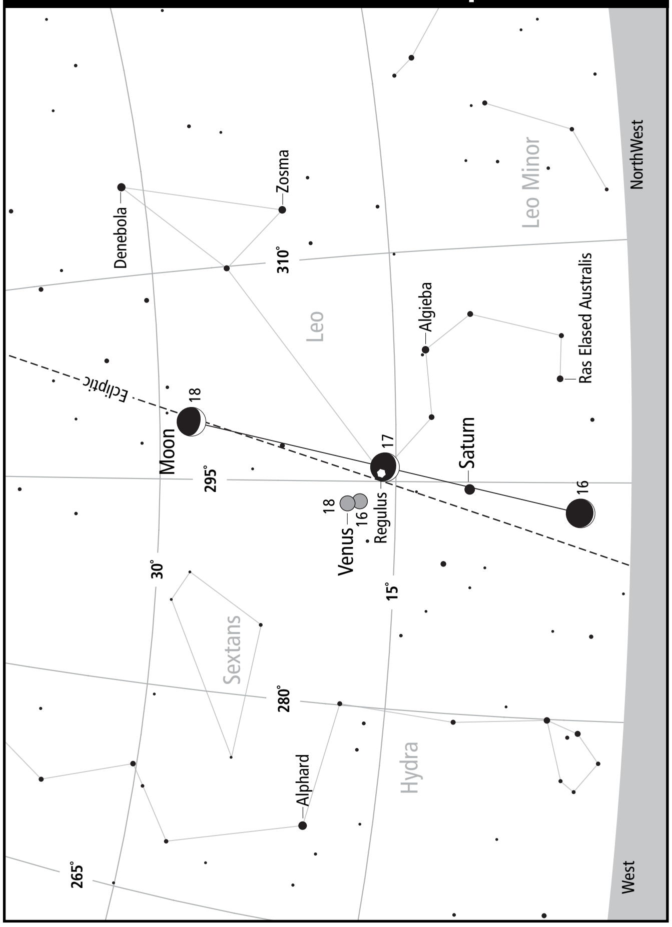
SKYVIEW JULY 15 8pm – SOUTHERN CROSS



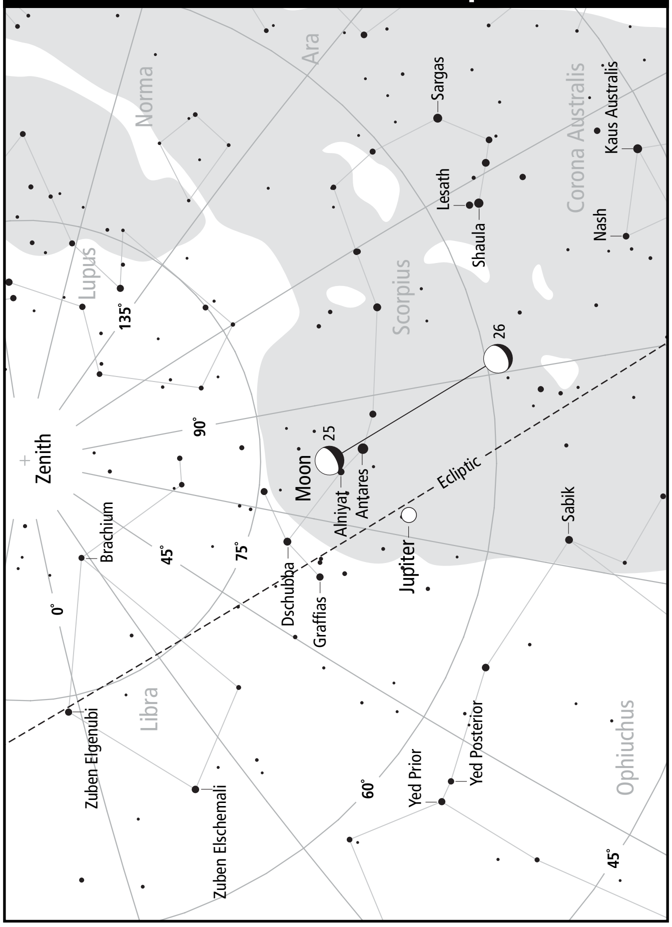
SKYVIEW 2007 JUNE 24 - JULY 6 7pm



SKYVIEW 2007 JULY 16-18 7pm



SKYVIEW 2007 JULY 25-26 7pm



AUGUST 2007

HIGHLIGHTS

***Moon** rises in near total lunar eclipse in evening of 28th.*

***Venus** visible low in the western evening twilight in first half of the month, then low in the eastern morning twilight in last half of the month.*

***Mars** visible in the NE before dawn.*

***Jupiter** visible nearly all night, sets after midnight.*

***Saturn** visible in the early evening twilight in the NW sky in the first half of the month.*

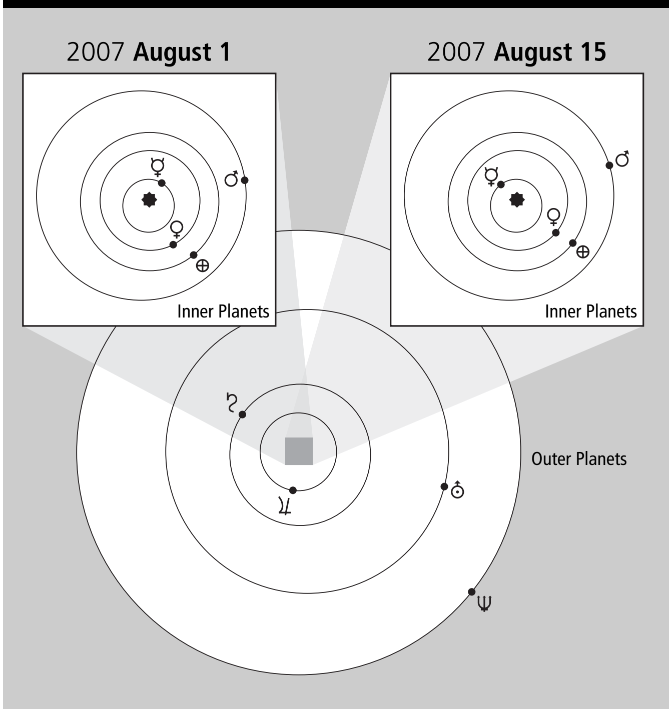
DIARY

Day	Hour	
2	03	Mercury 6° S. of *Pollux*
3	12	Venus 6° S. of *Regulus*
4		Max activity of iota-Aquarid S. meteor s.
4	08	Moon at perigee
6	05	**Last Quarter**
7	12	Mars 6° S. of Moon
7	14	Jupiter stationary
8		Max activity of delta-Aquarid N. meteor s.
13	07	**New Moon**
14	02	Neptune at opposition
16	04	Mercury in superior conjunction
18	12	Venus in inferior conjunction
19		Max activity of iota-Aquarid N. meteor s.
19	11	Moon at apogee
21	08	**First Quarter**
22	07	Saturn in conjunction with Sun
22	09	*Antares* 0.°7 N. of Moon
22	11	Jupiter 6° N. of Moon
24	08	Mars 5° N. of *Aldebaran*
28	19	**Full Moon** – Lunar Eclipse
31	08	Moon at perigee

SUN+MOON RISE/SET

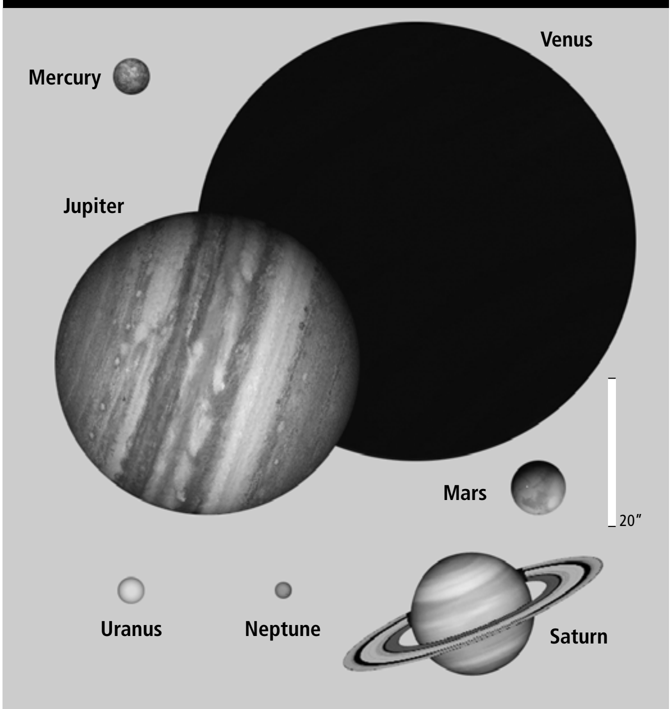
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0706	69	0542	1223	1740	291	1904	2009	0829	97
2	0705	69	0541	1223	1741	291	1905	2115	0900	91
3	0705	70	0541	1223	1741	290	1905	2221	0930	84
4	0704	70	0540	1223	1742	290	1906	2329	1001	75
5	0703	70	0539	1223	1743	290	1906	DNR	1034	64
6	0702	71	0538	1223	1743	289	1907	0038	1112	53
7	0701	71	0538	1222	1744	289	1908	0148	1157	41
8	0700	71	0537	1222	1745	289	1908	0258	1249	30
9	0659	72	0536	1222	1745	288	1909	0403	1349	21
10	0658	72	0535	1222	1746	288	1909	0501	1453	12
11	0658	72	0535	1222	1747	288	1910	0551	1600	6
12	0657	73	0534	1222	1747	287	1910	0632	1706	2
13	0656	73	0533	1222	1748	287	1911	0706	1808	0
14	0655	73	0532	1221	1749	287	1911	0736	1908	1
15	0654	74	0531	1221	1749	286	1912	0803	2005	3
16	0653	74	0530	1221	1750	286	1912	0829	2101	7
17	0652	74	0529	1221	1750	285	1913	0854	2156	13
18	0651	75	0528	1221	1751	285	1913	0920	2252	20
19	0649	75	0527	1220	1752	285	1914	0948	2348	29
20	0648	76	0526	1220	1752	284	1914	1019	DNS	38
21	0647	76	0525	1220	1753	284	1915	1056	0046	47
22	0646	76	0524	1220	1754	283	1915	1138	0145	57
23	0645	77	0523	1219	1754	283	1916	1228	0243	66
24	0644	77	0522	1219	1755	283	1917	1326	0338	75
25	0643	78	0521	1219	1755	282	1917	1429	0428	83
26	0642	78	0520	1219	1756	282	1918	1536	0512	91
27	0640	78	0519	1218	1757	281	1918	1644	0551	96
28	0639	79	0518	1218	1757	281	1919	1752	0626	99
29	0638	79	0517	1218	1758	281	1919	1900	0659	100
30	0637	80	0515	1217	1758	280	1920	2008	0730	98
31	0636	80	0514	1217	1759	280	1920	2117	0801	93

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

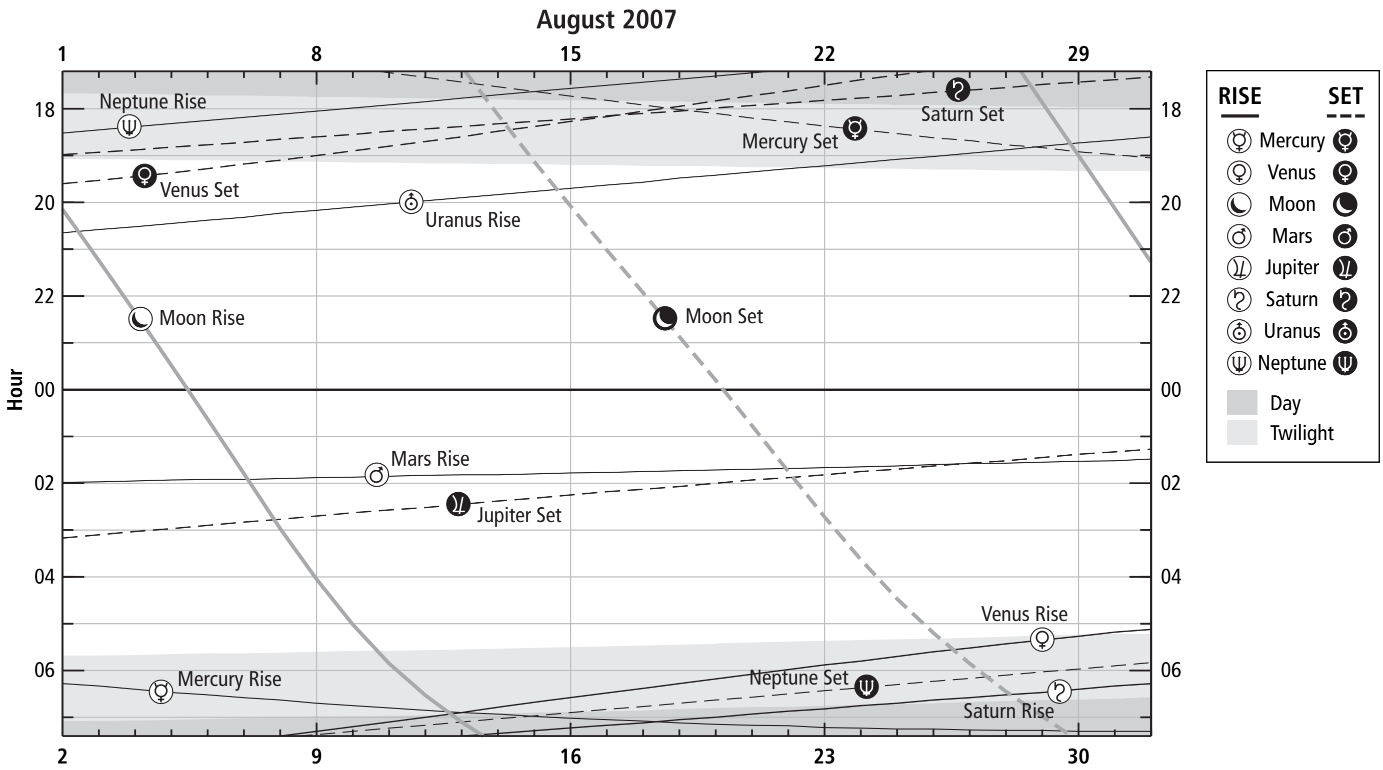


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY Rise h m	MERCURY Set h m	VENUS Rise h m	VENUS Set h m	MARS Rise h m	MARS Set h m	JUPITER Rise h m	JUPITER Set h m	SATURN Rise h m	SATURN Set h m	URANUS Rise h m	URANUS Set h m	NEPTUNE Rise h m	NEPTUNE Set h m
1	0613	1626	0803	1936	0159	1231	1313	0314	0807	1859	2039	0913	1831	0754
2	0617	1631	0758	1932	0159	1229	1309	0310	0804	1856	2035	0909	1827	0750
3	0620	1635	0752	1927	0158	1227	1305	0306	0800	1853	2031	0905	1823	0746
4	0624	1640	0747	1922	0157	1226	1301	0302	0757	1849	2027	0901	1819	0742
5	0628	1646	0741	1917	0156	1224	1257	0258	0753	1846	2023	0857	1815	0738
6	0631	1651	0736	1911	0155	1222	1253	0254	0749	1843	2019	0853	1811	0734
7	0635	1656	0730	1906	0155	1221	1249	0250	0746	1839	2014	0849	1807	0730
8	0638	1702	0724	1900	0154	1219	1245	0246	0742	1836	2010	0845	1803	0726
9	0642	1708	0718	1854	0153	1217	1241	0242	0739	1833	2006	0841	1759	0722
10	0645	1714	0712	1848	0152	1216	1237	0238	0735	1829	2002	0837	1755	0718
11	0648	1720	0706	1842	0151	1214	1233	0234	0732	1826	1958	0833	1751	0714
12	0651	1726	0700	1836	0150	1212	1229	0231	0728	1823	1954	0829	1746	0710
13	0654	1732	0654	1829	0149	1210	1226	0227	0724	1819	1950	0825	1742	0706
14	0656	1738	0647	1823	0149	1209	1222	0223	0721	1816	1946	0821	1738	0702
15	0659	1744	0641	1816	0148	1207	1218	0219	0717	1813	1942	0817	1734	0658
16	0701	1749	0635	1810	0147	1205	1214	0215	0714	1809	1938	0813	1730	0654
17	0703	1755	0629	1803	0146	1204	1210	0211	0710	1806	1934	0809	1726	0650
18	0705	1801	0623	1757	0145	1202	1206	0208	0707	1803	1929	0805	1722	0646
19	0707	1806	0617	1750	0144	1200	1203	0204	0703	1759	1925	0801	1718	0642
20	0709	1812	0611	1743	0143	1159	1159	0200	0700	1756	1921	0757	1714	0638
21	0710	1817	0605	1737	0142	1157	1155	0156	0656	1753	1917	0753	1710	0634
22	0711	1822	0559	1730	0141	1155	1151	0153	0652	1749	1913	0749	1706	0630
23	0713	1827	0553	1723	0140	1154	1147	0149	0649	1746	1909	0745	1702	0626
24	0714	1832	0548	1717	0139	1152	1144	0145	0645	1743	1905	0741	1658	0622
25	0715	1837	0542	1711	0138	1150	1140	0142	0642	1739	1901	0737	1654	0618
26	0715	1841	0536	1704	0136	1149	1136	0138	0638	1736	1857	0733	1650	0614
27	0716	1846	0531	1658	0135	1147	1133	0134	0635	1733	1853	0729	1646	0610
28	0717	1850	0526	1652	0134	1145	1129	0131	0631	1729	1848	0725	1641	0606
29	0717	1855	0521	1646	0133	1144	1125	0127	0628	1726	1844	0721	1637	0602
30	0718	1859	0516	1640	0132	1142	1121	0123	0624	1723	1840	0717	1633	0558
31	0718	1903	0511	1635	0131	1140	1118	0120	0620	1719	1836	0713	1629	0554

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

DAY	PHENOMENON h m	Satellite	Event
1	0030	I	Ec.R.
1	1938	I	Sh.I.
1	2043	I	Tr.E.
1	2149	I	Sh.E.
3	0045		GRS
3	0230	II	Oc.D.
3	2036		GRS
4	2037	II	Tr.I.
4	2254	II	Sh.I.
4	2311	II	Tr.E.
5	0129	II	Sh.E.
5	0223		GRS
5	2119	III	Tr.E.
5	2214		GRS
5	2341	III	Sh.I.
6	0203	III	Sh.E.
6	2039	II	Ec.R.
7	0155	I	Tr.I.
7	2302	I	Oc.D.
7	2351		GRS

DAY	PHENOMENON h m	Satellite	Event
8	0225	I	Ec.R.
8	1942		GRS
8	2023	I	Tr.I.
8	2133	I	Sh.I.
8	2234	I	Tr.E.
8	2344	I	Sh.E.
9	2054	I	Ec.R.
10	0129		GRS
10	2120		GRS
11	2305	II	Tr.I.
12	0131	II	Sh.I.
12	0140	II	Tr.E.
12	2247	III	Tr.I.
12	2258		GRS
13	0105	III	Tr.E.
13	2315	II	Ec.R.
15	0036		GRS
15	0053	I	Oc.D.
15	2027		GRS
15	2215	I	Tr.I.
15	2328	I	Sh.I.
16	0026	I	Tr.E.
16	0139	I	Sh.E.
16	1921	I	Oc.D.
16	2008	III	Ec.R.
16	2249	I	Ec.R.
17	2008	I	Sh.E.
17	2205		GRS
19	0136	II	Tr.I.
19	2343		GRS
20	1934		GRS
20	2044	II	Oc.D.

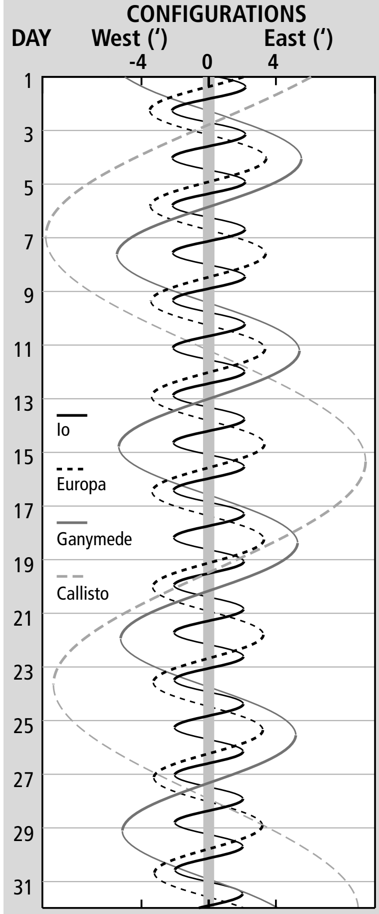
DAY	PHENOMENON h m	Satellite	Event
21	0151	II	Ec.R.
22	0120		GRS
22	2001	II	Sh.E.
22	2112		GRS
23	0008	I	Tr.I.
23	0123	I	Sh.I.
23	2115	I	Oc.D.
23	2142	III	Ec.D.
24	0009	III	Ec.R.
24	0044	I	Ec.R.
24	1952	I	Sh.I.
24	2047	I	Tr.E.
24	2203	I	Sh.E.
24	2249		GRS
27	0027		GRS
27	2019		GRS
27	2317	II	Oc.D.
29	2002	II	Tr.E.
29	2003	II	Sh.I.
29	2157		GRS
29	2238	II	Sh.E.
30	2029	III	Oc.D.
30	2253	III	Oc.R.
30	2309	I	Oc.D.
31	2031	I	Tr.I.
31	2147	I	Sh.I.
31	2241	I	Tr.E.
31	2335		GRS
31	2358	I	Sh.E.

Moons:
I Io — III Ganymede
II Europa — IV Callisto

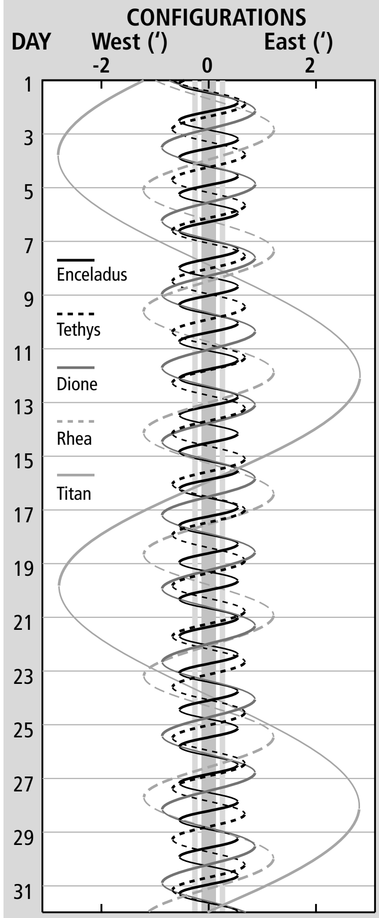
Events:
D Disappear — R Reappear
E Egress — I Ingress
Ec Eclipse — Oc Occult
Sh Shadow — Tr Transit

GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

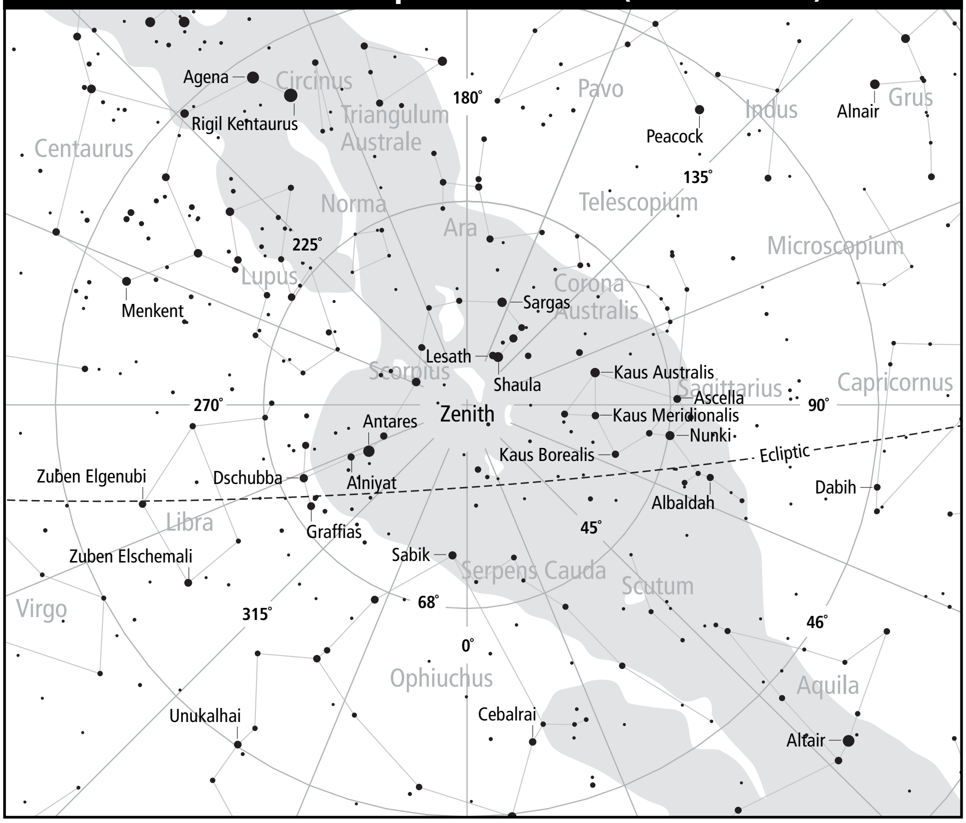
JUPITER MOONS



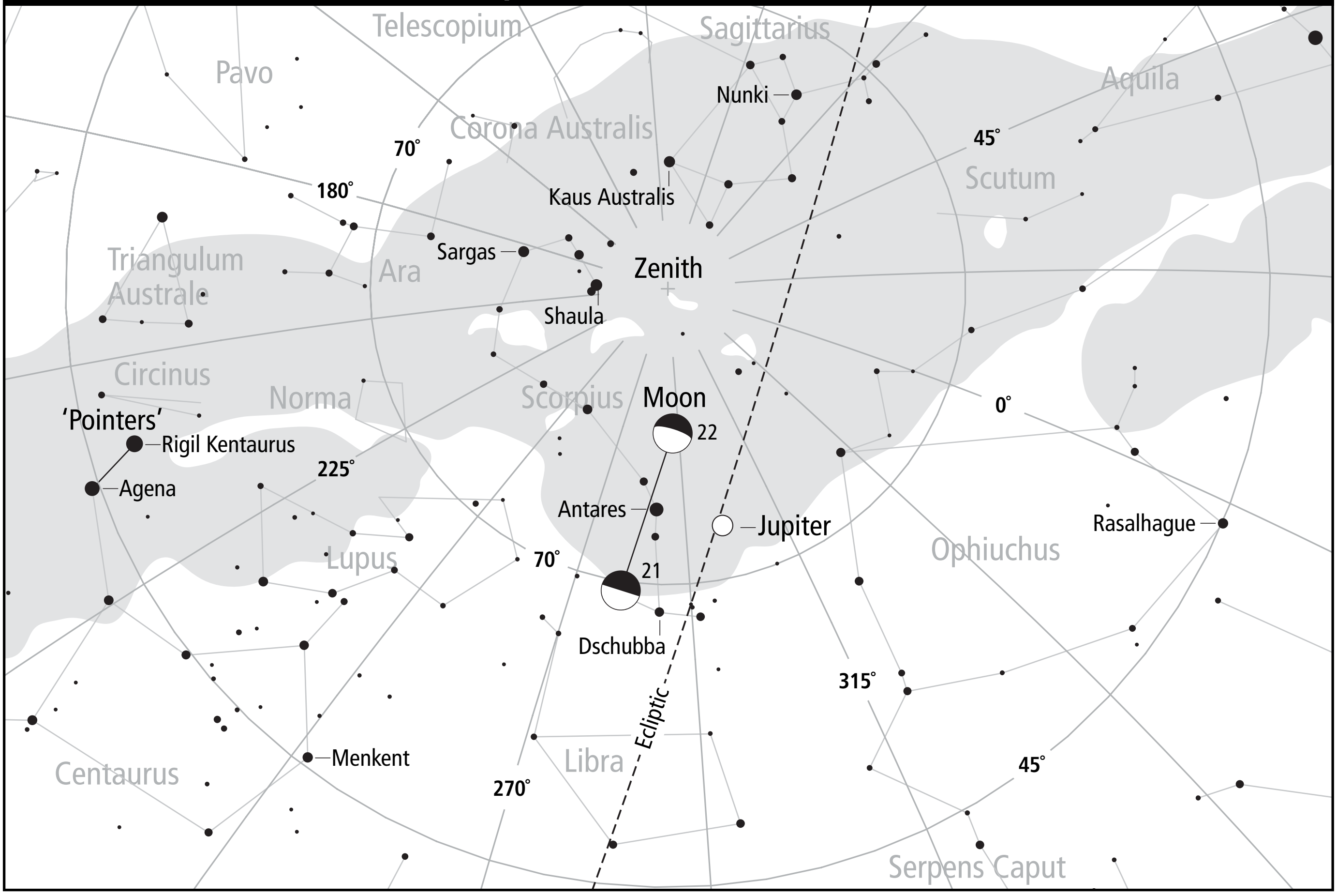
SATURN MOONS



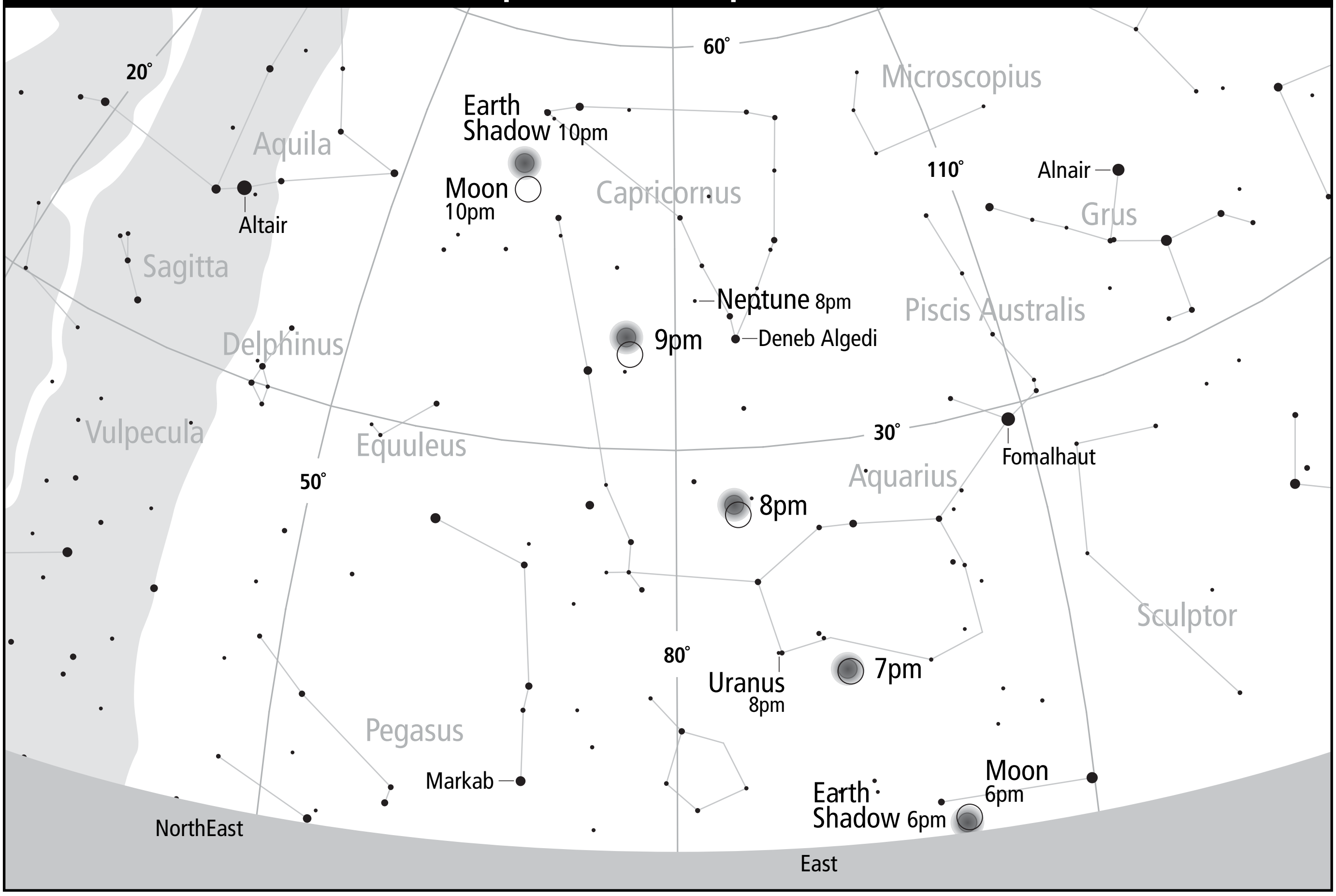
SKYVIEW AUGUST 15 8pm – ZENITH (OVERHEAD)



SKYVIEW 2007 AUGUST 21-22 8pm



SKYVIEW 2007 AUGUST 28 6-10pm (stars at 8pm)



SEPTEMBER 2007

HIGHLIGHTS

Moon *occults Saturn on 10th.* ***Beware this event occurs close to the Sun****.*

Mercury *visible low in western evening twilight all month.*

Venus *clearly visible in the eastern sky in the early morning.*

Mars *visible in the NE before dawn.*

Jupiter *visible all evening.*

Saturn *visible in the morning twilight in the NE sky in the last half of the month.*

DIARY

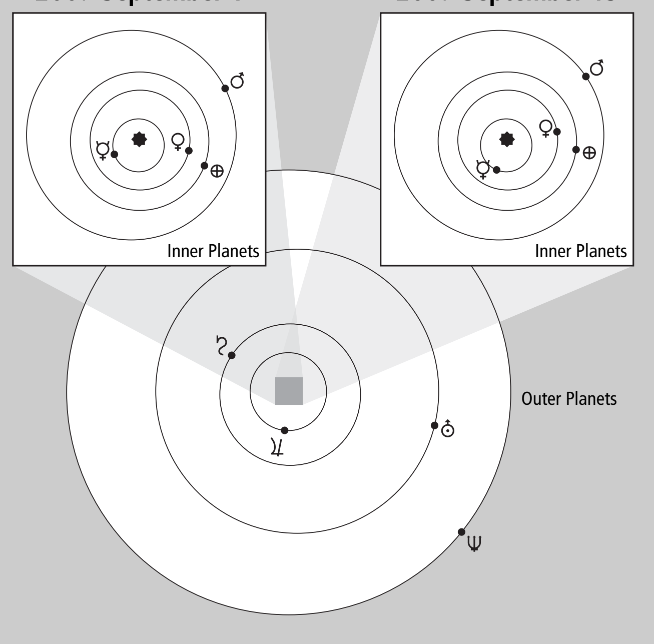
Day	Hour	
4	11	**Last Quarter**
4	22	Mars 6° S. of Moon
7	22	Venus stationary
10	03	Uranus at opposition
10	09	*Regulus* 0.°2 S. of Moon
10	10	Saturn 0.°8 N. of Moon - Occultation
11	21	**New Moon**
13	22	Mercury 2° N. of Moon
16	05	Moon at apogee
18	16	*Antares* 0.°7 N. of Moon
18	23	Jupiter 6° N. of Moon
19		Maximum activity of Piscid meteor shower
20	01	**First Quarter**
22	17	Mercury 0.°09 N. of Spica
23	18	Equinox
24	07	Venus greatest illuminated extent
27	04	**Full Moon**
28	10	Moon at perigee
30	00	Mercury greatest elongation E. (26°)

SUN+MOON RISE/SET

DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0634	80	0513	1217	1800	279	1921	2227	0834	86
2	0633	81	0512	1216	1800	279	1922	2339	0912	77
3	0632	81	0511	1216	1801	278	1922	DNR	0955	66
4	0631	82	0510	1216	1801	278	1923	0050	1045	55
5	0629	82	0508	1216	1802	278	1923	0157	1142	44
6	0628	83	0507	1215	1803	277	1924	0257	1245	33
7	0627	83	0506	1215	1803	277	1924	0348	1351	23
8	0626	84	0505	1214	1804	276	1925	0431	1456	15
9	0624	84	0503	1214	1805	276	1926	0507	1558	8
10	0623	84	0502	1214	1805	275	1926	0538	1658	3
11	0622	85	0501	1213	1806	275	1927	0606	1756	1
12	0620	85	0459	1213	1806	274	1927	0631	1852	0
13	0619	86	0458	1213	1807	274	1928	0656	1947	1
14	0618	86	0457	1212	1808	274	1929	0722	2042	4
15	0616	87	0455	1212	1808	273	1929	0749	2139	9
16	0615	87	0454	1212	1809	273	1930	0819	2236	15
17	0614	88	0453	1211	1809	272	1931	0853	2334	23
18	0612	88	0451	1211	1810	272	1931	0933	DNS	31
19	0611	88	0450	1211	1811	271	1932	1019	0032	40
20	0610	89	0449	1210	1811	271	1933	1112	0127	50
21	0608	89	0447	1210	1812	270	1933	1212	0218	60
22	0607	90	0446	1210	1812	270	1934	1316	0304	69
23	0606	90	0444	1209	1813	269	1935	1422	0345	79
24	0605	91	0443	1209	1814	269	1935	1529	0421	87
25	0603	91	0442	1208	1814	269	1936	1637	0454	94
26	0602	92	0440	1208	1815	268	1937	1746	0526	98
27	0601	92	0439	1208	1816	268	1937	1856	0558	100
28	0559	93	0437	1207	1816	267	1938	2008	0631	99
29	0558	93	0436	1207	1817	267	1939	2122	0708	95
30	0557	94	0435	1207	1817	266	1940	2236	0750	88

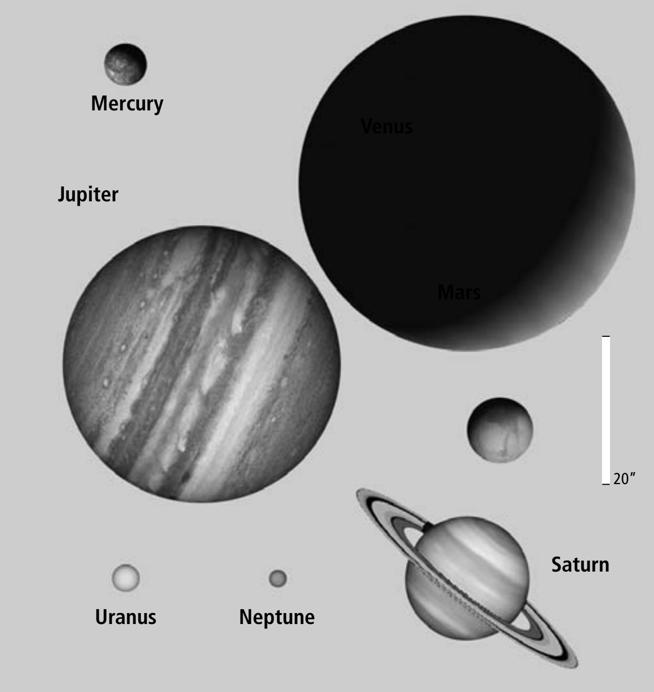
PLANET POSITIONS

2007 **September 1** 2007 **September 15**



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

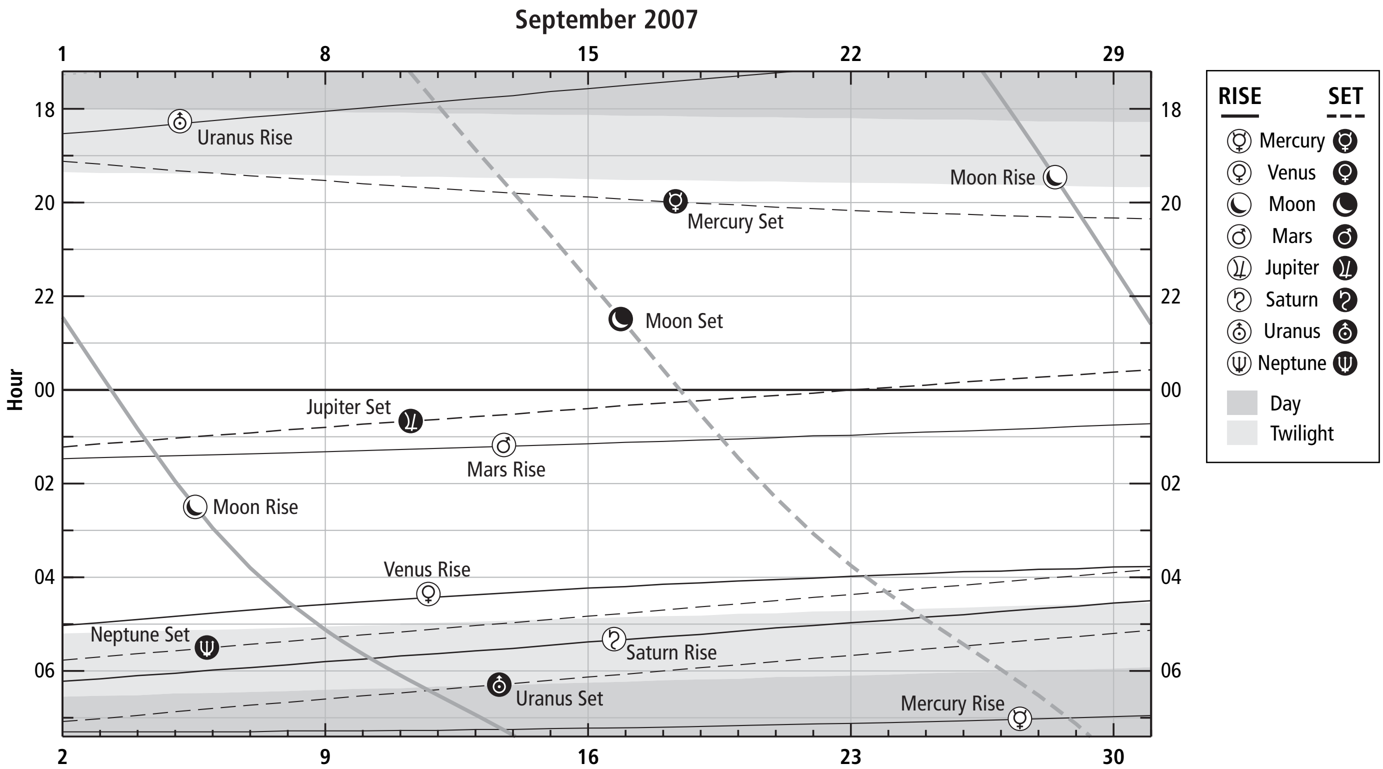


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY Rise h m	MERCURY Set h m	VENUS Rise h m	VENUS Set h m	MARS Rise h m	MARS Set h m	JUPITER Rise h m	JUPITER Set h m	SATURN Rise h m	SATURN Set h m	URANUS Rise h m	URANUS Set h m	NEPTUNE Rise h m	NEPTUNE Set h m
1	0718	1907	0507	1629	0129	1139	1114	0116	0617	1716	1832	0709	1625	0550
2	0718	1911	0502	1624	0128	1137	1110	0113	0613	1713	1828	0705	1621	0546
3	0718	1915	0458	1619	0127	1135	1107	0109	0610	1709	1824	0701	1617	0542
4	0718	1919	0454	1614	0126	1134	1103	0106	0606	1706	1820	0657	1613	0538
5	0718	1922	0450	1609	0124	1132	1100	0102	0603	1703	1815	0652	1609	0534
6	0718	1926	0446	1605	0123	1130	1056	0058	0559	1659	1811	0648	1605	0530
7	0718	1929	0442	1600	0122	1128	1052	0055	0556	1656	1807	0644	1601	0526
8	0717	1932	0438	1556	0121	1127	1049	0051	0552	1653	1803	0640	1557	0522
9	0717	1936	0435	1552	0119	1125	1045	0048	0548	1649	1759	0636	1553	0518
10	0717	1939	0432	1548	0118	1123	1042	0044	0545	1646	1755	0632	1549	0514
11	0716	1942	0428	1544	0116	1121	1038	0041	0541	1643	1751	0628	1545	0510
12	0716	1945	0425	1541	0115	1120	1034	0038	0538	1639	1747	0624	1541	0506
13	0715	1948	0422	1537	0113	1118	1031	0034	0534	1636	1743	0620	1537	0502
14	0715	1951	0420	1534	0112	1116	1027	0031	0531	1633	1738	0616	1533	0458
15	0714	1953	0417	1531	0111	1114	1024	0027	0527	1629	1734	0612	1529	0454
16	0713	1956	0414	1528	0109	1112	1020	0024	0523	1626	1730	0608	1525	0450
17	0713	1959	0412	1525	0107	1111	1017	0020	0520	1622	1726	0604	1521	0446
18	0712	2001	0409	1522	0106	1109	1013	0017	0516	1619	1722	0600	1516	0442
19	0711	2003	0407	1520	0104	1107	1010	0014	0513	1616	1718	0556	1512	0438
20	0710	2006	0405	1518	0103	1105	1006	0010	0509	1612	1714	0552	1508	0434
21	0709	2008	0403	1515	0101	1103	1003	0007	0505	1609	1710	0548	1504	0430
22	0708	2010	0401	1513	0059	1101	1000	0004	0502	1606	1705	0544	1500	0426
23	0707	2012	0359	1511	0058	1059	0956	0000	0458	1602	1701	0540	1456	0422
23								2357						
24	0706	2014	0357	1509	0056	1057	0953	2354	0455	1559	1657	0536	1452	0418
25	0705	2015	0355	1508	0054	1055	0949	2350	0451	1555	1653	0532	1448	0414
26	0704	2017	0353	1506	0053	1053	0946	2347	0448	1552	1649	0528	1444	0410
27	0703	2018	0352	1505	0051	1052	0942	2344	0444	1549	1645	0524	1440	0406
28	0701	2019	0350	1503	0049	1050	0939	2341	0440	1545	1641	0520	1436	0402
29	0700	2020	0349	1502	0047	1047	0936	2337	0437	1542	1637	0516	1432	0358
30	0658	2021	0347	1501	0045	1045	0932	2334	0433	1539	1633	0512	1428	0354

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

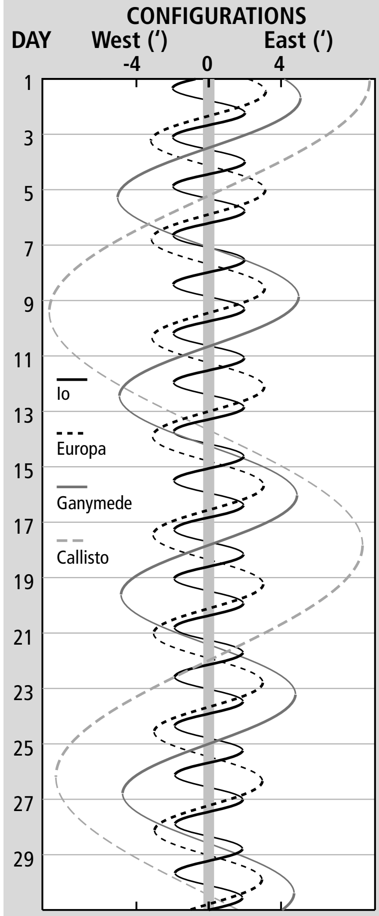
DAY	PHENOMENON h m	Sat.	Event
1	1926		GRS
1	2108	I	Ec.R.
3	2104		GRS
5	2003	II	Tr.I.
5	2239	II	Tr.E.
5	2240	II	Sh.I.
5	2242		GRS
7	0028	III	Oc.D.
7	2020	II	Ec.R.
7	2226	I	Tr.I.
7	2342	I	Sh.I.
8	0020		GRS
8	0036	I	Tr.E.
8	1933	I	Oc.D.
8	2011		GRS
8	2304	I	Ec.R.
9	2021	I	Sh.E.
10	1937	III	Sh.I.
10	2149		GRS
10	2204	III	Sh.E.
12	2242	II	Tr.I.
12	2327		GRS
14	2256	II	Ec.R.
15	0022	I	Tr.I.
15	2057		GRS
15	2129	I	Oc.D.
16	2005	I	Sh.I.
16	2102	I	Tr.E.
16	2216	I	Sh.E.
17	2057	III	Tr.E.
17	2235		GRS
17	2337	III	Sh.I.
20	2004		GRS
21	2027	II	Oc.D.
22	2142		GRS
22	2326	I	Oc.D.
23	0255	I	Ec.R.
23	1950	II	Sh.E.
23	2048	I	Tr.I.
23	2200	I	Sh.I.
23	2259	I	Tr.E.
24	2123	I	Ec.R.
24	2239	III	Tr.I.
24	2320		GRS
27	2050		GRS
28	2011	III	Ec.R.
28	2307	II	Oc.D.
29	2228		GRS
30	1952	II	Sh.I.
30	2004	II	Tr.E.
30	2228	II	Sh.E.
30	2245	I	Tr.I.

Moons: I Io; II Europa; III Ganymede; IV Callisto

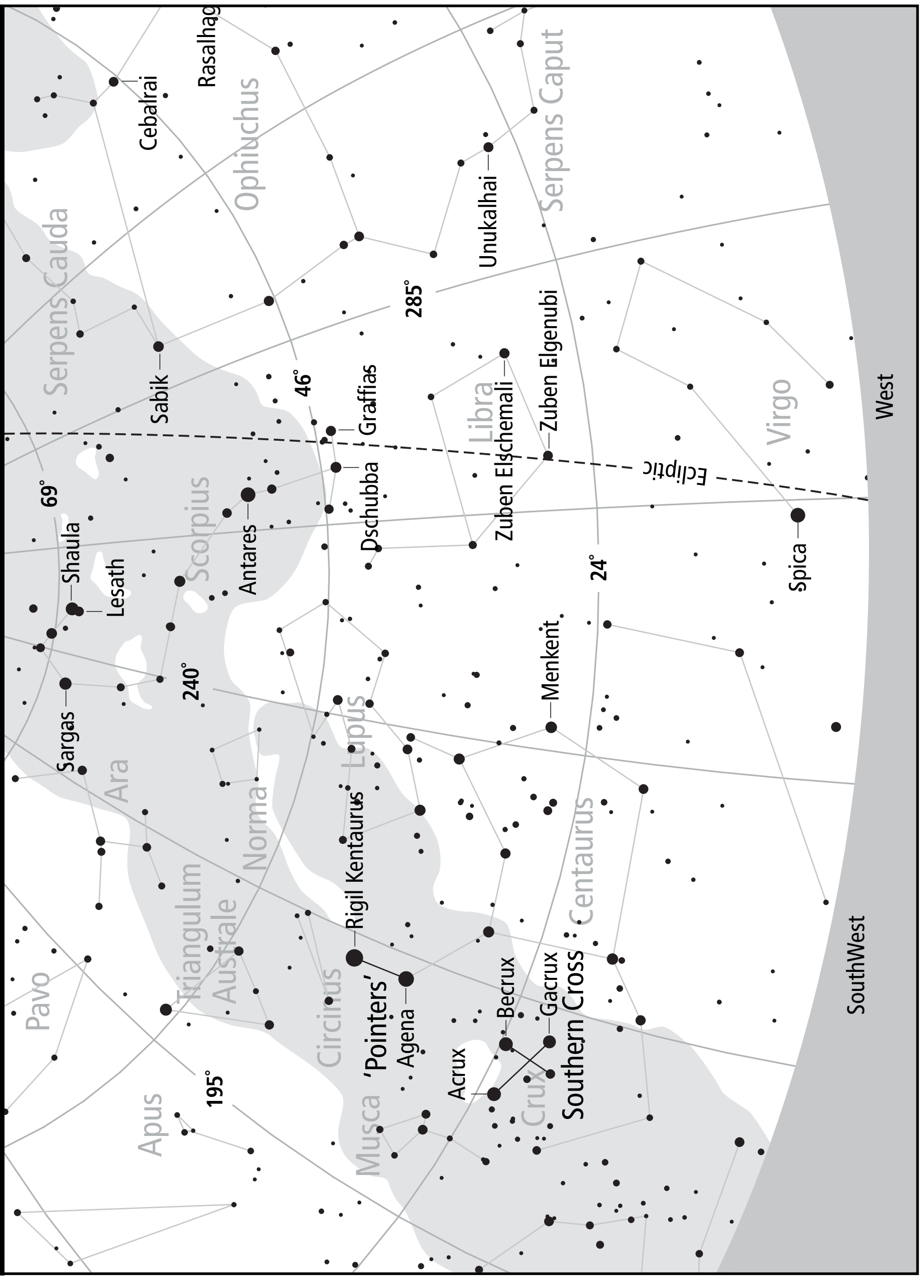
Events: D Disappear; R Reappear; E Egress; I Ingress; Ec Eclipse; Oc Occult; Sh Shadow; Tr Transit

GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

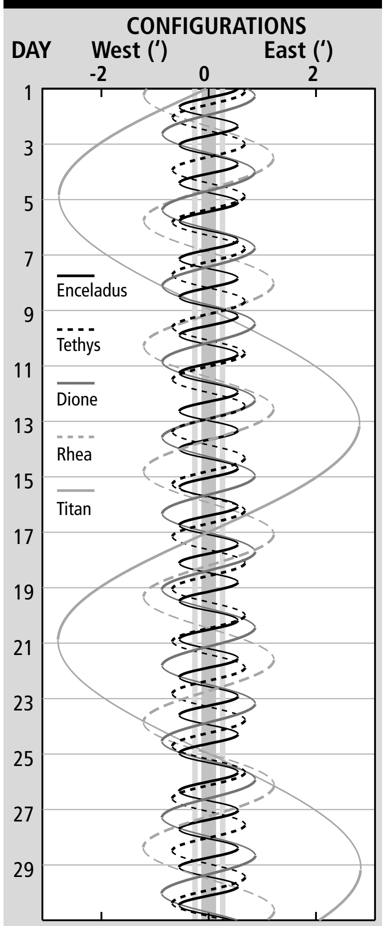
JUPITER MOONS



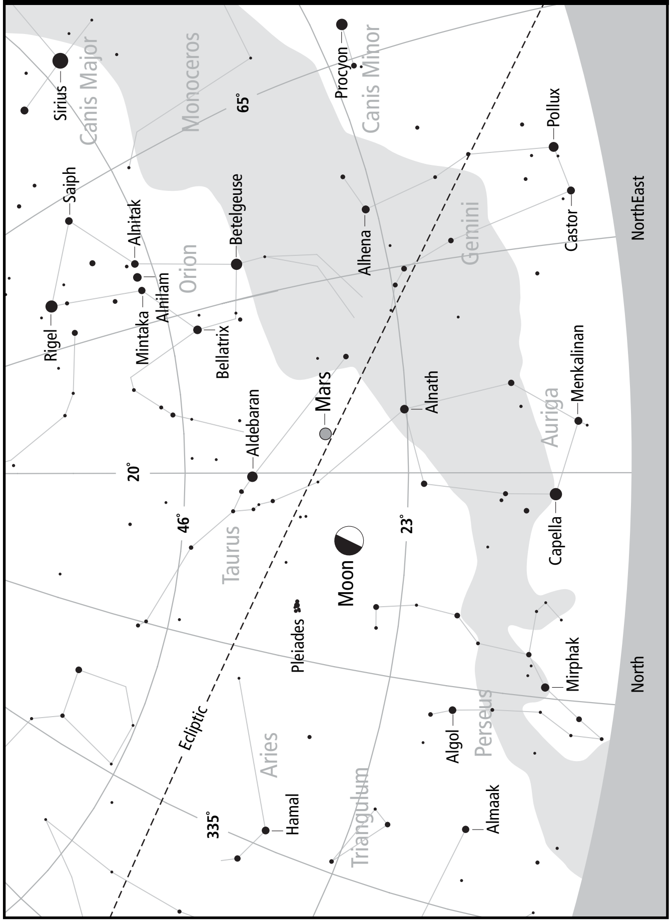
SKYVIEW SEPTEMBER 15 8pm – LOOKING WEST (and SOUTHERN CROSS)



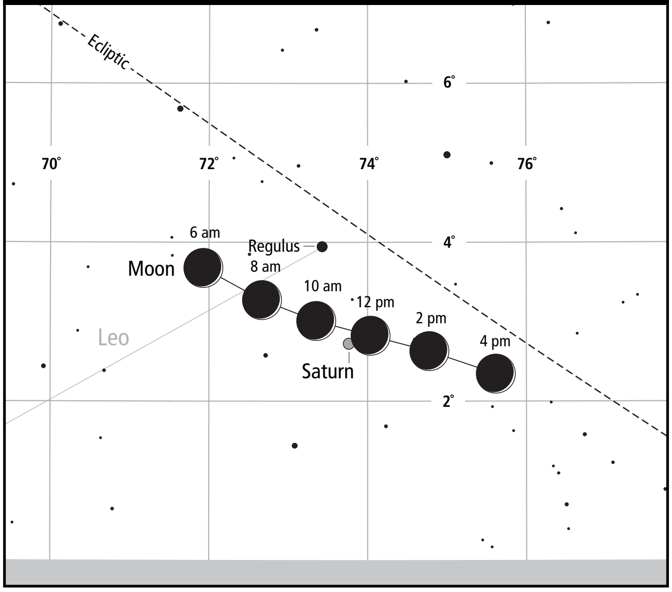
SATURN MOONS



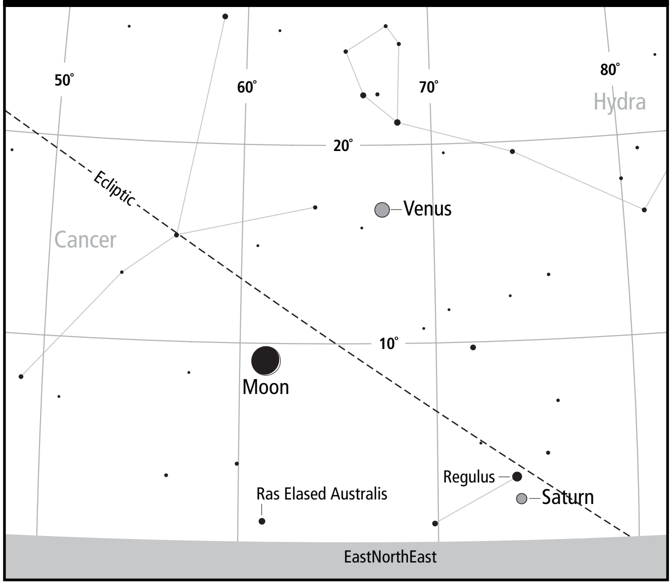
SKYVIEW 2007 SEPTEMBER 4 5am



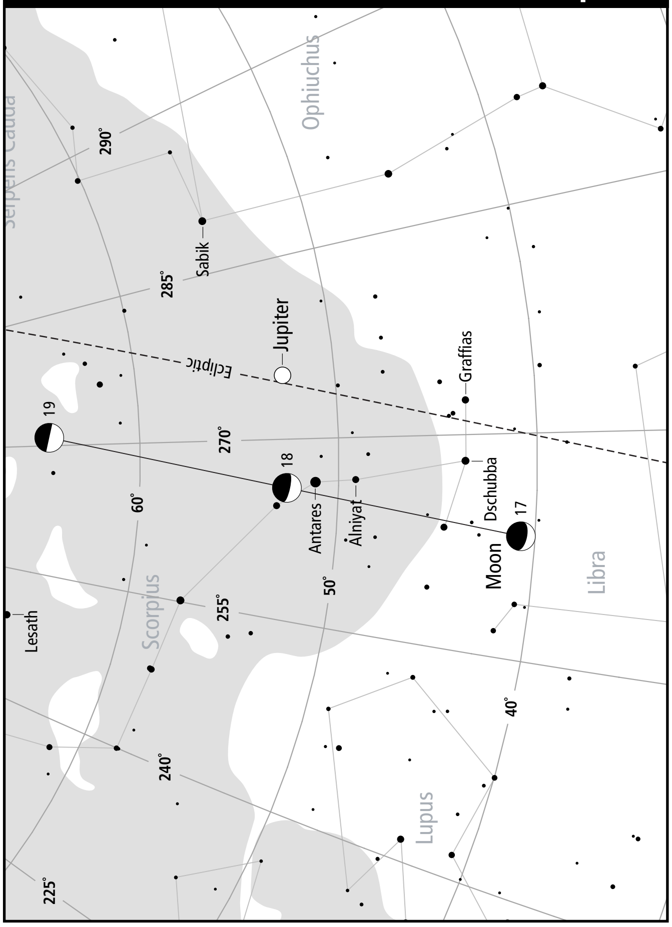
SKYVIEW 2007 SEPTEMBER 9 6am-4pm



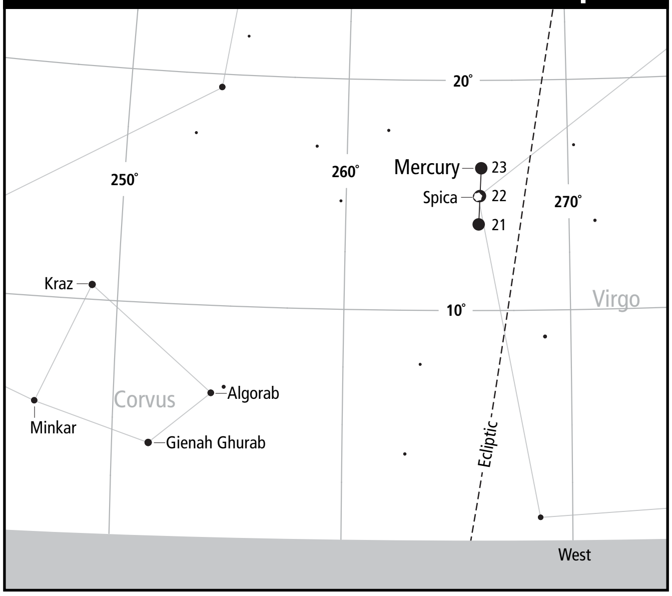
SKYVIEW 2007 SEPTEMBER 9 6am



SKYVIEW 2007 SEPTEMBER 17-19 8pm



SKYVIEW 2007 SEPTEMBER 19-21 7pm



OCTOBER 2007

HIGHLIGHTS

Mercury *visible very low in western evening twilight in first half of month.*

Venus *clearly visible in the eastern sky before dawn, close to Moon on 7th and visible in day time. Conjunction with Saturn on 15th.*

Mars *visible in the north to NE before dawn.*

Jupiter *visible nearly all evening.*

Saturn *visible before dawn in the NE sky.*

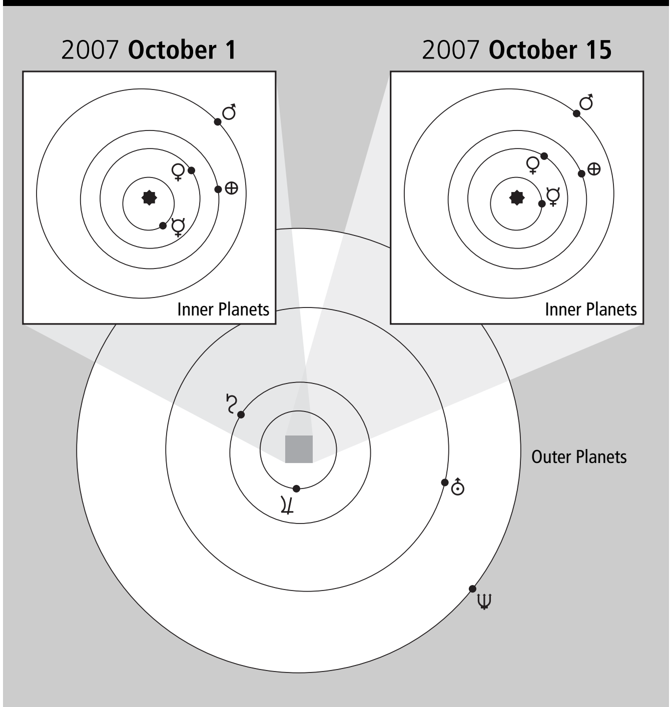
DIARY

Day	Hour	
3	04	Mars 5° S. of Moon
3	18	**Last Quarter**
7	11	Venus 3° S. of Moon
7	15	*Regulus* 0.°2 S. of Moon
8	00	Saturn 1.°3 N. of Moon
9	19	Venus 3° S. of *Regulus*
11	13	**New Moon**
12	15	Mercury stationary
13	09	Mercury 1.°3 N. of Moon
13	18	Moon at apogee
15	22	Venus 3° S. of Saturn
15	23	*Antares* 0.°5 N. of Moon
16	14	Jupiter 5° N. of Moon
18		Max activity of epsilon-Geminid meteor s.
19	17	**First Quarter**
21		Max activity of epsilon-Orionid meteor s.
24	08	Mercury in inferior conjunction
26	13	**Full Moon**
26	20	Moon at perigee
28	23	Venus greatest elongation W. (46°)
31	03	Mars 3° S. of Moon

SUN+MOON RISE/SET

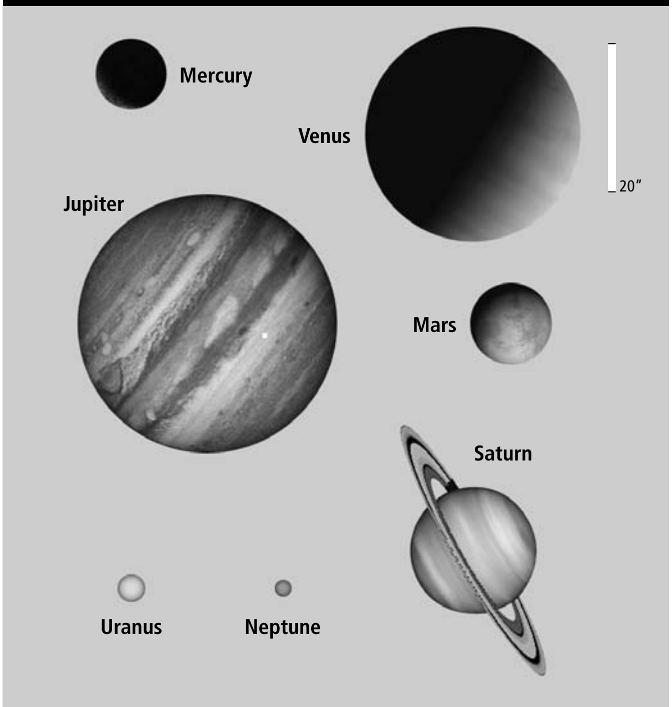
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0555	94	0433	1206	1818	266	1940	2347	0839	80
2	0554	94	0432	1206	1819	265	1941	DNR	0936	69
3	0553	95	0430	1206	1819	265	1942	0051	1038	58
4	0551	95	0429	1206	1820	264	1943	0146	1144	47
5	0550	96	0428	1205	1821	264	1944	0231	1249	37
6	0549	96	0426	1205	1821	264	1944	0309	1352	27
7	0548	97	0425	1205	1822	263	1945	0341	1452	19
8	0546	97	0423	1204	1823	263	1946	0409	1550	11
9	0545	98	0422	1204	1823	262	1947	0435	1645	6
10	0544	98	0420	1204	1824	262	1948	0500	1740	2
11	0543	98	0419	1204	1825	261	1949	0525	1835	0
12	0541	99	0418	1203	1826	261	1950	0552	1931	0
13	0540	99	0416	1203	1826	260	1950	0621	2028	2
14	0539	100	0415	1203	1827	260	1951	0654	2126	6
15	0538	100	0414	1203	1828	259	1952	0731	2224	11
16	0537	101	0412	1202	1828	259	1953	0815	2319	17
17	0535	101	0411	1202	1829	259	1954	0905	DNS	25
18	0534	102	0409	1202	1830	258	1955	1001	0011	34
19	0533	102	0408	1202	1831	258	1956	1101	0058	43
20	0532	102	0407	1202	1831	257	1957	1205	0139	53
21	0531	103	0405	1201	1832	257	1958	1309	0216	64
22	0530	103	0404	1201	1833	256	1959	1415	0250	74
23	0529	104	0403	1201	1834	256	2000	1522	0321	83
24	0528	104	0401	1201	1835	256	2001	1630	0352	91
25	0527	105	0400	1201	1835	255	2002	1741	0424	96
26	0526	105	0359	1201	1836	255	2003	1856	0459	99
27	0525	105	0358	1201	1837	254	2004	2012	0540	100
28	0524	106	0356	1200	1838	254	2005	2127	0627	97
29	0523	106	0355	1200	1839	254	2007	2237	0722	91
30	0522	107	0354	1200	1839	253	2008	2338	0825	83
31	0521	107	0353	1200	1840	253	2009	DNR	0932	73

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

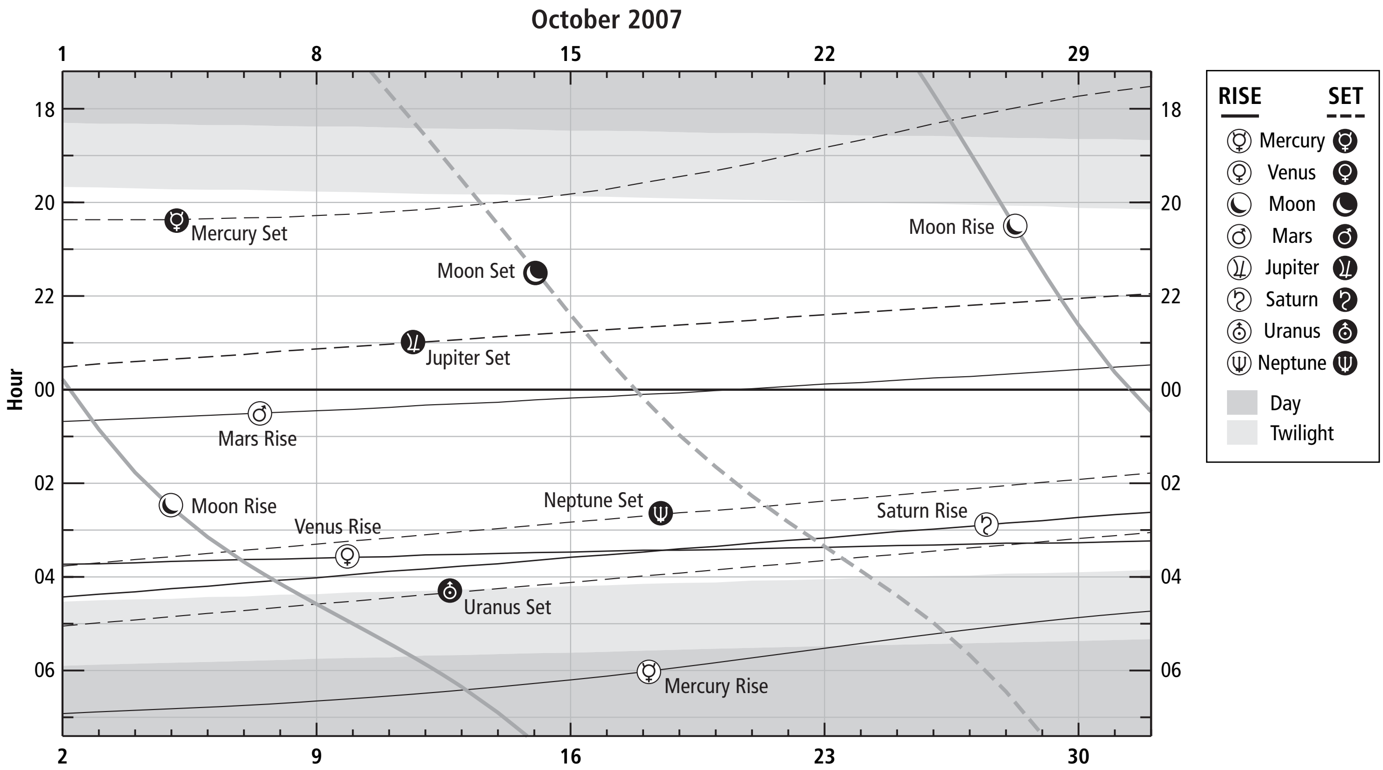


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY Rise h m	MERCURY Set h m	VENUS Rise h m	VENUS Set h m	MARS Rise h m	MARS Set h m	JUPITER Rise h m	JUPITER Set h m	SATURN Rise h m	SATURN Set h m	URANUS Rise h m	URANUS Set h m	NEPTUNE Rise h m	NEPTUNE Set h m
1	0657	2022	0346	1500	0043	1043	0929	2331	0430	1535	1629	0508	1424	0350
2	0655	2022	0344	1459	0041	1041	0925	2327	0426	1532	1624	0503	1420	0346
3	0653	2022	0343	1458	0039	1039	0922	2324	0422	1528	1620	0459	1416	0342
4	0651	2022	0342	1457	0037	1037	0919	2321	0419	1525	1616	0455	1412	0338
5	0649	2021	0340	1456	0035	1035	0915	2318	0415	1521	1612	0451	1408	0334
6	0647	2020	0339	1456	0033	1033	0912	2315	0412	1518	1608	0447	1404	0330
7	0645	2019	0338	1455	0031	1031	0909	2311	0408	1515	1604	0443	1400	0326
8	0642	2017	0337	1455	0029	1028	0905	2308	0404	1511	1600	0439	1356	0322
9	0639	2015	0336	1454	0027	1026	0902	2305	0401	1508	1556	0435	1352	0318
10	0636	2012	0335	1454	0025	1024	0859	2302	0357	1504	1552	0431	1348	0314
11	0633	2009	0334	1454	0023	1021	0856	2259	0353	1501	1548	0427	1344	0310
12	0629	2005	0332	1454	0020	1019	0852	2256	0350	1457	1544	0423	1340	0306
13	0625	2000	0331	1454	0018	1017	0849	2252	0346	1454	1539	0419	1336	0302
14	0621	1955	0330	1454	0016	1014	0846	2249	0343	1451	1535	0415	1332	0258
15	0617	1949	0329	1454	0013	1012	0843	2246	0339	1447	1531	0411	1328	0254
16	0612	1943	0328	1454	0011	1009	0839	2243	0335	1444	1527	0407	1324	0250
17	0607	1935	0327	1454	0009	1007	0836	2240	0332	1440	1523	0403	1320	0246
18	0602	1927	0326	1454	0006	1004	0833	2237	0328	1437	1519	0359	1316	0242
19	0556	1919	0326	1454	0004	1002	0830	2234	0324	1433	1515	0355	1312	0238
20	0550	1910	0325	1454	0001	0959	0826	2231	0321	1430	1511	0351	1309	0235
20					2359									
21	0544	1900	0324	1455	2356	0956	0823	2227	0317	1426	1507	0347	1305	0231
22	0538	1850	0323	1455	2353	0954	0820	2224	0313	1423	1503	0343	1301	0227
23	0532	1840	0322	1456	2351	0951	0817	2221	0310	1419	1459	0339	1257	0223
24	0525	1830	0321	1456	2348	0948	0813	2218	0306	1416	1455	0335	1253	0219
25	0519	1819	0320	1456	2345	0945	0810	2215	0302	1412	1451	0331	1249	0215
26	0513	1810	0319	1457	2343	0942	0807	2212	0259	1409	1447	0327	1245	0211
27	0507	1801	0318	1458	2340	0939	0804	2209	0255	1405	1443	0323	1241	0207
28	0502	1752	0317	1458	2337	0936	0801	2206	0251	1402	1439	0319	1237	0203
29	0457	1744	0317	1459	2334	0933	0758	2203	0248	1358	1435	0315	1233	0159
30	0452	1737	0316	1500	2331	0930	0754	2200	0244	1355	1431	0311	1229	0155
31	0448	1731	0315	1500	2328	0927	0751	2157	0240	1351	1427	0307	1225	0151

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

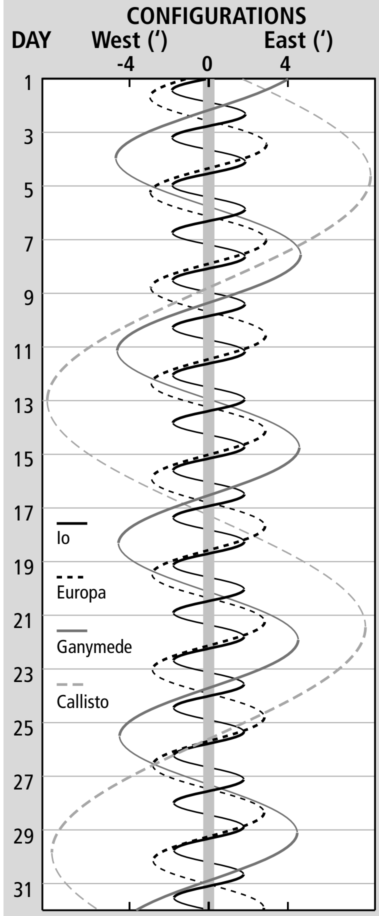
DAY	PHENOMENON h m	Satellite	Event
1	1954	I	Oc.D.
1	2319	I	Ec.R.
2	1958		GRS
2	2035	I	Sh.E.
4	2136		GRS
5	2138	III	Ec.D.
6	2314		GRS
7	2012	II	Tr.I.
7	2229	II	Sh.I.
7	2249	II	Tr.E.
8	2153	I	Oc.D.
9	1959	II	Ec.R.
9	2018	I	Sh.I.
9	2044		GRS
9	2124	I	Tr.E.
9	2230	I	Sh.E.
11	2222		GRS
12	2117	III	Oc.D.
14	1951		GRS
16	2112	I	Tr.I.
16	2130		GRS
16	2213	I	Sh.I.
16	2234	II	Ec.R.
17	2138	I	Ec.R.
21	2038		GRS
23	2039	II	Oc.D.
23	2207	III	Sh.E.
23	2216		GRS
24	2023	I	Oc.D.
25	2048	I	Sh.E.
28	2124		GRS

Moons:
- I Io
- II Europa
- III Ganymede
- IV Callisto

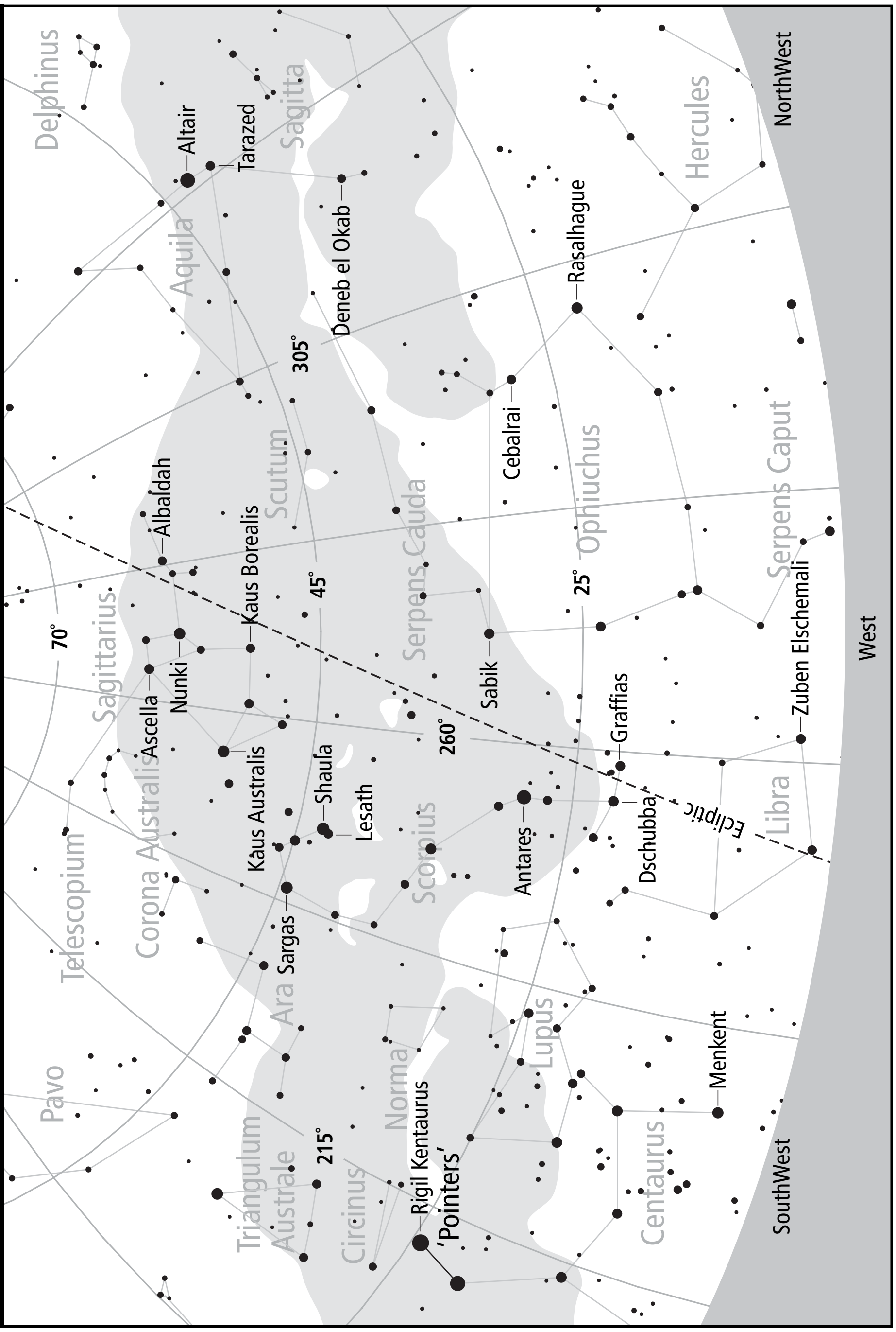
Events:
- D Disappear
- R Reappear
- E Egress
- I Ingress
- Ec Eclipse
- Oc Occult
- Sh Shadow
- Tr Transit

GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

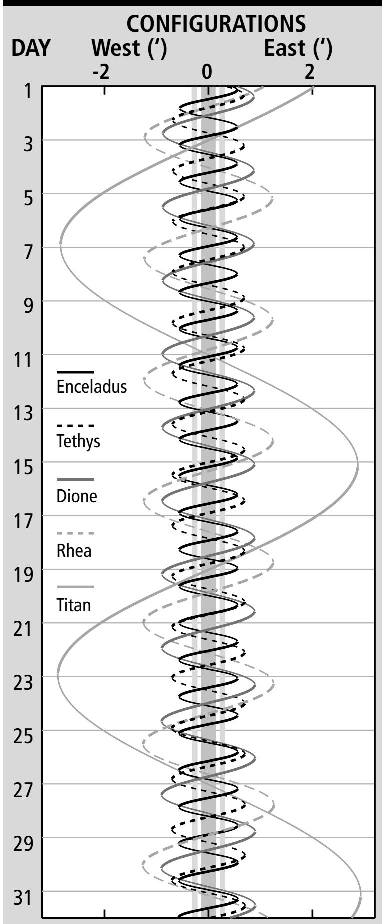
JUPITER MOONS



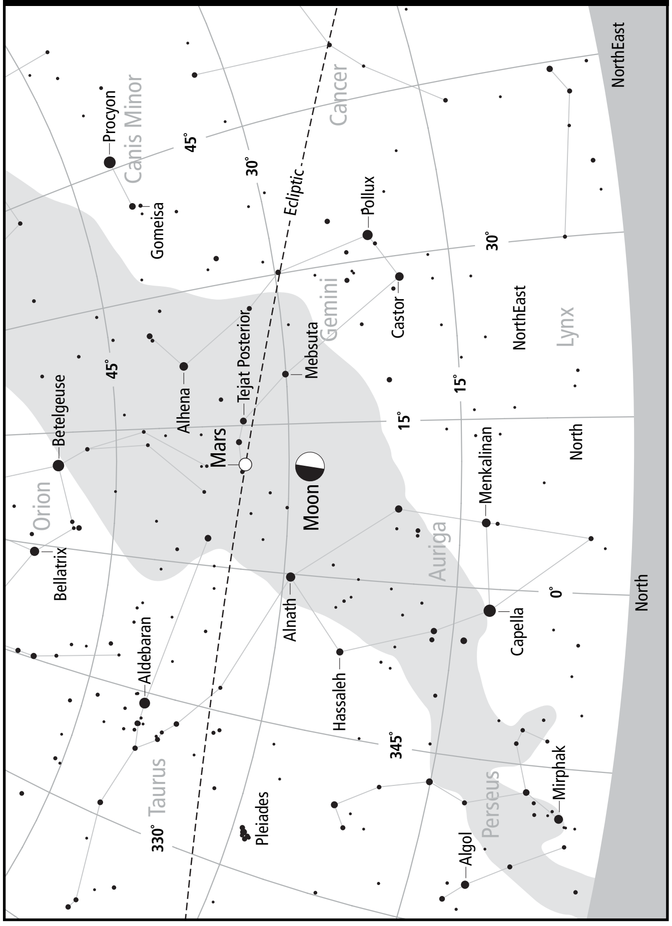
SKYVIEW OCTOBER 15 8pm – LOOKING WEST



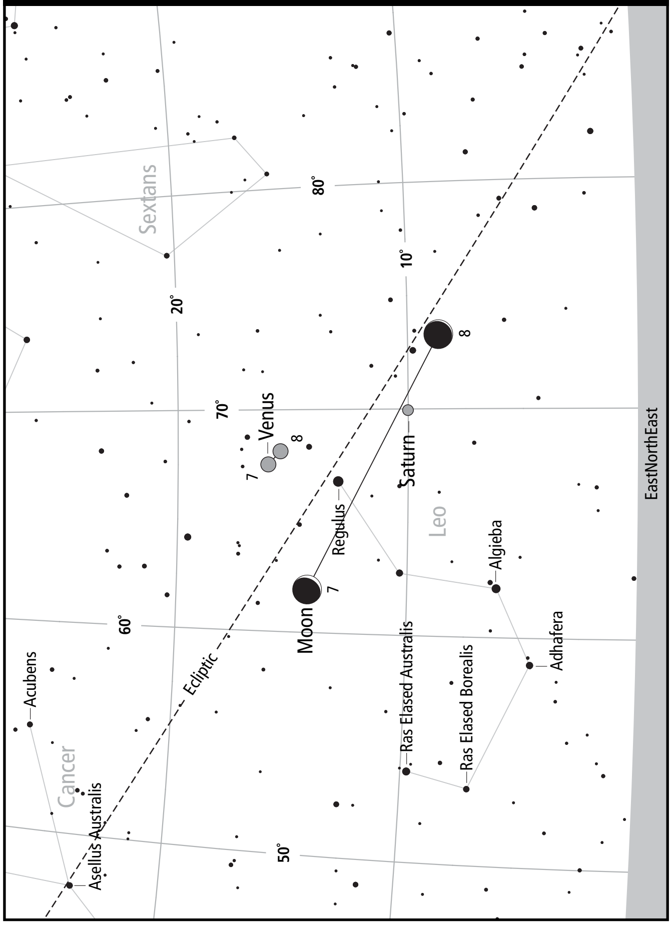
SATURN MOONS



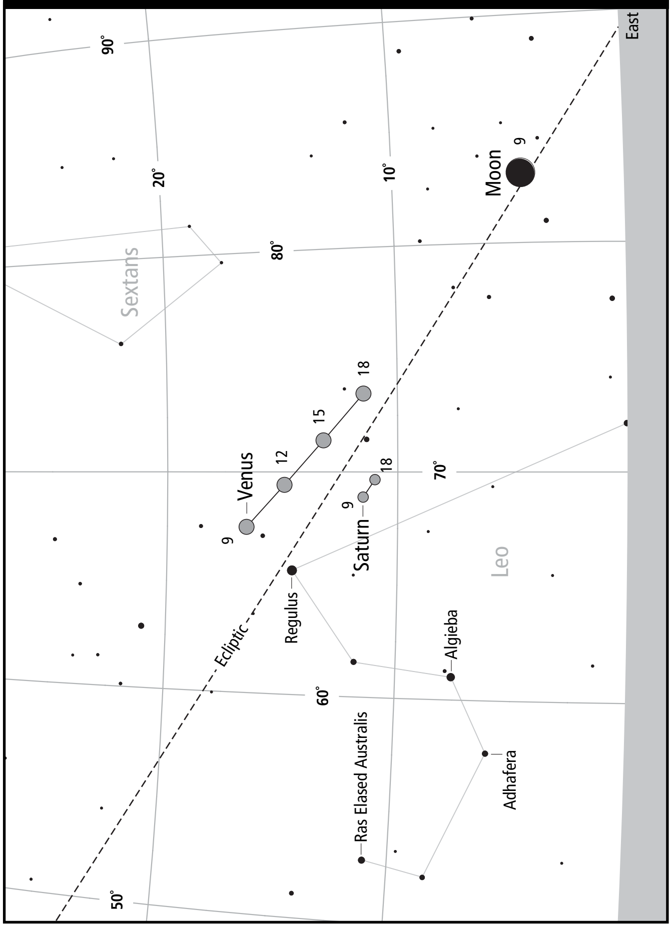
SKYVIEW 2007 OCTOBER 3 5am



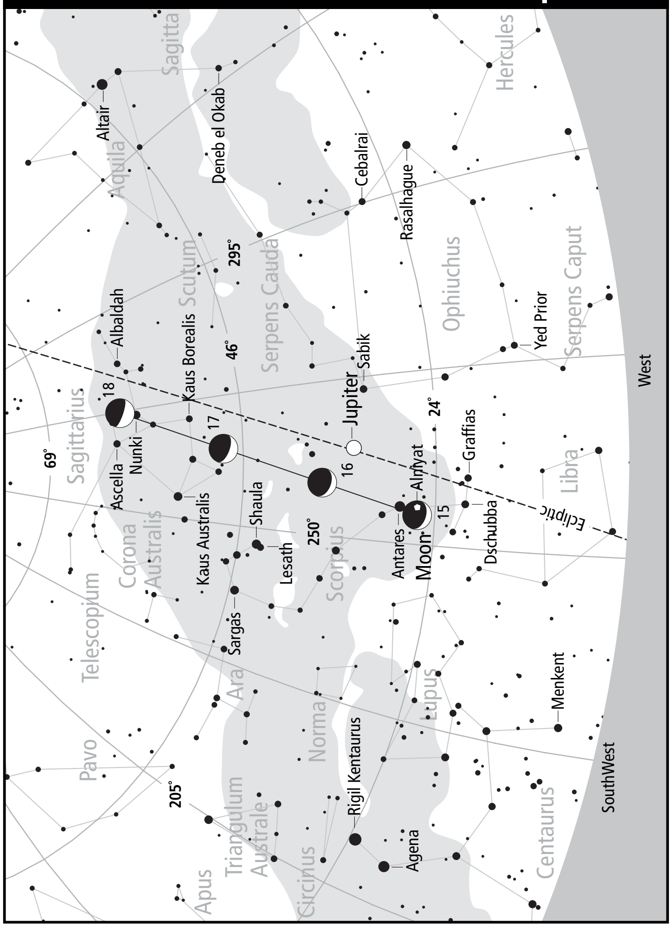
SKYVIEW 2007 OCTOBER 7-8 5am



SKYVIEW 2007 OCTOBER 9-18 5am



SKYVIEW 2007 OCTOBER 15-18 8pm



NOVEMBER 2007

HIGHLIGHTS

Mercury *visible very low in eastern morning twilight all month.*

Venus *clearly visible in the eastern sky before dawn.*

Mars *rises in the NE before midnight and visible in the northern sky until dawn.*

Jupiter *sets in the west mid evening.*

Saturn *visible before dawn in the NE sky.*

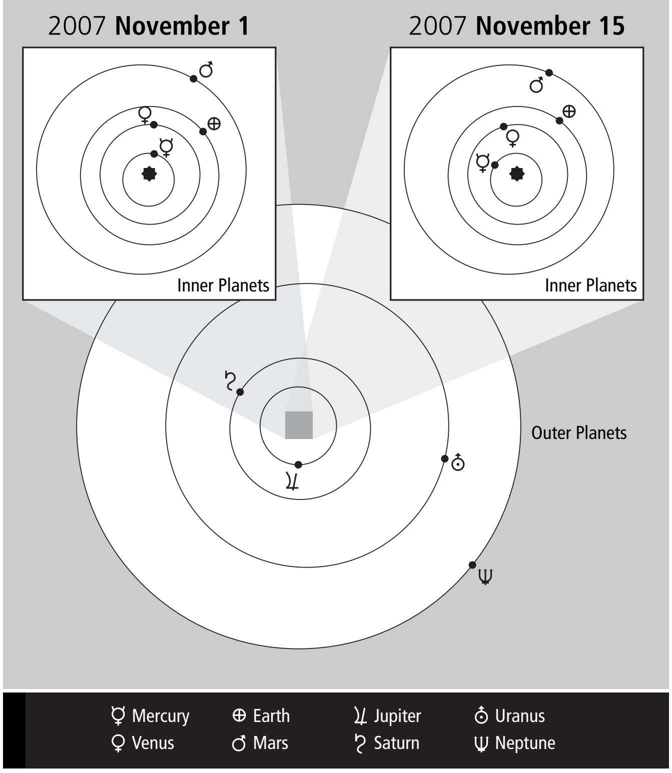
DIARY

Day	Hour	
1	04	Neptune stationary
1	21	Mercury stationary
2	05	**Last Quarter**
3	21	*Regulus* 0.°03 N. of Moon
4	11	Saturn 1.°8 N. of Moon
5		Max activity of Southern Taurid meteors
6	04	Venus 3° N. of Moon
8	19	Mercury 7° N. of Moon
9	05	Mercury greatest elongation W. (19°)
9	21	Moon at apogee
10	07	**New Moon**
12		Maximum activity of Northern Taurid meteor shower
12	05	*Antares* 0.°4 N. of Moon
13	06	Jupiter 5° N. of Moon
16	00	Mars stationary
17		Maximum activity of Leonid meteor shower
18	07	**First Quarter**
22		Max activity of alpha-Monocerotid meteors
24	08	Moon at perigee
24	22	**Full Moon**
25	02	Uranus stationary
27	14	Mars 1.°7 S. of Moon
29	06	Venus 4° N. of *Spica*

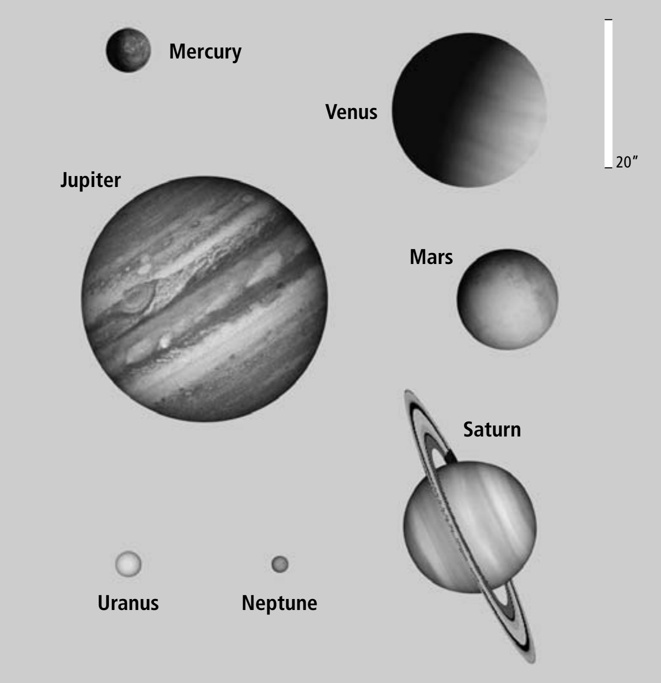
SUN+MOON RISE/SET

DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0520	107	0351	1200	1841	252	2010	0028	1040	63
2	0519	108	0350	1200	1842	252	2011	0109	1145	52
3	0518	108	0349	1200	1843	252	2012	0143	1246	42
4	0517	108	0348	1200	1844	251	2013	0213	1345	32
5	0516	109	0347	1200	1845	251	2014	0239	1441	23
6	0515	109	0346	1200	1845	251	2016	0305	1535	16
7	0515	110	0344	1200	1846	250	2017	0330	1630	10
8	0514	110	0343	1200	1847	250	2018	0355	1725	5
9	0513	110	0342	1200	1848	250	2019	0424	1822	2
10	0512	111	0341	1200	1849	249	2020	0455	1920	0
11	0512	111	0340	1201	1850	249	2022	0531	2017	1
12	0511	111	0339	1201	1851	249	2023	0613	2114	3
13	0510	112	0338	1201	1852	248	2024	0701	2206	7
14	0510	112	0337	1201	1852	248	2025	0755	2254	12
15	0509	112	0337	1201	1853	248	2026	0854	2337	19
16	0509	113	0336	1201	1854	247	2028	0955	DNS	28
17	0508	113	0335	1201	1855	247	2029	1057	0015	37
18	0508	113	0334	1202	1856	247	2030	1200	0048	47
19	0507	113	0333	1202	1857	246	2031	1304	0119	58
20	0507	114	0332	1202	1858	246	2032	1409	0149	69
21	0506	114	0332	1202	1859	246	2034	1516	0219	79
22	0506	114	0331	1203	1900	246	2035	1627	0252	87
23	0505	115	0330	1203	1901	245	2036	1742	0328	94
24	0505	115	0330	1203	1901	245	2037	1858	0412	98
25	0505	115	0329	1203	1902	245	2038	2013	0503	100
26	0504	115	0328	1204	1903	245	2039	2120	0604	98
27	0504	116	0328	1204	1904	244	2041	2217	0712	94
28	0504	116	0327	1204	1905	244	2042	2304	0822	87
29	0504	116	0327	1205	1906	244	2043	2342	0931	78
30	0504	116	0327	1205	1907	244	2044	DNR	1036	69

PLANET POSITIONS



PLANET APPEARANCE

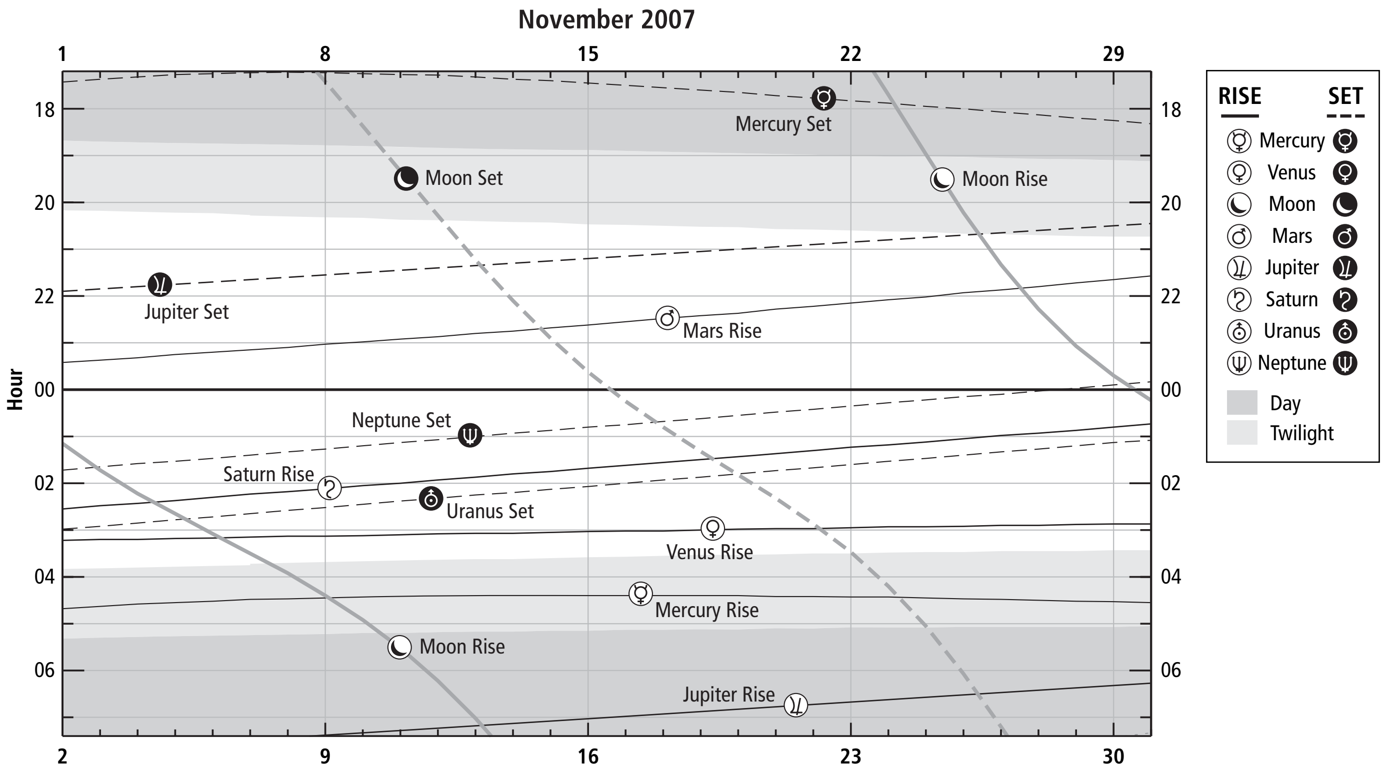


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY Rise h m	MERCURY Set h m	VENUS Rise h m	VENUS Set h m	MARS Rise h m	MARS Set h m	JUPITER Rise h m	JUPITER Set h m	SATURN Rise h m	SATURN Set h m	URANUS Rise h m	URANUS Set h m	NEPTUNE Rise h m	NEPTUNE Set h m
1	0444	1726	0314	1501	2325	0924	0748	2154	0237	1348	1423	0303	1221	0147
2	0441	1722	0313	1502	2322	0921	0745	2151	0233	1344	1419	0259	1217	0143
3	0438	1719	0312	1503	2319	0918	0742	2148	0229	1340	1415	0255	1213	0139
4	0435	1716	0312	1504	2315	0914	0739	2145	0226	1337	1411	0251	1209	0135
5	0433	1715	0311	1504	2312	0911	0736	2142	0222	1333	1406	0247	1205	0132
6	0431	1714	0310	1505	2309	0907	0733	2139	0218	1330	1402	0243	1202	0128
7	0429	1713	0309	1506	2306	0904	0729	2136	0214	1326	1359	0239	1158	0124
8	0428	1714	0308	1507	2302	0900	0726	2133	0211	1322	1355	0235	1154	0120
9	0427	1715	0308	1508	2259	0857	0723	2130	0207	1319	1351	0231	1150	0116
10	0426	1716	0307	1509	2255	0853	0720	2127	0203	1315	1347	0227	1146	0112
11	0425	1717	0306	1510	2252	0849	0717	2124	0200	1312	1343	0223	1142	0108
12	0424	1719	0305	1511	2248	0845	0714	2121	0156	1308	1339	0219	1138	0104
13	0424	1722	0304	1512	2245	0842	0711	2118	0152	1304	1335	0215	1134	0100
14	0424	1724	0304	1514	2241	0838	0708	2115	0148	1301	1331	0212	1130	0056
15	0424	1727	0303	1515	2237	0834	0705	2112	0145	1257	1327	0208	1126	0052
16	0424	1730	0302	1516	2233	0830	0702	2109	0141	1253	1323	0204	1122	0048
17	0424	1733	0301	1517	2229	0825	0659	2106	0137	1250	1319	0200	1119	0045
18	0424	1736	0301	1518	2225	0821	0656	2103	0133	1246	1315	0156	1115	0041
19	0424	1739	0300	1519	2222	0817	0653	2100	0130	1242	1311	0152	1111	0037
20	0424	1743	0259	1521	2217	0813	0650	2057	0126	1239	1307	0148	1107	0033
21	0425	1746	0258	1522	2213	0808	0647	2054	0122	1235	1303	0144	1103	0029
22	0425	1750	0258	1523	2209	0804	0644	2051	0118	1231	1259	0140	1059	0025
23	0426	1753	0257	1525	2205	0759	0640	2048	0114	1228	1255	0136	1055	0021
24	0426	1757	0256	1526	2201	0755	0637	2045	0111	1224	1251	0132	1051	0017
25	0427	1800	0256	1527	2156	0750	0634	2042	0107	1220	1247	0128	1048	0013
26	0428	1804	0255	1529	2152	0745	0631	2039	0103	1216	1243	0124	1044	0009
27	0429	1808	0254	1530	2148	0740	0628	2036	0059	1213	1239	0120	1040	0006
28	0430	1812	0254	1531	2143	0736	0625	2033	0056	1209	1235	0116	1036	0002
28														2358
29	0431	1815	0253	1533	2139	0731	0622	2030	0052	1205	1231	0112	1032	2354
30	0432	1819	0252	1534	2134	0726	0619	2027	0048	1201	1228	0108	1028	2350

SOLAR SYSTEM RISE/SET

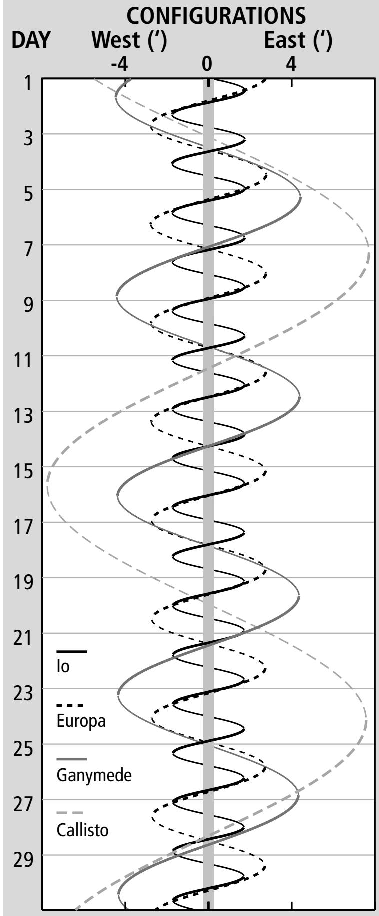


JUPITER MOONS + GREAT RED SPOT

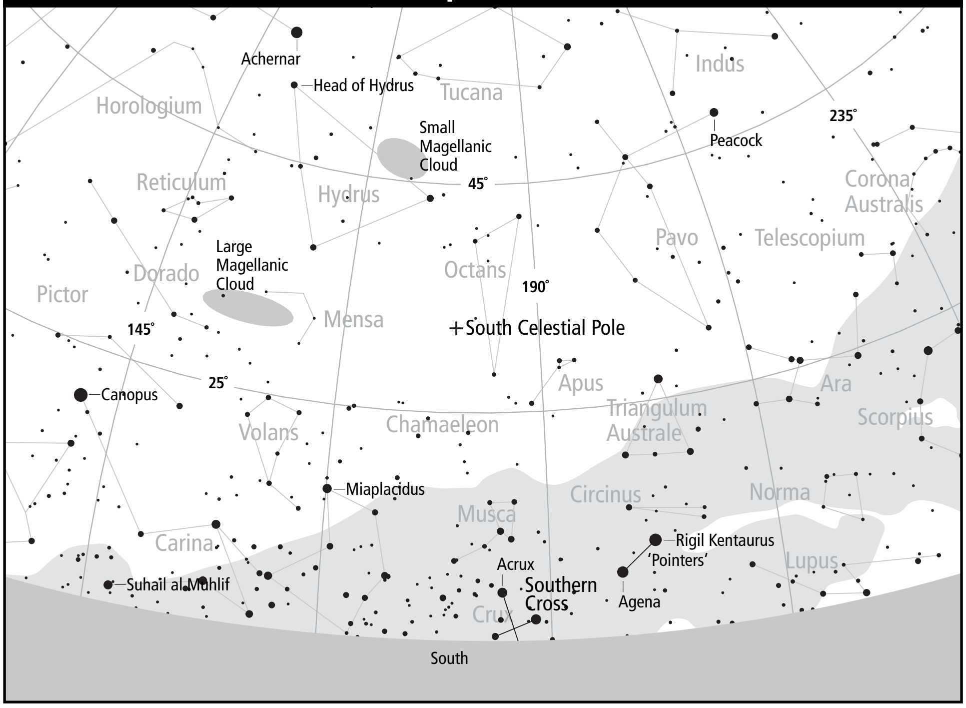
DAY	PHENOMENON h m	Satellite	Event	
1	2031	I	Sh.I.	Shadow Ingress
1	2037	II	Tr.E.	Transit Egress
1	2153	I	Tr.E.	Transit Egress
2	2032		GRS	Great Red Spot
8	2048	II	Tr.I.	Transit Ingress
9	2118		GRS	Great Red Spot
14	2026		GRS	Great Red Spot
16	2057	I	Oc.D.	Occult Disappear
17	2101	I	Sh.E.	Shadow Egress
24	2042	I	Sh.I.	Shadow Ingress

Moons:	I	Io	III	Ganymede
	II	Europa	IV	Callisto
Events:	D	Disappear	R	Reappear
	E	Egress	I	Ingress
	Ec	Eclipse	Oc	Occult
	Sh	Shadow	Tr	Transit
	GRS	Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown		

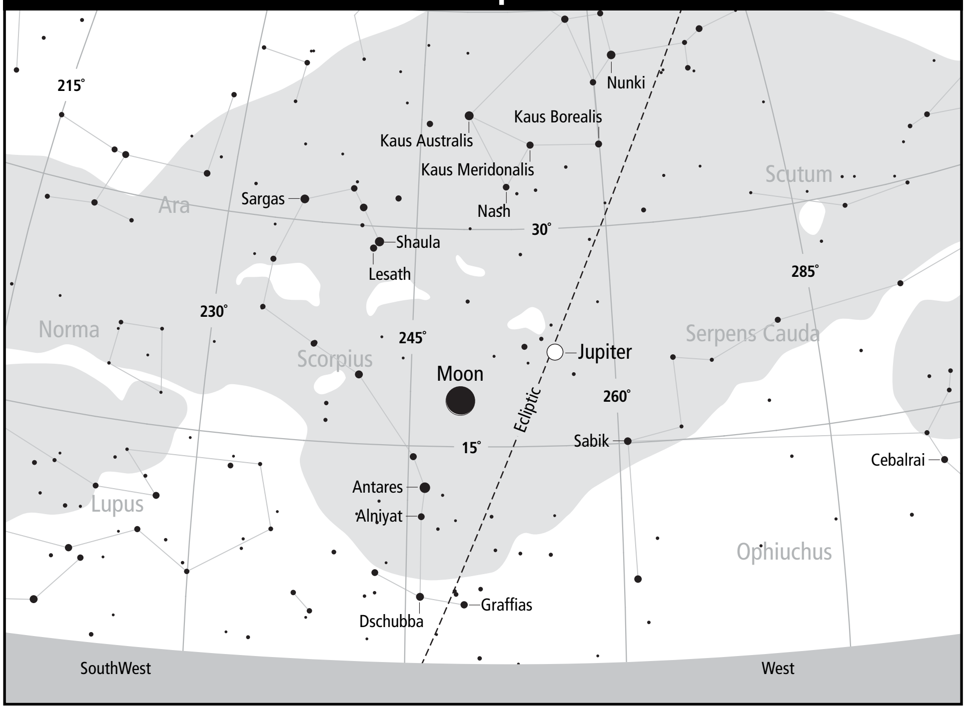
JUPITER MOONS



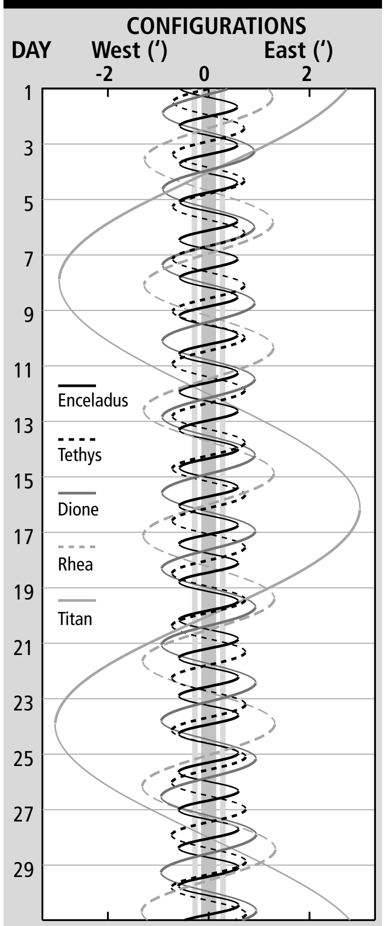
SKYVIEW NOVEMBER 15 8pm – SOUTHERN CROSS



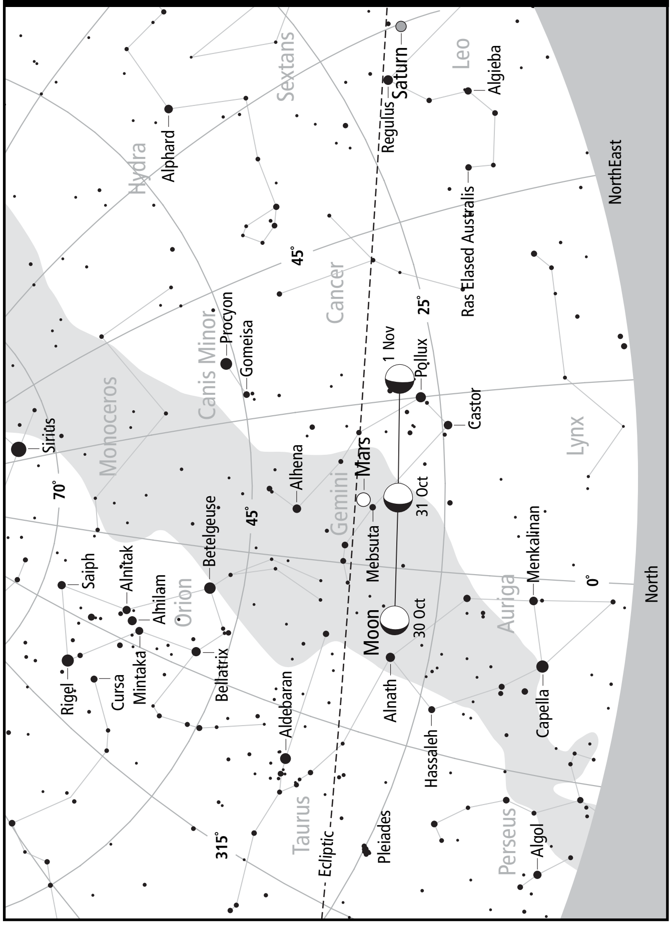
SKYVIEW NOVEMBER 12 7.30pm



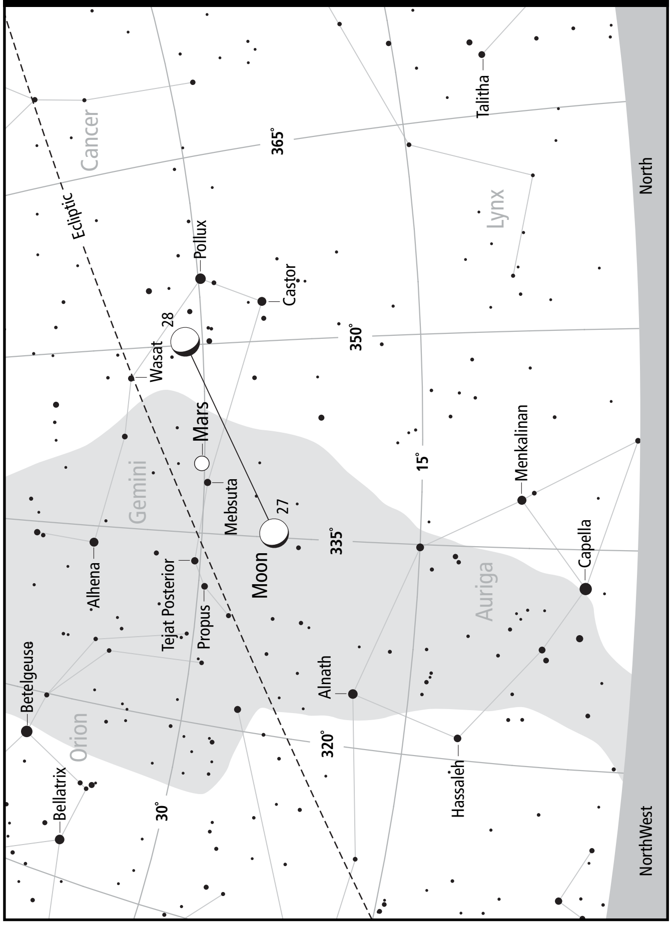
SATURN MOONS



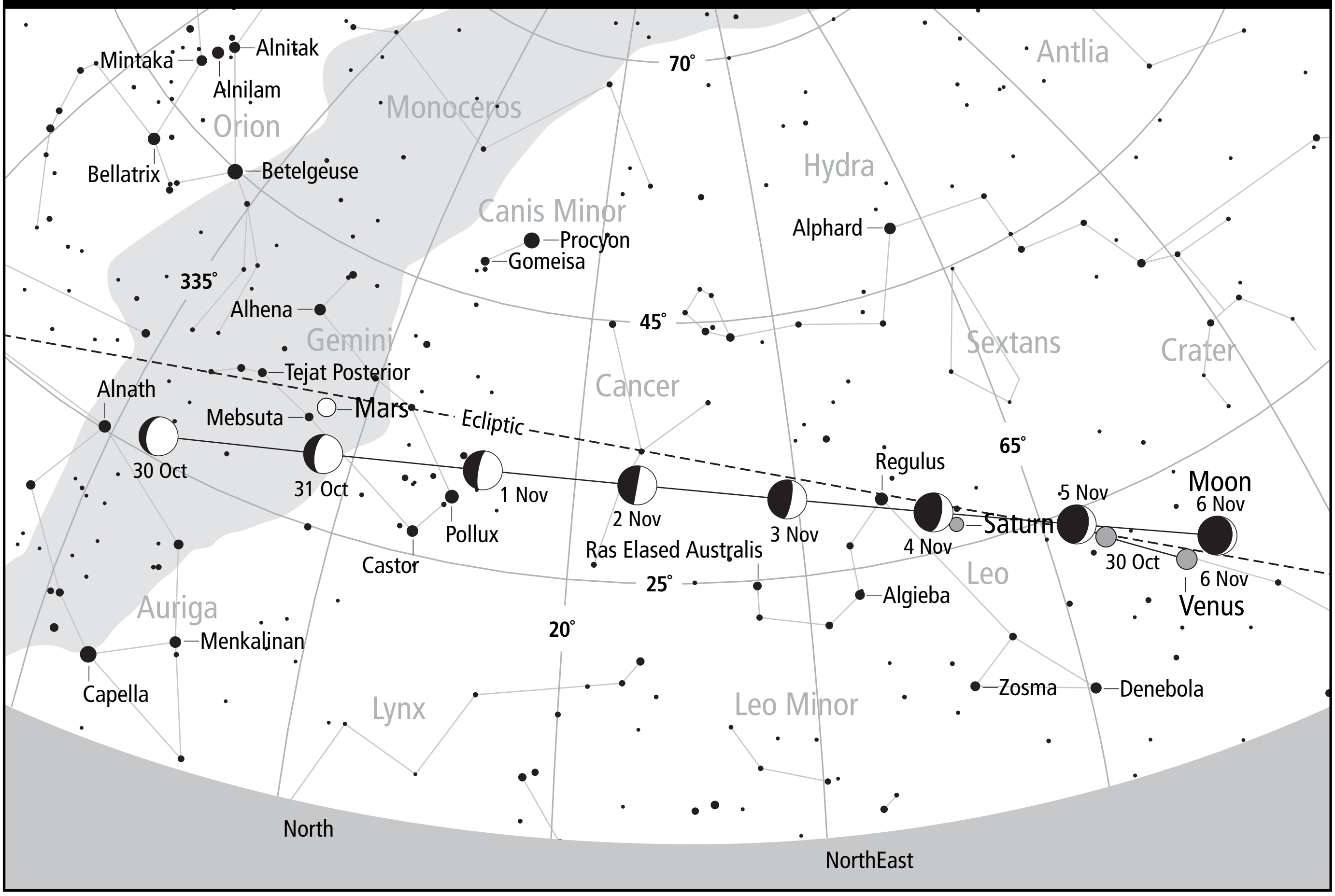
SKYVIEW 2007 OCT 30 - NOV 1 4am



SKYVIEW 2007 NOVEMBER 27-28 4am



SKYVIEW 2007 OCTOBER 30 - NOVEMBER 6 5am



DECEMBER 2007

HIGHLIGHTS

Venus *clearly visible in the eastern sky before dawn.*
Mars *rises in the NE in the mid evening and visible in the northern sky until dawn.*
Jupiter *visible in western evening twilight in first half of the month.*
Saturn *rises before midnight from the middle of the month and is visible until dawn.*

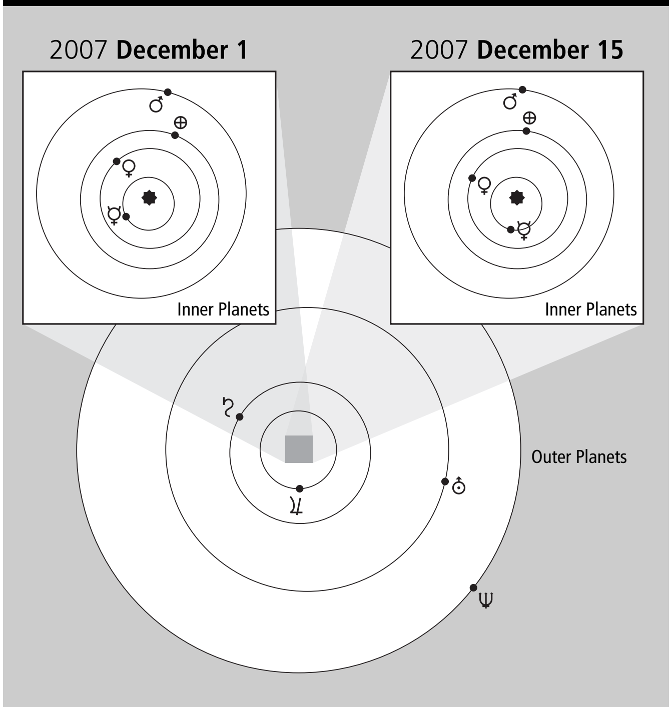
DIARY

Day	Hour	
1	04	*Regulus* 0.°3 N. of Moon
1	21	**Last Quarter**
1	21	Saturn 2° N. of Moon
2		Max activity of chi-Orionid meteor shower
6		Max activity of Phoenicid meteor shower
6		Max activity of Puppid-Velids meteor s.
6	09	Venus 7° N. of Moon
7	01	Moon at apogee
8		Max activity of Monocerotid (Dec.) meteor s.
10	02	**New Moon**
11		Max activity of sigma-Hydrid meteor s.
14		Max activity of Geminid meteor shower
17	18	**First Quarter**
17	23	Mercury in superior conjunction
19		Max activity of Coma Berenicid meteor s.
19	08	Mars closest approach
20	20	Saturn stationary
22	14	Solstice
22	18	Moon at perigee
23	14	Jupiter in conjunction with Sun
24	09	**Full Moon**
24	11	Mars 0.°9 S. of Moon
25	04	Mars at opposition
28	13	*Regulus* 0.°06 N. of Moon
29	06	Saturn 3° N. of Moon
31	14	**Last Quarter**

SUN+MOON RISE/SET

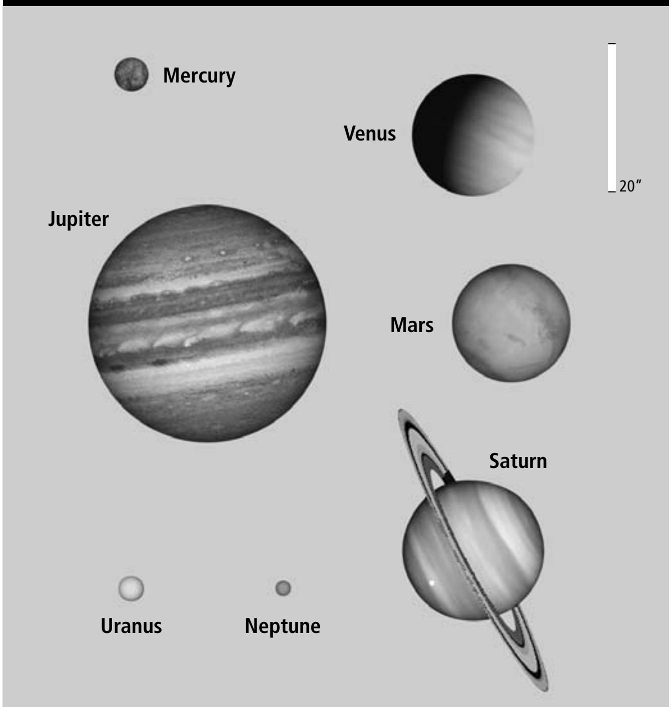
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0503	116	0326	1205	1908	243	2045	0014	1137	59
2	0503	117	0326	1206	1908	243	2046	0042	1234	49
3	0503	117	0325	1206	1909	243	2047	0108	1330	39
4	0503	117	0325	1207	1910	243	2048	0133	1425	30
5	0503	117	0325	1207	1911	243	2049	0159	1520	22
6	0503	117	0325	1207	1912	243	2050	0226	1616	14
7	0503	117	0325	1208	1912	242	2051	0256	1713	9
8	0503	118	0324	1208	1913	242	2052	0331	1811	4
9	0503	118	0324	1209	1914	242	2053	0411	1908	1
10	0504	118	0324	1209	1915	242	2054	0458	2002	0
11	0504	118	0324	1210	1915	242	2055	0551	2052	1
12	0504	118	0324	1210	1916	242	2056	0648	2136	4
13	0504	118	0325	1210	1917	242	2057	0749	2215	8
14	0504	118	0325	1211	1918	242	2057	0851	2250	14
15	0505	118	0325	1211	1918	242	2058	0953	2321	22
16	0505	118	0325	1212	1919	242	2059	1055	2350	32
17	0505	118	0325	1212	1919	242	2100	1157	DNS	42
18	0506	118	0326	1213	1920	242	2100	1301	0019	53
19	0506	118	0326	1213	1921	241	2101	1408	0049	64
20	0507	119	0326	1214	1921	241	2101	1518	0122	74
21	0507	119	0327	1214	1922	241	2102	1631	0201	84
22	0507	119	0327	1215	1922	241	2102	1745	0247	92
23	0508	119	0328	1215	1923	241	2103	1856	0342	97
24	0509	119	0328	1216	1923	241	2103	1959	0446	100
25	0509	119	0329	1216	1924	241	2104	2052	0557	99
26	0510	118	0329	1217	1924	242	2104	2135	0708	96
27	0510	118	0330	1217	1924	242	2104	2211	0817	91
28	0511	118	0331	1218	1925	242	2105	2241	0922	84
29	0511	118	0332	1218	1925	242	2105	2309	1023	75
30	0512	118	0332	1219	1925	242	2105	2334	1120	66
31	0513	118	0333	1219	1926	242	2105	DNR	1216	57

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

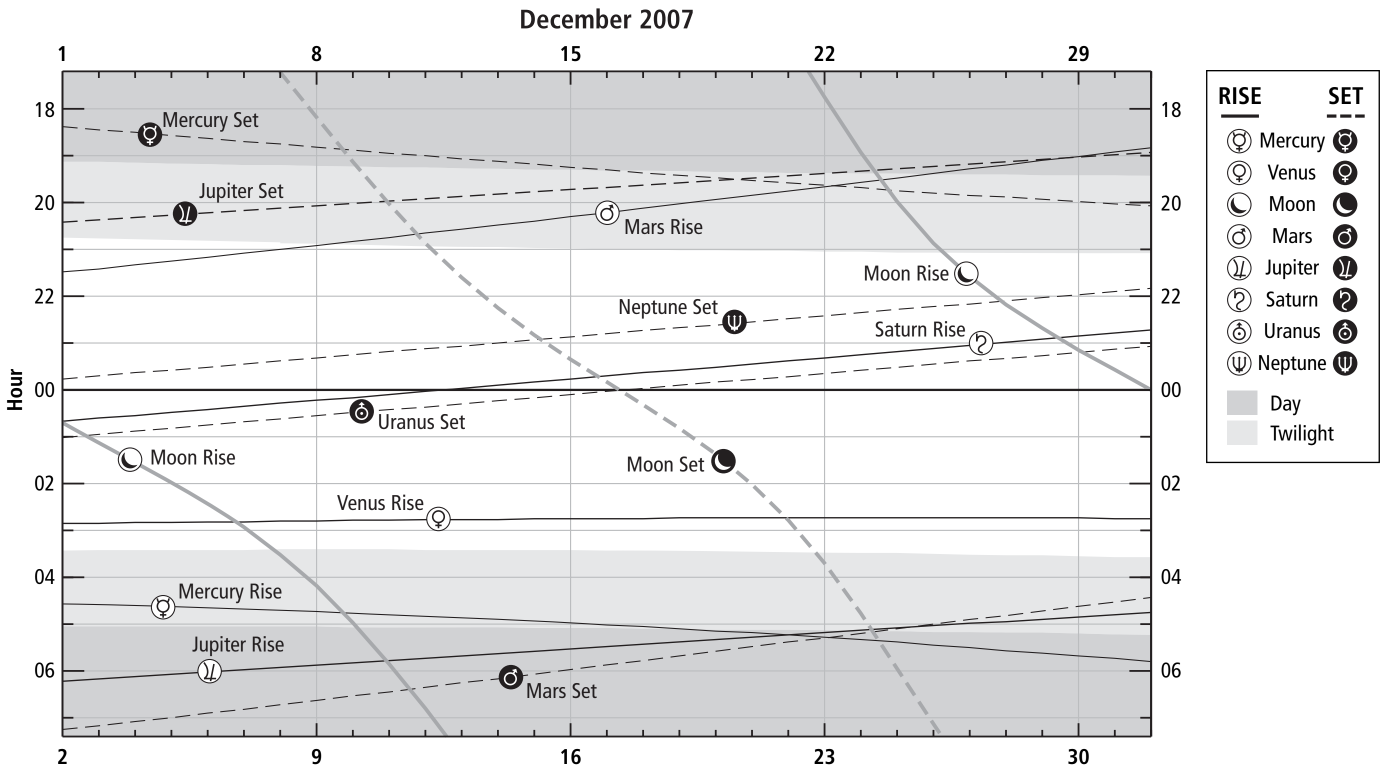


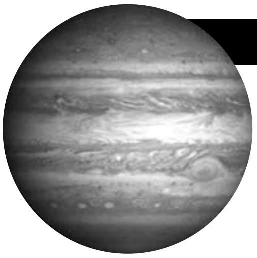
1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY Rise h m	MERCURY Set h m	VENUS Rise h m	VENUS Set h m	MARS Rise h m	MARS Set h m	JUPITER Rise h m	JUPITER Set h m	SATURN Rise h m	SATURN Set h m	URANUS Rise h m	URANUS Set h m	NEPTUNE Rise h m	NEPTUNE Set h m
1	0433	1823	0252	1536	2129	0720	0616	2025	0044	1158	1224	0105	1024	2346
2	0434	1827	0251	1537	2125	0715	0613	2022	0040	1154	1220	0101	1021	2342
3	0435	1830	0251	1539	2120	0710	0610	2019	0036	1150	1216	0057	1017	2338
4	0436	1834	0250	1540	2115	0705	0607	2016	0033	1146	1212	0053	1013	2335
5	0438	1838	0250	1542	2110	0700	0604	2013	0029	1143	1208	0049	1009	2331
6	0439	1842	0249	1543	2105	0654	0601	2010	0025	1139	1204	0045	1005	2327
7	0441	1845	0249	1545	2100	0649	0558	2007	0021	1135	1200	0041	1001	2323
8	0442	1849	0248	1546	2055	0643	0556	2004	0017	1131	1156	0037	0958	2319
9	0444	1853	0248	1548	2050	0638	0553	2001	0013	1127	1153	0033	0954	2315
10	0446	1857	0247	1549	2045	0632	0550	1958	0010	1123	1149	0029	0950	2311
11	0448	1900	0247	1551	2039	0627	0547	1955	0006	1120	1145	0025	0946	2307
12	0450	1904	0246	1553	2034	0621	0544	1952	0002	1116	1141	0022	0942	2304
12									2358					
13	0452	1907	0246	1554	2029	0615	0541	1949	2354	1112	1137	0018	0938	2300
14	0454	1911	0246	1556	2024	0610	0538	1946	2350	1108	1133	0014	0935	2256
15	0456	1915	0245	1558	2018	0604	0535	1943	2346	1104	1129	0010	0931	2252
16	0458	1918	0245	1559	2013	0558	0532	1941	2342	1100	1126	0006	0927	2248
17	0501	1922	0245	1601	2007	0552	0529	1938	2338	1056	1122	0002	0923	2244
17												2358		
18	0503	1925	0245	1603	2002	0547	0526	1935	2335	1052	1118	2354	0919	2240
19	0506	1928	0244	1604	1956	0541	0523	1932	2331	1048	1114	2350	0915	2237
20	0509	1932	0244	1606	1951	0535	0520	1929	2327	1044	1110	2347	0912	2233
21	0511	1935	0244	1608	1945	0529	0517	1926	2323	1040	1106	2343	0908	2229
22	0514	1938	0244	1610	1940	0523	0514	1923	2319	1037	1103	2339	0904	2225
23	0517	1941	0244	1611	1934	0518	0511	1920	2315	1033	1059	2335	0900	2221
24	0520	1945	0244	1613	1929	0512	0508	1917	2311	1029	1055	2331	0856	2217
25	0523	1948	0244	1615	1923	0506	0505	1914	2307	1025	1051	2327	0853	2213
26	0527	1951	0244	1617	1917	0500	0502	1911	2303	1021	1047	2323	0849	2210
27	0530	1953	0244	1618	1912	0454	0459	1908	2259	1017	1043	2320	0845	2206
28	0534	1956	0244	1620	1906	0449	0457	1905	2255	1013	1040	2316	0841	2202
29	0537	1959	0244	1622	1901	0443	0454	1902	2251	1009	1036	2312	0837	2158
30	0541	2002	0244	1624	1855	0437	0451	1859	2247	1005	1032	2308	0834	2154
31	0544	2004	0245	1626	1850	0432	0448	1856	2243	1001	1028	2304	0830	2150

SOLAR SYSTEM RISE/SET





ASTRO FACT

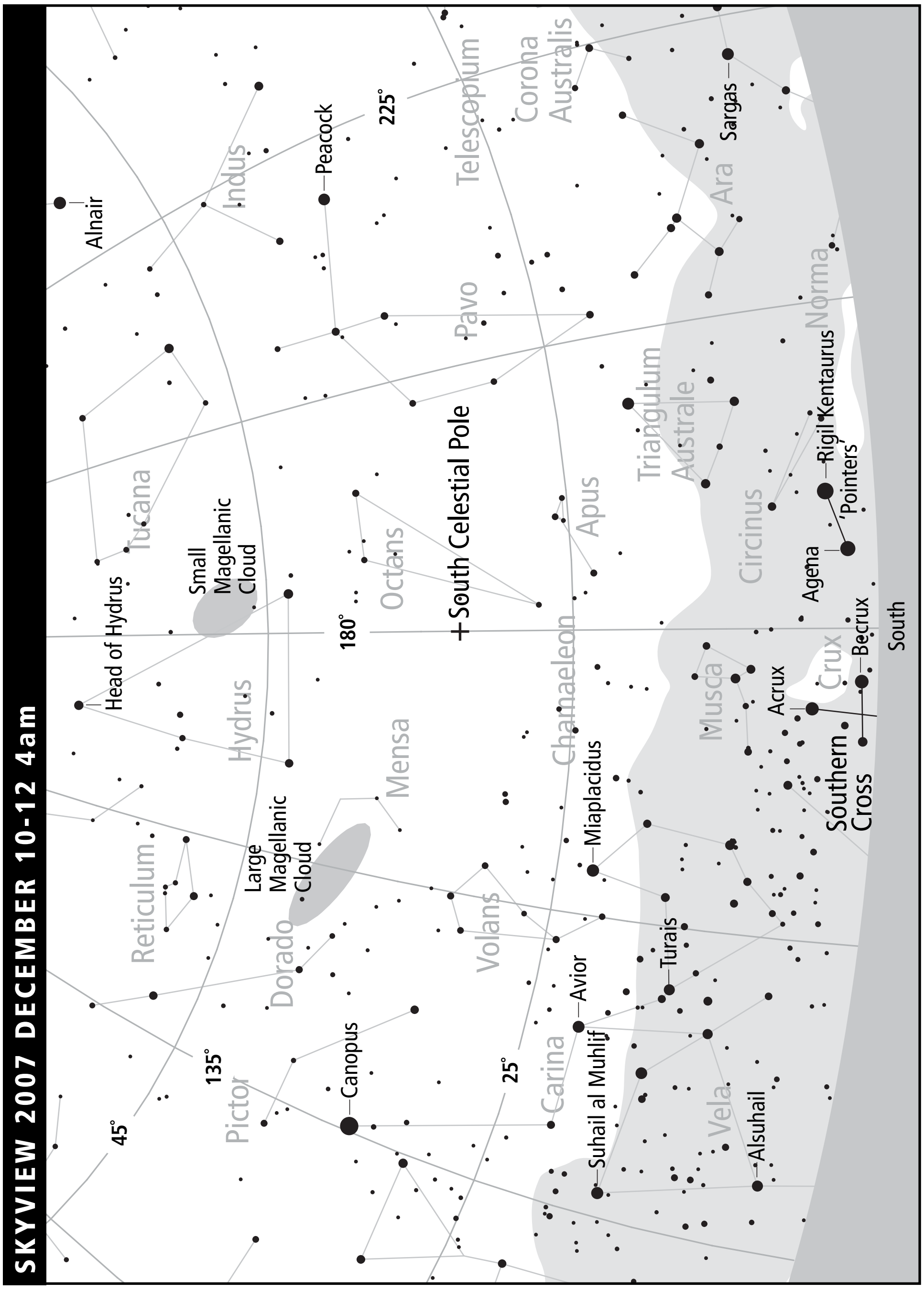
Jupiter's Great Red Spot

Jupiter's Red Spot is about 20,000 km long (about 1.5 times the diameter of Earth) and was named around 150 years ago when it was a distinct red colour. Since that time it has changed to a pale brown colour and is not very prominent.

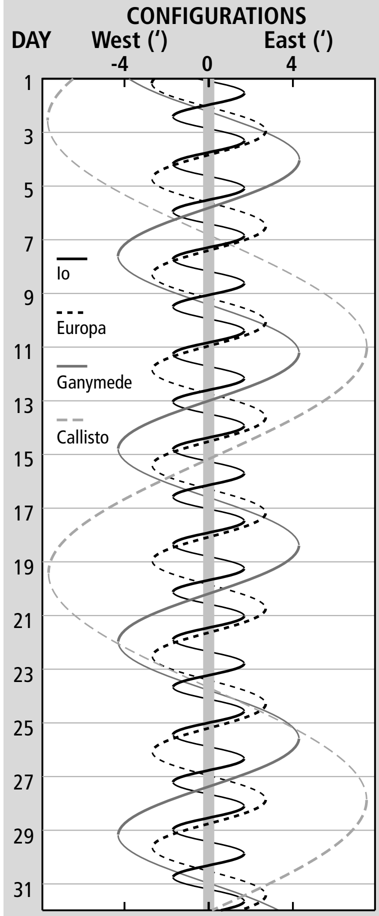
It is defined as a high-pressure cyclonic storm (unlike Earth's cyclones, which are low-pressure zones). The Red Spot rotates once counter-clockwise every 6 days and winds in its outer regions reach 350km/h while those at its centre are much lower. Trace amounts of organic molecules composed of hydrogen and carbon atoms, and possibly sulphur and phosphorus atoms, give the Red Spot and other features of the Jovian atmosphere their distinct colours.

Predicting the visibility times of the Red Spot is a little difficult because:

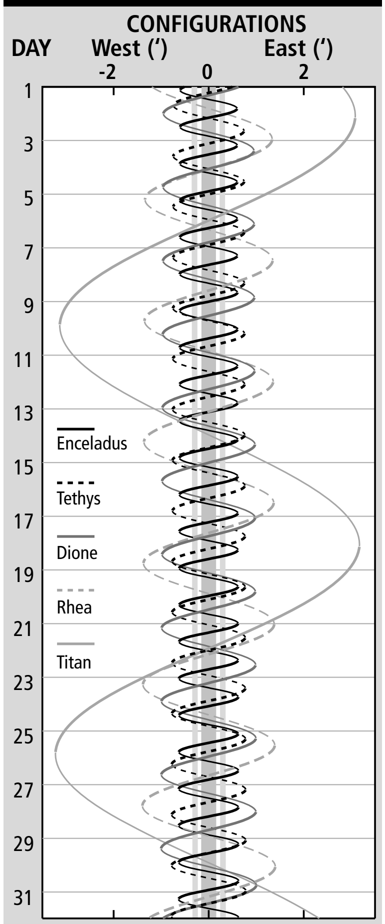
- its position slowly varies with time owing to the variable drag it experiences in the Jovian atmosphere, and
- Jupiter doesn't rotate as a solid object; clouds near the equator rotate a little faster than those closer to the poles.



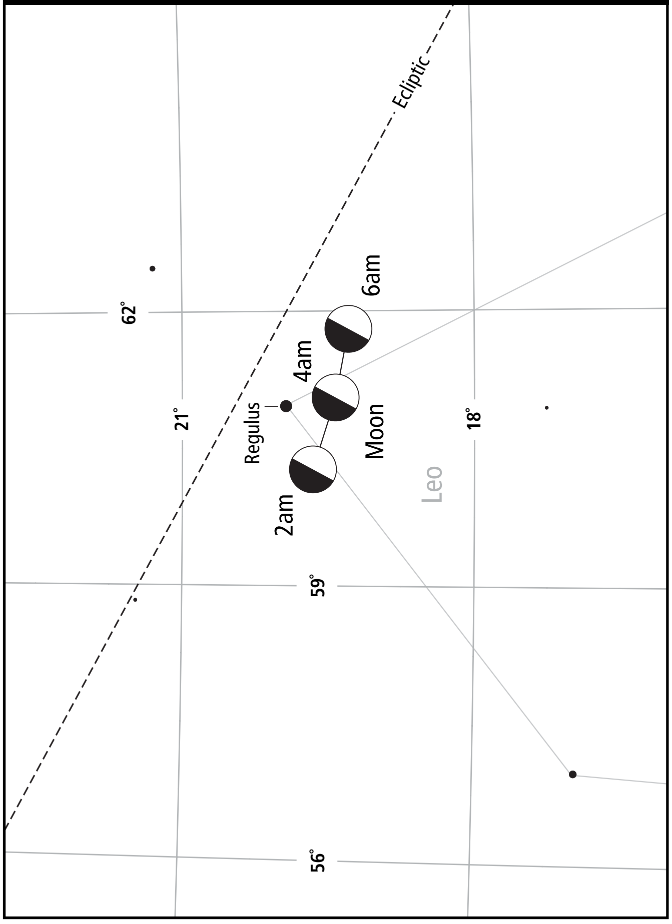
JUPITER MOONS



SATURN MOONS



SKYVIEW 2007 DECEMBER 1 2am-6pm



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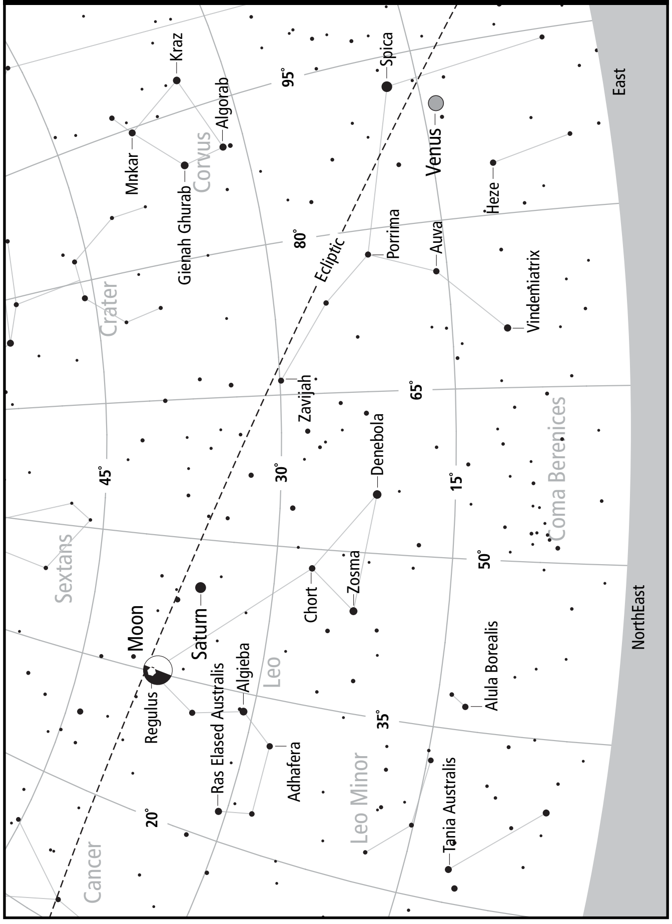

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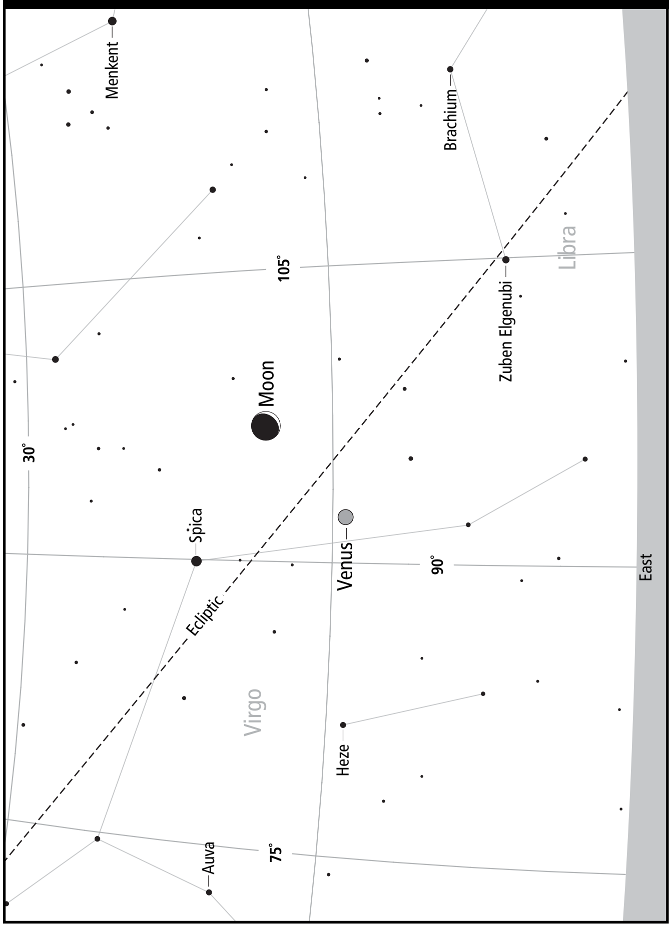
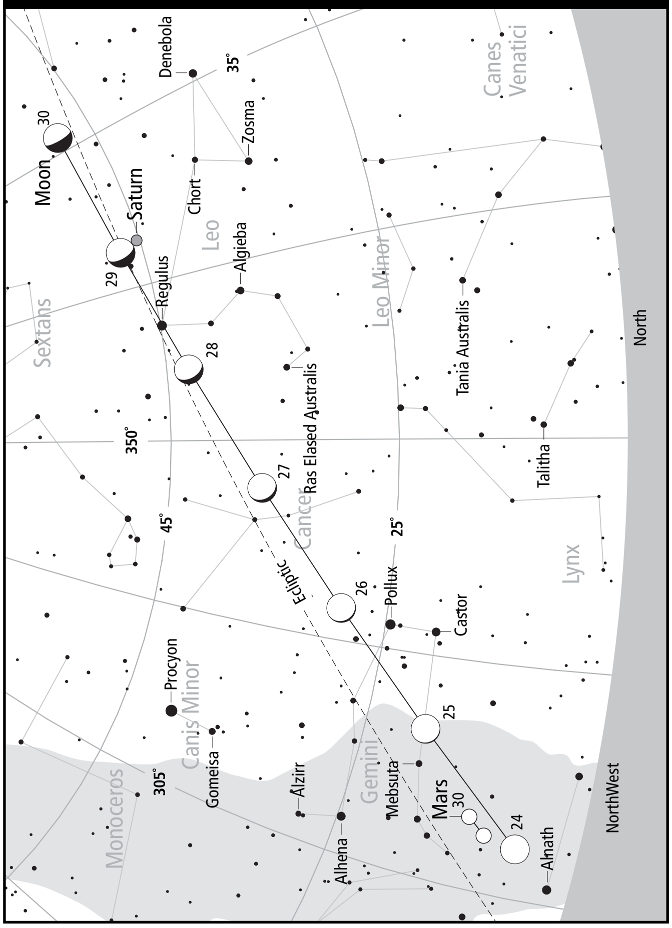


SKYVIEW 2007 DECEMBER 24-30 4am

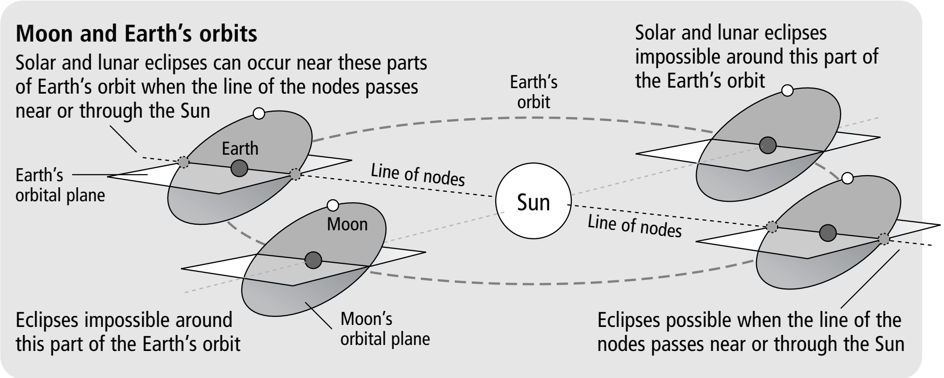


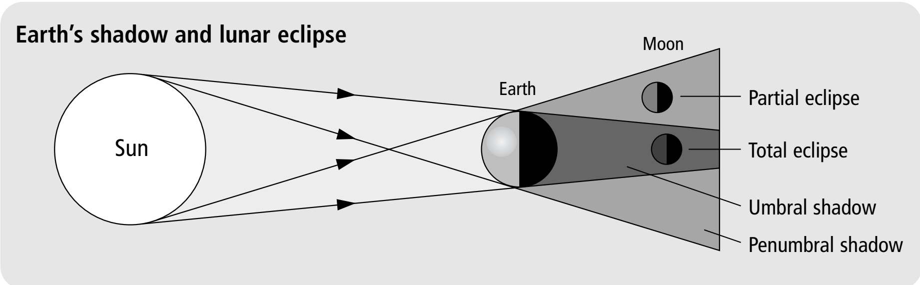
SPECIAL EVENTS – ECLIPSES & OCCULTATIONS

***Some** of the more spectacular and/or rare celestial events are discussed in this section. In particular, the date, time and region where the event is actually visible are provided. Consult the definitions the Section* Background & General Information *for a concise description of these events and the terminology used. Some of these events are not visible from Western Australia but are included for completeness and may assist those who travel to other parts of the world.*

Lunar eclipses

Eclipses are a geometrical phenomenon and occur when either the Moon is in the Earth's shadow (a lunar eclipse) or the Earth is shadowed by the Moon (a solar eclipse). This shadowing requires all three objects to be aligned in space. The Earth's full shadow (umbra) is rather large, about three times the width of the Moon at its orbital distance, and lunar eclipses are visible from a wide region of the globe. (Total solar eclipses only occur in a region approximately 20km wide – the size of the Moon's full shadow on Earth – that moves across the globe.) On average there are about 1.5 umbral lunar eclipses per year, and even more of the fainter penumbral lunar eclipses, where the Moon does not enter the full shadow of the Earth. Also, for any given year there is a 2/3 chance of having two umbral lunar eclipses, or a total lunar eclipse.





Lunar eclipses can only occur at Full Moon phase, where the Moon and Sun are on opposite sides of the Earth. So the Moon starts out very bright and can dim significantly especially for a total eclipse. The amount of dimming depends on which part of the Earth's shadow the Moon traverses. Also, the Moon doesn't necessarily get completely obscured in the shadow - during total eclipse it can have a grey, orange, red or copper hue. Some sunlight can refract and bend through the Earth's atmosphere and this casts a glow on the Moon that is then reflected back to Earth. The colour and brightness can vary between total lunar eclipses as it depends on the type and amount of dust in the atmosphere that the sunlight traverses.

Lunar eclipses are necessarily night-time eclipses, and are safe to view because the Moon is nowhere near as bright as the Sun. **(Solar (daytime) eclipses are unsafe to view.)** Special equipment is not necessary to observe lunar eclipses and a good view can be obtained with the unaided eye. Binoculars are easy to use and assist observation while providing a wide-field view.

Lunar eclipses have played an important part in history. Some historical battles have been lost because of a belief by one side that a lunar eclipse was a bad omen. In 413 BCE, the Syracusan navy destroyed an Athenian fleet after its leader delayed a retreat on account of a total lunar eclipse, in 1453 the defenders of Constantinople were so frightened by a partial lunar eclipse that the fall of the city was hastened, and in 1917 Lawrence of Arabia's force was assisted in the capture of Aqaba when the town's superstitious defenders panicked during a lunar eclipse.

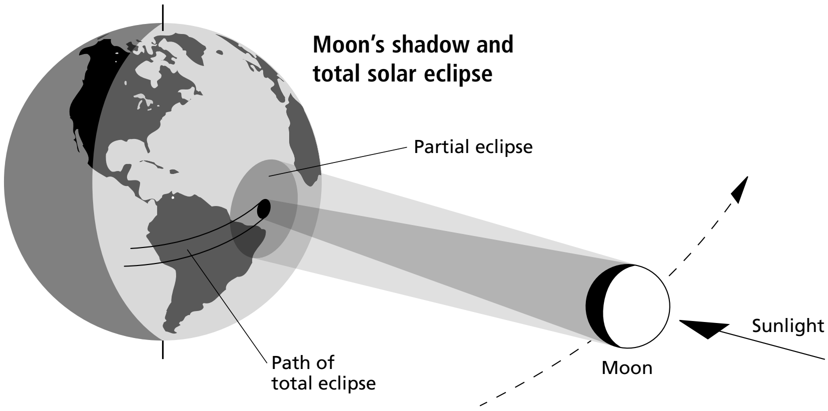
Before the night of a lunar eclipse in 1504, Christopher Columbus tricked disgruntled natives, in what is now Jamaica, to continue supplying him with food when he told them that God would make the Moon "appear inflamed with wrath, denoting the evils God would inflict upon them". The natives were so frightened that they continued supplying Columbus with food.

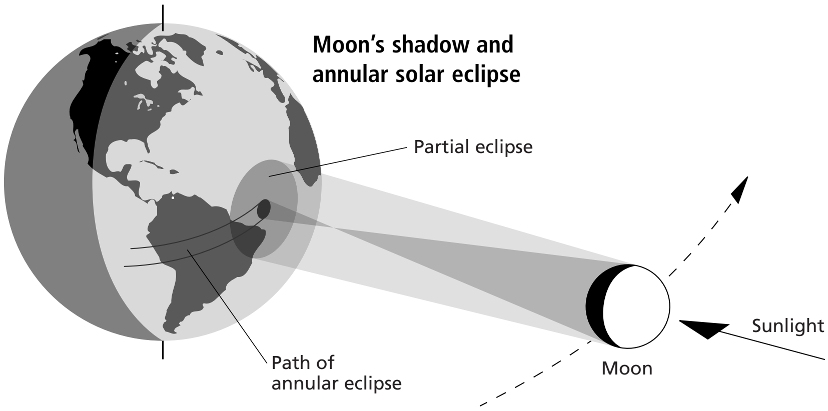
Lunar eclipses have aided our understanding of the world. Greek scientist/philosopher Aristotle (384-322 BCE) inferred that the shape of the Earth was round from the observation that the Earth's shadow seen in lunar eclipses was always circular. In the 3rd C BCE, Aristarchus of Samos calculated the diameter of the Moon by measuring the duration of a lunar eclipse. Also, a partial solution to the 'longitude problem' was derived in the 17th C CE that involved the simultaneous observation of a lunar eclipse from many locations.

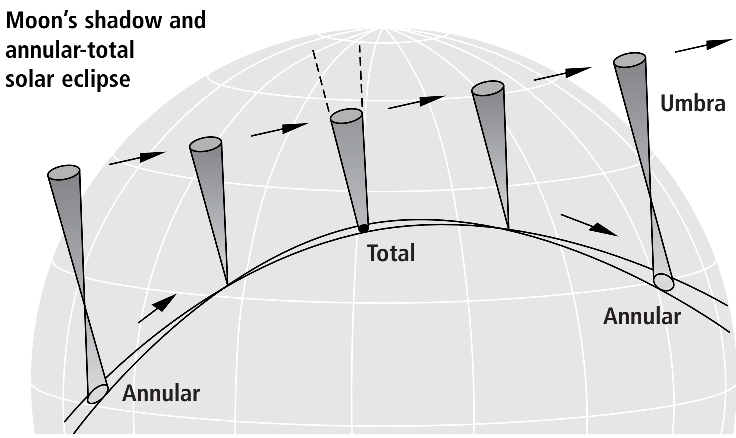
Solar and lunar eclipses often occur in pairs, and this is evident in the two pairs of eclipses that occur this year. This pairing occurs because the orbital plane of the Moon about the Earth is aligned with the Earth - Sun direction around these times. This is the basic requirement in order for an eclipse to occur. The orientation of the Moon's orbital plane slowly changes and so eclipses don't always occur at New Moon (when solar eclipses can occur) and Full Moon (when lunar eclipses can occur).

REMEMBER: Never look at the Sun with the unaided eye or with an optical instrument. You may suffer permanent eye damage.

Solar eclipses







Solar eclipses are daytime eclipses and can only occur at New Moon phase when the Sun and Earth are on opposite sides of the Moon. The Moon's full shadow (umbra) is significantly smaller than that cast by the Earth and total solar eclipses only occur in a region approximately 20km wide. This shadow moves across the Earth in response to the motion of the Moon in its orbit about Earth, and Earth's orbital motion around the Sun. The penumbra of the Moon is quite large and a wide swath around the region of total eclipse experiences a partial solar eclipse. The amount of partial eclipse uniformly decreases to zero at the outer edge of the penumbra. Sometimes the Sun, Moon and Earth alignment is not perfect and the eclipse is only partial.

Not only do solar eclipses require a geometrical lineup of the Sun, Moon and Earth, they also require the angular size of the Moon on the sky to be large enough to obscure the Sun. At most times the Moon covers approximately the same area on the sky as the Sun. However, at the times when the Moon is furthest from Earth, in its non-circular orbit, it covers a smaller area than that of the Sun. A similar situation occurs when the Sun is larger than average around the time the Earth is closest to the Sun (perihelion). (See the Angular Sizes of the Planets 2007 graph in the Section: *Solar System Information* to see how the apparent size of both the Sun and Moon changes throughout the year.) Solar eclipses at these times cannot be total. The Sun remains visible as a ring around the edge of the Moon, over a track about 20 kilometres wide across the Earth. Such events are called annular solar eclipses. So fine is this size balance that sometimes a solar eclipse can change from annular, to total, and sometimes back to annular. This occurs because of the curvature of the Earth's surface and so the region closest to the Moon can be up to one Earth radius, 6,371 kilometres, closer than surrounding regions. The solar eclipse of 2005 April 8 was one of the rare annular total type, but unfortunately could not be witnessed from anywhere in Australia.

At the present epoch 26% of eclipses are total, 32% are annular, 35% are partial and 5% are annular-total. The remainder are relatively rare eclipses that occur at polar regions where only a part of the Moon's umbra, or its extension, intersects the Earth. On average there are 2.2 solar eclipses (of any type) per year. However, a given place on the Earth experiences a total eclipse only every 375 years and an annular eclipse every 224 years. Total eclipses are more common the further north the latitude because solar eclipses are more common in summer and Earth's perihelion occurs in the northern summer. Annular eclipses are less frequent around equatorial regions because these regions are generally closer to the Moon.

Southern regions also experience more annular eclipses than corresponding northern latitudes because the Earth is at aphelion (furthest from the Sun) in the southern summer.

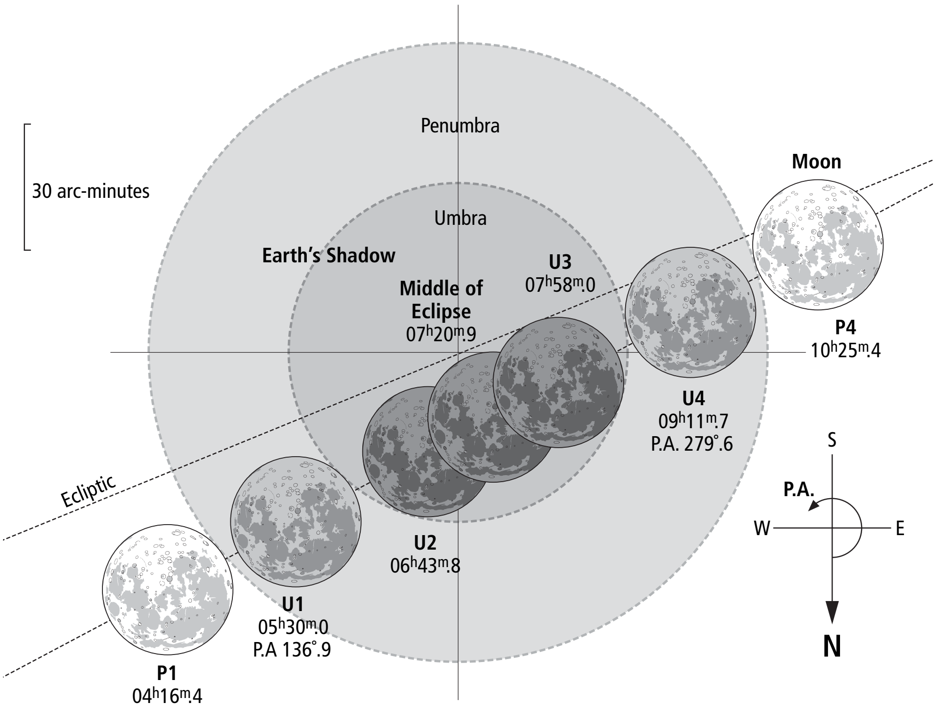
Solar and lunar eclipses often occur in pairs, and this is evident in the two pairs of eclipses that occur this year. This pairing occurs because the orbital plane of the Moon about the Earth is aligned with the Earth - Sun direction around these times. This is the basic requirement in order for an eclipse to occur. The orientation of the Moon's orbital plane slowly changes and so eclipses don't always occur at New Moon (when solar eclipses can occur) and Full Moon (when lunar eclipses can occur).

REMEMBER: Never look at the Sun with the unaided eye or with an optical instrument. You may suffer permanent eye damage.

March 4 (starts March 3 elsewhere): Total Eclipse of the Moon

Only the early portion of this event is visible in WA as the eclipse ends well after Moonset. Observers in WA will see a gradient of light (on the side closest to horizon) to dark across the Moon becoming most prominent around the time the Moon enters the umbra. The part of the Moon in the umbra will appear dark but may not be easily visible as it low on the horizon.

All of this eclipse is visible from Africa, Europe, and the middle east.



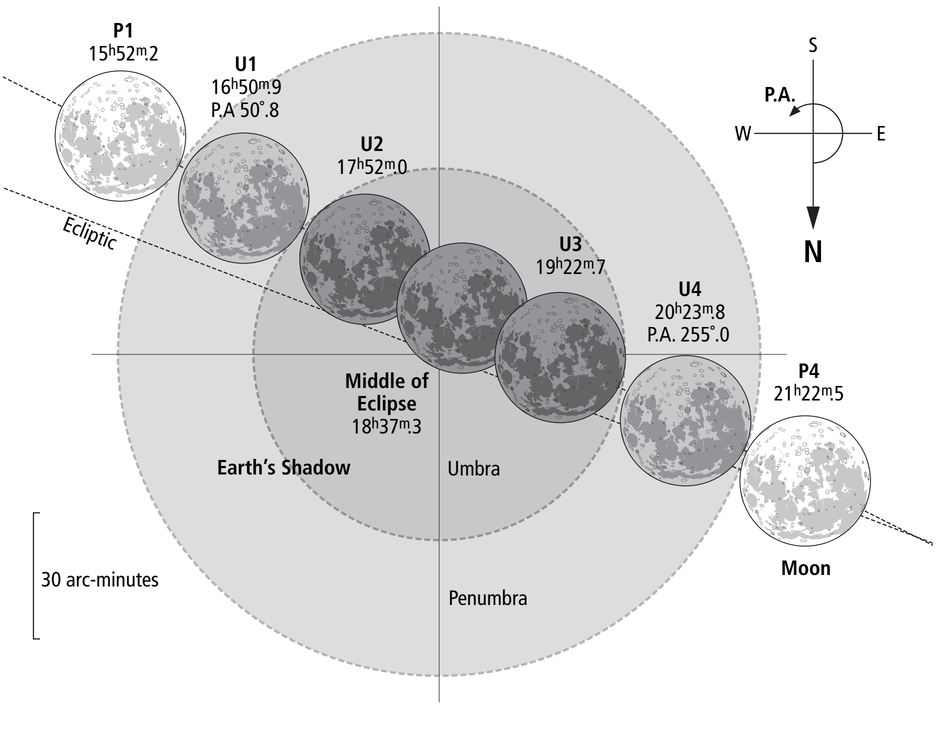
EVENT	TIME (WAST) Hour	Minute
Moon enters penumbra	04	16
Moon enters umbra	05	30
Moon set (Perth)	06	09
Moon fully in umbra	06	44
mid eclipse	07	21
Moon exits umbra	07	58
Moon exits penumbra	09	12
eclipse ends	10	25

August 28: Total Eclipse of the Moon

This eclipse starts before the Moon rises in WA. Observers in the east of the state will see more of the eclipse.

Observers in the Perth region get to see the unusual sight of the rising of a totally eclipsed Moon. However, the visibility of this event at that time in uncertain because the sky background will be very bright because the Sun has not quite set. The best time to view the totally eclipsed Moon will be just before it exits the umbra.

This event is visible in its entirety from eastern Australia, New Zealand, Oceania, and the west coast of North America.



EVENT	TIME (WAST) Hour	Minute
Moon enters penumbra	15	52
Moon enters umbra	16	51
Moon fully in umbra	17	52
Moonrise (Perth)	17	52
mid eclipse	18	37
Moon exits umbra	19	23
Moon exits penumbra	20	24
eclipse ends	21	22

March 19: Partial Eclipse of the Sun

This event is not visible from anywhere in Australia.

This event is visible from most of Alaska, eastern and central Asia and the western part of Russia.

The eclipse begins at 0038 UT (0838 WAST) at longitude 83° East and latitude 15° North and ends at 0425 UT (2125 WAST) at longitude 157° West and latitude 73° North.

REMEMBER: Never look at the Sun with the unaided eye or with an optical instrument. You may suffer permanent eye damage.

September 11: Partial Eclipse of the Sun

This event is not visible from anywhere in Australia.

This event is visible from parts of Antarctica and South America.

The eclipse begins at 1026 UT (1826 WAST) at longitude 66° West and latitude 17° South and ends at 1436 UT (2236 WAST) at longitude 34° East and latitude 74° South.

REMEMBER: Never look at the Sun with the unaided eye or with an optical instrument. You may suffer permanent eye damage.

Occultations of planets and bright stars by the Moon

An occultation is the obscuration of one celestial body by another of greater apparent diameter; especially the passage of the Moon in front of a star or planet, or the disappearance of a satellite behind the disk of its primary. If the primary source of illumination of a reflecting body is cut off by the occultation, the phenomenon is also called an eclipse. The occultation of the Sun by the Moon is a solar eclipse.

The Moon passes in front of the following planets and bright stars during this year.

Moon Occultations 2007

DATE (WAST) d h	Body	Areas of Visibility
Jan 7 02	Saturn	N.E. Russia, Arctic regions, N. Scandinavia, N.W. Canada, Alaska
Jan 7 13	*Regulus*	E. Europe, E. Scandinavia, W. Russia
Jan 12 04	*Spica*	Antarctica, S.E. Indian Ocean
Jan 15 21	*Antares*	S. tip of Africa, part of Antarctica, S. tip of S. America
Jan 21 01	Venus	S.W. Africa, Antarctica, S. tip of S. America
Jan 22 14	Uranus	Japan, Philippines, Indonesia, E. Indian Ocean, S. tip of India
Feb 3 07	Saturn	Central Asia, E. Scandinavia, Arctic regions
Feb 3 22	*Regulus*	N.W. North America, N. Greenland
Feb 8 12	*Spica*	S. of S. America
Feb 12 06	*Antares*	Southern Ocean, Antarctica
Mar 2 10	Saturn	W. Russia, Europe except W. British Isles and S.W. Europe
Mar 3 05	*Regulus*	E. Central Asia, Arctic regions
Mar 11 14	*Antares*	Antarctica, S. part of S. America
Mar 17 11	Mercury	Southern Ocean south of New Zealand
Mar 29 12	Saturn	N. British Isles, N. Scandinavia, N. Atlantic Ocean, E. Greenland
Mar 30 11	*Regulus*	W. Europe, British Isles, Scandinavia, Arctic regions
Apr 7 21	*Antares*	S. part of S. Antarctica, W. Antarctica, W. Oceania
Apr 14 10	Mars	S. and E. Asia, India, E. tip of Africa
Apr 15 04	Uranus	E. Siberia, Japan, Alaska, N.W. Canada
Apr 25 18	Saturn	N. Greenland, N.W. Canada, Alaska, E. tip of Siberia
Apr 26 17	*Regulus*	N.W. North America, Arctic regions
May 5 02	*Antares*	New Zealand, Tasmania, part of Antarctica, S.E. Africa
May 12 15	Uranus	N. Atlantic Ocean, British Isles except S.E. part, E. Greenland
May 23 03	Saturn	Europe, British Isles, N.E. Africa, N.W. Asia, Arctic regions, N.W. Canada
May 24 00	*Regulus*	Asia except E. part, N.E. Europe, British Isles, Greenland, N.E. tip of Canada
June 1 09	*Antares*	S. half of S. America, part of Antarctica, S.W. Indian Ocean
June 18 23	Venus	W. Asia, Europe except S. Iberia, British Isles, Greenland, N. Canada
June 19 16	Saturn	Japan, Central Asia, E. part of Europe
June 20 08	*Regulus*	E. Siberia, N. America except N.E., Caribbean, N.W. South America
June 28 16	*Antares*	W. Oceania, W. tip of Antarctica, S. part of S. America
July 04 03	Neptune	Part of Antarctica
July 17 07	Saturn	Hawaiian Islands, W. parts of central S. America
July 17 19	*Regulus*	Europe, British Isles, S. and W. Asia, Indonesia, S. Philippines, **N.W. Australia**
July 26 00	*Antares*	S. tip of Africa, Antarctica, **S. parts of Australia** and New Zealand
July 31 09	Neptune	Part of Antarctica, Kerguelen Is
Aug 22 09	*Antares*	Antarctica, Southern Ocean, New Zealand
Sept 10 09	*Regulus*	Polynesia, Japan, Central Asia
Sept 10 10	Saturn	S. Indian Ocean, W. tip of Australia, part of Antarctica
Sept 18 16	*Antares*	Antarctica, Southern Ocean, S. Madagascar
Oct 7 15	*Regulus*	Europe, S. British Isles, N. and E. Africa, Middle East
Oct 8 00	Saturn	Southern Ocean, S. of Polynesia
Oct 15 23	*Antares*	Antarctica, S. half of S. America
Oct 21 11	Neptune	Part of Antarctica, S. Georgia
Nov 3 21	*Regulus*	S. North America, Caribbean, north S. America
Nov 12 05	*Antares*	S. part of S. America, S. Pacific Ocean, most of New Zealand, Polynesia.
Nov 17 19	Neptune	Antarctica, **S. Australia**, New Zealand
Dec 1 04	*Regulus*	E. India, S.E. Asia, **N.E. Australia**, New Zealand, Micronesia, Melanesia
Dec 15 02	Neptune	Part of Antarctica, S. tip S. America, S. Africa
Dec 24 11	Mars	N.W. Canada, Alaska, Arctic regions, N. Russia, E. Europe, N.E. British Isles
Dec 28 13	*Regulus*	S. America except S. part, S. Atlantic Ocean

Definition of the Planets in the Solar System

The following is reproduced in part from the resolutions of 26th General Assembly of the International Astronomical Union (IAU, the world's organisation of professional astronomers) held in Prague (Czech Republic) from 2006 August 14th to 25th.

Apparently the discussions were vigorous with supporters divided roughly into two groups. One group supported a "physical" definition – that a planet is a near spherical body in hydrostatic equilibrium (gravitational compression is balanced by an outward force such as "gas pressure"). Using this definition the planets total 12. The other group supported a "dynamical" definition where a planet is an object that gravitationally dominates its neighbourhood – in this case there are 8 planets.

The resolution adopted by the IAU General Assembly (see below) is a compromise which also defines two categories of bodies different from the planets, and modifies the former rules. The naming "minor planets" disappears and is replaced by either "dwarf planets" which designates Solar System bodies big enough to be nearly spherical, or "small Solar System bodies" which designates the other objects including the comets. The planetary satellites are not concerned by these new definitions.

An IAU process will be established to assign borderline objects into either dwarf planet and other categories.

Background

Since 1992, numerous celestial bodies orbiting around the Sun beyond Neptune's orbit have been discovered. Due to its physical and dynamical characteristics, Pluto appears associated to these trans-Neptunian bodies. In 2003, the discovery of 2003 UB_{313} (now named (136199) Eris), a trans-Neptunian object (TNO) bigger than Pluto, raised serious questions about the definition of a planet: if Pluto is a planet, Eris is another one...

IAU Resolution: Definition of a Planet in the Solar System

Contemporary observations are changing our understanding of planetary systems, and it is important that our nomenclature for objects reflect our current understanding. This applies, in particular, to the designation "planets". The word planet originally described "wanderers" that were known only as moving lights in the sky. Recent discoveries lead us to create a new definition, which we can make using currently available scientific information.

The IAU therefore resolves that planets and other bodies in our Solar System be defined into three distinct categories in the following way.

SUN & PLANET DATA

NAME	MEAN RADIUS (kilometres)	VOLUME (Earth =1)	FLATTENING (Earth =1)	MASS (x 10^{23} kg)	DENSITY (g/cm³)	EQUATORIAL GRAVITY (m/s²)	GEOMETRIC ALBEDO
Sun	696000	1305000	0.00005	19890850	1.407	274.0	-
Mercury	2440 ± 1	0.056	0.0000	3.302	5.427	3.701	0.106
Venus	6051.84 ± 0.01	0.857	0.000	48.685	5.204	8.87	0.65
Earth	6371.01 ± 0.02	1	0.00335	59.736	5.515	9.780327	0.367
Mars	3389.92 ± 0.04	0.151	0.00648	6.4185	3.9335 ± 0.0004	3.69	0.15
Jupiter	69911 ± 6	1321	0.06487	18986	1.326	23.12 ± 0.01	0.52
Saturn	58232 ± 6	764	0.09796	5684.6	0.6873	8.96 ± 0.01	0.47
Uranus	25362 ± 12	63	0.02293	868.32	1.318	8.69 ± 0.01	0.51
Neptune	24624 ± 21	58	0.01708	1024.3	1.638	11.00 ±0.05	0.41
Ceres*	948	0.003	-	0.0095	2.08	0.27	0.1132
Pluto*	1151	0.006	-	0.1314 ± 0.0018	2	0.655	0.3
Eris*	1200 ± 50	0.007	-	-	-	-	0.860 ± 0.07

NAME	V (1,0) Brightness at opposition	SIDEREAL ROTATION PERIOD (hours)	SIDEREAL ORBIT PERIOD (Years)	a Semi-major axis (AU)	e eccentricity	i inclination (°)	OBLIQUITY (°)
Sun	-26.74	609.12	-	-	-	-	7.25
Mercury	-0.42	1407.509	0.2408467	0.38709893	0.20563069	7.00487	0.01
Venus	-4.4	-5832.444	0.61519726	0.72333199	0.00677323	3.39471	177.36
Earth	-3.86	23.93419	1.0000174	1.00000011	0.01671022	0.00005	23.45
Mars	-1.52	24.622962	1.8808476	1.52366231	0.09341233	1.85061	25.19
Jupiter	-9.4	9.92425	11.862615	5.20336301	0.04839266	1.30530	3.13
Saturn	-8.88	10.65622	29.447498	9.53707032	0.05415060	2.48446	26.73
Uranus	-7.19	17.24 ± 0.01	84.016846	19.19126393	0.04716771	0.76986	97.77
Neptune	-6.87	16.11 ± 0.01	164.79132	30.06896348	0.00858587	1.76917	28.32
Ceres*	3.3	9.075	4.59930	2.76555996	0.07990478	10.58674	-
Pluto*	-1.0	153.28	247.92065	39.48168677	0.24880766	17.14175	122.53
Eris*	-1.1	>8	557.0	67.696	0.4409	44.17853	-

Legend:

Flattening Degree to which poles are flattened with respect to the equator (difference between polar and equatorial radius as a proportion of the mean radius)
Geometric Albedo Proportion of incident light reflected
Sidereal Rotation Period Rotation period as measured from a fixed star (not measured from the orbiting Earth)
Sidereal Orbit Period Orbital period as measured from a fixed star (not measured from the orbiting Earth)

V (1,0) Brightness at opposition (magnitude)
a Semi-major Axis
e Eccentricity
i Inclination
Obliquity Angle between rotation axis and orbital axis
± The uncertainty in the quantity
***** Dwarf planet

Data from NASA/JPL (http://ssd.jpl.nasa.gov/)

1. *Planets*

A planet is a celestial body that:

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

The eight planets are: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

2. *Dwarf Planets*

A dwarf planet is a celestial body that:

(a) is in orbit around the Sun,
(b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and
(c) has NOT cleared the neighbourhood around its orbit, and
(d) is not a satellite

Objects with sufficiently known characteristics to be classified as dwarf planets are (1) Ceres, (134340) Pluto, and (136199) Eris. The number in brackets is the minor planet catalogue number – a standard astronomical cataloguing/naming convention.

The following is the IAU's Minor Planet Center (MPC) explanation from 2006 September 8 for the numbering.

Since at least one of the "dwarf planets" is already included in the catalogue of numbered "minor planets", and since the MPC Terms of Reference emphasize the need for the MPC to maintain a database of the astrometric observations of such bodies observed beyond the confines of the earth's atmosphere, Pluto and (other bodies) are now being added to this list of objects with reliable orbit determinations under the numbers (134340) and (136199), respectively. It should be noted that, just as some of the numbered objects that have exhibited cometary activity also have designations in the catalogue of numbered periodic comets, the numbering of "dwarf planets" does not preclude their having dual designations in possible separate catalogues of such bodies.

Note: *This numbering does NOT mean that Pluto is an asteroid or a minor planet (a now defunct definition, see above).*

3. *Small Solar System Bodies*

All other objects, except satellites, orbiting the Sun shall be referred to collectively as "small Solar System bodies". This includes: the classical asteroids (except the largest one, 1 Ceres) that are not dwarf planets; the Centaurs and Neptune Trojans; the smaller TNOs (except dwarf planets such as Pluto and Eris); and all comets.

MOON & SATELLITE DATA

NAME	$1/m_{pl}$ Proportion of Planet Mass	MEAN RADIUS (kilometres)	MEAN DENSITY (g/cm³)	MAGNITUDE (V_0 or R)	GEOMETRIC ALBEDO	a Semi-major axis (1000km)	e eccentricity	i inclination (°)	P Sidereal Period (days)
EARTH									
Moon	0.0123	1737.5 ± 0.1	3.344 ± 0.005	-12.74	0.12	384.4	0.0554	5.16	27.322
MARS									
Deimos	3.740E-09	6.2 ± 0.18	2.247 ± 0.251	12.45 ± 0.05	0.068 ± 0.007	23.46	0.0002	1.793	1.262
Phobos	1.651E-08	11.1 ± 0.15	1.867 ± 0.076	11.4 ± 0.2	0.071 ± 0.012	9.38	0.0151	1.075	0.319
JUPITER									
Adrastea	3.95E-12	8.2 ± 2.0	3.0	18.7	0.100 ± 0.045	129	0.0018	0.054	0.298
Aitne	2.37E-14	1.5	2.6	22.7	0.04	23550	0.291	165.7	741.0r
Amalthea	1.09E-09	83.5 ± 2.4	0.849 ± 0. 199	14.1 ± 0.2	0.090 ± 0.005	181.4	0.0031	0.388	0.498
Ananke	1.58E-11	14	2.6	18.75 ± 0.02	0.04	21276	0.2435	148.889	629.77r
Aoede	4.74E-14	4	2.6	22.5	0.04	23801	0.405	159.4	748.8r
Arche	2.37E-14	1.5	2.6	22.8	0.04	22930	0.259	165.0	723.9r
Autonoe	4.74E-14	2.0	2.6	22.0	0.04	24120	0.415	151.9	765.1r
Callirrhoe	4.58E-13	4.3	2.6	20.73 ± 0.04	0.04	24103	0.2828	147.158	758.77r
Callisto	5.67E-05	2410.3 ± 1.5	1.834 ± 0.004	5.65 ± 0.10	0.17 ± 0.02	1882.7	0.0074	0.187	16.69
Carme	6.95E-11	15	2.6	17.55 ± 0.02	0.06	23400	0.2533	164.907	734.17r
Chaldene	3.95E-14	1.9	2.6	22.5	0.04	23180	0.238	165.4	723.8r
Cyllene	7.89E-15	2	2.6	23.2	0.04	24000	0.412	141.0	737.8r
Elara	4.58E-10	43	2.6	16.32 ± 0.02	0.04	11741	0.2174	26.627	259.64
Erinome	2.37E-14	1.6	2.6	22.8	0.04	23280	0.270	164.9	728.3r
Euanthe	2.37E-14	1.5	2.6	22.8	0.04	21030	0.176	145.9	620.0r
Eukelade	4.74E-14	2	2.6	22.6	0.04	24560	0.345	163.4	781.6r
Euporie	7.89E-15	1.0	2.6	23.1	0.04	19390	0.156	147.0	553.1r
Europa	2.53E-05	1560.8 ± 0.5	3.013 ± 0.005	5.29 ± 0.02	0.67 ± 0.03	671.1	0.0094	0.469	3.551
Eurydome	2.37E-14	1.5	2.6	22.7	0.04	23220	0.345	150.1	720.8r
Ganymede	7.81E-05	2631.2 ± 1.7	1.942 ± 0.005	4.61 ± 0.03	0.43 ± 0.02	1070.4	0.0011	0.170	7.155
Harpalyke	6.31E-14	2.2	2.6	22.2	0.04	21110	0.227	148.7	623.3r
Hegemone	2.37E-14	3	2.6	22.9	0.04	24510	0.264	152.6	781.6r
Helike	4.74E-14	4	2.6	22.6	0.04	20980	0.157	156.1	617.3r
Hermippe	4.74E-14	2.0	2.6	22.1	0.04	21250	0.251	150.3	631.9r
Himalia	3.55E-09	85	2.6	14.62 ± 0.02	0.04	11461	0.1623	27.496	250.56
Io	4.70E-05	1821.6 ± 0.5	3.528 ± 0.006	5.02 ± 0.03	0.63 ± 0.02	421.8	0.0041	0.036	1.769
Iocaste	1.03E-13	2.6	2.6	21.8	0.04	21270	0.218	159.7	631.5r
Isonoe	3.95E-14	1.9	2.6	22.5	0.04	23220	0.261	165.0	725.5r
Kale	7.89E-15	1.0	2.6	23.0	0.04	23120	0.475	165.3	720.9r
Kallichore	7.89E-15	2	2.6	23.7	0.04	22400	163.9	163.9	683.0r
Kalyke	1.03E-13	2.6	2.6	21.8	0.04	23580	0.243	165.2	743.0r
Karpo	2.37E-14	3	2.6	23.0	0.04	17100	0.295	55.1	456.5
Leda	5.76E-12	10	2.6	19.50 ± 0.03	0.04	11165	0.1636	27.457	240.92
Lysithea	3.32E-11	18	2.6	18.25 ± 0.04	0.04	11717	0.1124	28.302	259.20
Magaclite	3.63E-13	2.7	2.6	21.7	0.04	23810	0.425	152.7	752.8r
Metis	3.95E-12	21.5 ± 2.0	3.0	17.5	0.061 ± 0.003	128	0.0012	0.019	0.295

MOON & SATELLITE DATA (continued)

NAME	$1/m_{pl}$ Proportion of Planet Mass	MEAN RADIUS (kilometres)	MEAN DENSITY (g/cm^3)	MAGNITUDE (V_0 or R)	GEOMETRIC ALBEDO	a Semi-major axis (1000km)	e eccentricity	i inclination (°)	P Sidereal Period (days)
Mneme	7.89E-15	2	2.6	23.3	0.04	20600	0.208	148.0	599.0r
Orthosie	7.89E-15	1.0	2.6	23.1	0.04	21170	0.272	141.9	623.0r
Pasiphae	1.58E-10	30	2.6	17.00 ± 0.20	0.04	23624	0.4090	151.431	743.63r
Pasithee	7.89E-15	1.0	2.6	23.2	0.04	23030	0.288	165.4	716.3r
Praxidike	2.29E-13	3.4	2.6	21.2	0.04	21150	0.220	148.7	625.3r
Sinope	3.95E-11	19	2.6	18.05 ± 0.02	0.04	23939	0.2495	158.109	758.90r
Sponde	7.89E-15	1.0	2.6	23.0	0.04	23810	0.415	155.0	749.1r
Taygete	8.68E-14	2.5	2.6	21.9	0.04	23360	0.251	165.2	732.2r
Thebe	5.76E-12	49.3 ± 2.0	3.0	16.0	0.047 ± 0.003	221.9	0.0177	1.070	0.675
Thelxinoe	-	2	-	-	-	20700	0.233	151.1	601.0r
Themisto	3.63E-13	4.0	2.6	21.0	0.04	7284	0.2426	43.259	130.02
Thyone	4.74E-14	2.0	2.6	22.3	0.04	21310	0.295	149.0	632.4r
S/2003 J 2	7.89E-15	2	2.6	23.2	0.04	28570	0.380	151.8	982.5r
S/2003 J 3	7.89E-15	2	2.6	23.4	0.04	18340	0.241	143.7	504.0r
S/2003 J 4	7.89E-15	2	2.6	23	0.04	23260	0.204	144.9	723.2r
S/2003 J 5	4.74E-14	4	2.6	22.4	0.04	24080	0.210	165.0	759.7r
S/2003 J 9	7.89E-16	1	2.6	23.7	0.04	22440	0.269	164.5	683.0r
S/2003 J 10	7.89E-15	2	2.6	23.6	0.04	24250	0.214	164.1	767.0r
S/2003 J 12	7.89E-16	1	2.6	23.9	0.04	19000	0.376	145.8	533.3r
S/2003 J 14	7.89E-15	2	2.6	23.6	0.04	25000	0.222	140.9	807.8r
S/2003 J 15	7.89E-15	2	2.6	23.5	0.04	22000	0.110	140.8	668.4r
S/2003 J 16	7.89E-15	2	2.6	23.3	0.04	21000	0.270	148.6	595.4r
S/2003 J 17	7.89E-15	2	2.6	23.4	0.04	22000	0.190	163.7	690.3r
S/2003 J 18	7.89E-15	2	2.6	23.4	0.04	20700	0.119	146.5	606.3r
S/2003 J 19	7.89E-15	2	2.6	23.7	0.04	22800	0.334	162.9	701.3r
S/2003 J 23	-	2	-	23.6	-	24060	0.309	149.2	759.7r
SATURN									
Albiorix	3.69E-11	13	2.3	20.5	0.06	16390	0.48	34.0	738
Atlas	1.90E-11	16 ± 4	0.63	19.0	0.4	137.7	0.000	0.000	0.602
Calypso	6.33E-12	9.5 ± 1.5	1.0	18.7	0.7	294.7	0.0005	1.473	1.888
Daphnis	-	7	-	24	-	136.5	0	0	0.594
Dione	1.93E-06	559. ± 5.	1.490 ± 0.040	10.4	0.6	377.4	0.0002	0.002	2.737
Enceladus	1.83E-07	249.4 ± 0.2	1.603 ± 0.345	11.8	1.0	238.1	0.0001	0.010	1.370
Epimetheus	9.41E-10	59.5 ± 3.0	0.606 ± 0.096	15.6	0.5	151.4	0.0205	0.335	0.694
Erriapo	1.34E-12	4	2.3	23.0	0.06	17610	0.47	33.5	871
Helene	4.48E-11	16 ± 4	1.5	18.4	0.6	377.4	0.0001	0.212	2.737
Hyperion	1.90E-08	133 ± 8	1.1 ± 0.6	14.4	0.3	1464.1	0.0175	0.568	21.28
Iapetus	3.42E-06	718 ± 8	1.253 ± 0.168	11	0.6	3560.8	0.0284	7.570	79.33
Ijiraq	2.11E-12	5	2.3	22.6	0.06	11440	0.32	49.1	451
Janus	3.39E-09	88.8 ± 4.0	0.656 ± 0.094	14.4	0.6	151.5	0.0073	0.165	0.695
Kiviuq	5.80E-12	7	2.3	22.0	0.06	11370	0.33	48.7	449
Methone	-	3	-	25	-	194	0	0	1.01
Mimas	6.72E-08	198.6 ± 0.6	1.169 ± 0.023	12.8	0.6	185.6	0.0206	1.566	0.942
Mundilfari	3.69E-13	2.8	2.3	23.8	0.06	18710	0.21	169.4	951r
Narvi	6.06E-13	3	2.3	24.0	0.06	18720	0.35	134.6	956r
Paaliaq	1.45E-11	9.5	2.3	21.3	0.06	15200	0.36	47.2	687
Pallene	-	4	-	25	-	211	0	0	1.14
Pan	4.75E-12	10 ± 3	0.63	19.4	0.5	133.6	0.0000	0.000	0.575
Pandora	3.43E-10	41.9 ± 2	0.63 ±0.1	16.4	0.5	141.7	0.0044	0.000	0.629
Phoebe	1.27E-08	110 ± 10	1.3 ±0.7	16.4	0.081 ± 0.002	12944.3	0.1644	174.751	548.21r
Polydeuces	-	4	-	25	-	377.4	0	0	2.74
Prometheus	5.80E-10	50.1 ± 3	0.63 ±0.1	15.8	0.6	139.4	0.0023	0.000	0.613
Rhea	4.08E-06	764 ± 4	1.240 ± 0.044	9.6	0.6	527.1	0.0009	0.327	4.518
Siarnaq	6.85E-11	16	2.3	20.1	0.06	18160	0.29	45.6	893
Skathi	5.54E-13	3.2	2.3	23.6	0.06	15650	0.27	148.5	729r
Suttungr	3.69E-13	2.8	2.3	23.9	0.06	19470	0.11	175.8	1017r
Tarvos	4.75E-12	6.5	2.3	22.1	0.06	18240	0.54	34.9	926
Telesto	1.27E-11	12 ± 3	1.0	18.5	1.0	294.70	0.0010	1.158	1.888
Tethys	1.09E-06	529.8 ± 1.5	0.991 ± 0.009	10.2	0.8	294.70	0.0001	0.168	1.888
Thrymr	3.69E-13	2.8	2.3	23.9	0.06	20470	0.47	175.0	1089r
Titan	2.37E-04	2575 ± 2	1.881 ± 0.005	8.4	0.2	1221.9	0.0288	1.634	15.95
Ymir	8.70E-12	8	2.3	21.7	0.06	23100	0.33	173.1	1312r
S/2004 S 7	-	6	-	24.5	-	19800	0.58	165.1	1103r
S/2004 S 8	-	6	-	24.6	-	22200	0.213	168	1355r
S/2004 S 9	-	5	-	24.7	-	19800	0.235	157.6	1077r
S/2004 S 10	-	6	-	24.4	-	19350	0.241	167	1026r
S/2004 S 11	-	6	-	24.1	-	16950	0.336	41	822
S/2004 S 12	-	5	-	24.8	-	19650	0.401	164	1048r
S/2004 S 13	-	6	-	24.5	-	18450	0.273	167.4	906r
S/2004 S 14	-	6	-	24.4	-	19950	0.292	162.7	1081r
S/2004 S 15	-	6	-	24.2	-	18750	0.18	156.9	1008r
S/2004 S 16	-	4	-	25	-	22200	0.135	163	1271r
S/2004 S 17	-	4	-	25.2	-	18600	0.259	166.6	986r

MOON & SATELLITE DATA (continued)

NAME	$1/m_{pl}$ Proportion of Planet Mass	MEAN RADIUS (kilometres)	MEAN DENSITY (g/cm^3)	MAGNITUDE (V_0 or R)	GEOMETRIC ALBEDO	a Semi-major axis (1000km)	e eccentricity	i inclination (°)	P Sidereal Period (days)
S/2004 S 18	-	7	-	23.8	-	19650	0.795	147.4	1052r
S/2004 S19	-	8	-	23.5	-	18217	0.36	153.3	912r
S/2006 S 1	-	6	-	24.6	-	18981	0.13	154.2	970r
S/2006 S 2	-	7	-	23.9	-	22350	0.341	148.4	1245r
S/2006 S 3	-	6	-	24.6	-	21132	0.471	150.8	1142r
S/2006 S 4	-	6	-	24.4	-	18105	0.374	172.7	905r
S/2006 S 5	-	6	-	24.6	-	23190	0.139	166.5	1314r
S/2006 S 6	-	6	-	24.7	-	18600	0.192	162.9	942r
S/2006 S 7	-	6	-	24.8	-	22290	0.368	166.9	1237r
S/2006 S 8	-	6	-	24.5	-	17610	0.418	155.6	869r
URANUS									
Ariel	1.56E-05	578.9 ± 0.6	1.665 ± 0.147	13.70 ± 0.04	0.39 ± 0.04	190.9	0.0012	0.041	2.520
Belinda	4.11E-09	40.3 ± 8	1.3	21.47 ± 0.09	0.07	75.3	0.0001	0.031	0.624
Bianca	1.07E-09	25.7 ± 2	1.3	22.52 ± 0.24	0.07	59.2	0.0009	0.193	0.435
Caliban	8.46E-09	49	1.5	22.42 ± 0.03	0.07	7231	0.1587	140.881	579.73r
Cordelia	5.18E-10	20.1 ± 3	1.3	23.62 ± 0.35	0.07	49.8	0.0003	0.085	0.335
Cressida	3.95E-09	39.8 ± 2	1.3	21.58 ± 0.11	0.07	61.8	0.0004	0.006	0.464
Cupid	-	12	-	26	-	74.8	0	0	-
Desdemona	2.05E-09	32.0 ± 4	1.3	21.99 ± 0.16	0.07	62.7	0.0001	0.113	0.474
Ferdinand	1.55E-11	6	1.5	25.1	0.04	20901	0.368	169.8	2823.4r
Francisco	1.55E-11	6	1.5	25.0	0.04	4276	0.146	145.2	266.6r
Juliet	6.42E-09	46.8 ± 4	1.3	21.12 ± 0.05	0.07	64.4	0.0007	0.065	0.493
Mab	-	16	-	26	-	97.7	0	0	-
Margaret	1.21E-11	6	1.5	25.2	0.04	14345	0.661	56.6	1694.8
Miranda	7.59E-07	235.8 ± 0.7	1.201 ± 0.137	15.79 ± 0.04	0.32 ± 0.03	129.9	0.0013	4.338	1.413
Oberon	3.47E-05	761.4 ± 2.6	1.630 ± 0.043	13.70 ± 0.04	0.23 ± 0.03	583.5	0.0014	0.068	13.46
Ophelia	6.21E-10	21.4 ± 4	1.3	23.26 ± 0.25	0.07	53.8	0.0099	0.104	0.376
Perdita	-	40	-	24.0	-	76.4	0	0	0.638
Portia	1.94E-08	67.6 ± 4	1.3	20.42 ± 0.05	0.07	66.1	0.0001	0.059	0.513
Prospero	2.42E-10	15	1.5	23.2	0.07	16418	0.443	151.91	1992.8r
Puck	3.33E-08	81 ± 2	1.3	19.75 ± 0.05	0.07	86	0.0001	0.319	0.762
Rosalind	2.93E-09	36 ± 6	1.3	21.79 ± 0.13	0.07	69.9	0.0001	0.279	0.558
Setebos	2.42E-10	15	1.5	23.3	0.07	17459	0.588	158.17	2202.3r
Stephano	6.90E-11	10	1.5	24.1	0.07	8002	0.230	144.06	676.5r
Sycorax	6.20E-08	95	1.5	20.82 ± 0.04	0.07	12179	0.5224	159.404	1288.30r
Titania	4.06E-05	788.9 ± 1.8	1.715 ± 0.044	13.49 ± 0.04	0.27 ± 0.03	436.3	0.0011	0.079	8.706
Trinculo	8.63E-12	5	1.5	25.4	0.04	8571	0.208	166.33	758.1r
Umbriel	1.35E-05	584.7 ± 2.8	1.400 ± 0.163	14.47 ± 0.04	0.21 ± 0.02	266	0.0039	0.128	4.144
NEPTUNE									
Despina	2.42E-08	75 ± 3	1.3	22.0	0.090	52.526	0.0002	0.064	0.335
Galatea	4.31E-08	88 ± 4	1.3	21.8	0.079	61.953	0.0000	0.062	0.429
Larissa	5.70E-08	97 ± 3	1.3	21.5	0.091	73.548	0.0014	0.205	0.555
Naiad	2.24E-09	33 ± 3	1.3	23.9	0.072	48.227	0.0004	4.746	0.294
Nereid	3.56E-07	170 ± 25	1.5	19.7	0.155	5513.4	0.7512	7.232	360.14
Proteus	5.80E-07	210 ± 7	1.3	19.8	0.096	117.647	0.0005	0.026	1.122
Psamathe	1.73E-10	14	1.5	25.6	0.16	46695	0.495	132.6	9115.9r
Thalassa	4.31E-09	41 ± 3	1.3	23.3	0.091	50.075	0.0002	0.209	0.327
Triton	2.46E-04	1353.4 ± 0.9	2.061 ± 0.007	13.472 ± 0.041	0.756 ± 0.041	354.8	0.0000	156.834	5.877r
S/2002 N 1	1.04E-09	24	1.5	24.5	0.16	15728	0.571	134.1	1879.7r
S/2002 N 2	1.04E-09	24	1.5	25.4	0.16	22422	0.293	48.5	2914.1
S/2002 N 3	1.04E-09	24	1.5	25.4	0.16	23571	0.424	34.7	3167.9
S/2002 N 4	1.90E-09	30	1.5	24.6	0.04	48387	0.450	137.4	9374.0r
PLUTO*									
Charon	0.123	593 ± 13	1.853 ± 0.158	17.26 ± 0.01	0.372 ± 0.012	19.41	0.0002	99.089	6.387
Nix	-	-	-	23	-	64.7	-	-	38.2
Hydra	-	-	-	23	-	49.4	-	-	25.5
ERIS*									
Dysnomia	-	150 ± 50	-	-	-	33000	-	-	14

Table column headings:

$1/m_{pl}$ Proportion of its planet's mass
Mean radius If no uncertainty is given, the value is computed from the magnitude and albedo
Mean density Derived from the GM and mean radius when an uncertainty is given, otherwise assumed
Magnitude Mean opposition magnitude: V_0, or red magnitude, R
Geometric Albedo Proportion of incident light reflected

a Semi-major Axis (mean value)
e Eccentricity (mean value)
i Inclination with respect to the reference plane
P Sidereal period (mean value)
***** Dwarf planet

Note 1: Moons are listed in alphabetical order, except for those recently discovered.
Note 2: Some data is unavailable owing to the relatively short time since the body was discovered
Note 3: Scientific notation is used in order to save space. Eg. 1.66667E-08 is the 'computer notation' equivalent to 1.66667×10^{-08} = 0.0000000166667
Note 4: Moon names of the form S/2004 X 1 are only provisional. The S indicates a satellite of a planet (a moon), the next four digits indicate the year in which it was discovered, the X can have values J, S, U or N indicating the moon orbits either Jupiter, Saturn, Uranus or Neptune, respectively, and the last number indicates the order in which this moon was discovered if more than one was discovered for the planet in the given year.
Note 5: r indicates retrograde motion.

Data from NASA/JPL (http://ssd.jpl.nasa.gov/), NASA/GSFC (http://nssdc.gsfc.nasa.gov/planetary) and The Giant Planet Satellite and Moon Page (http://www.ifa.hawaii.edu/~sheppard/satellites)

Planet, dwarf planet and satellite names

The naked eye planets were named in antiquity. But what about newly discovered moons and the geographical features revealed by spacecraft? A Commission of the International Astronomical Union (the organisation of professional astronomers) oversees and regulates naming. The rules are based on the needs of the astronomical community and reflect its international character and historical traditions. Planetary geographical features have Latin names. Latin is traditional, apolitical, and the closest thing to a universal language in modern history. The major rules are:

1. Nomenclature should be simple, clear, and unambiguous.
2. The number of names chosen for each body should be kept to a minimum, and their placement governed by the requirements of the scientific community.
3. Individual names chosen for each body should be expressed in the language of origin.
4. Where possible, the themes established in early Solar System nomenclature should be used and expanded on.
5. Solar System nomenclature should be international in its choice of names.
6. No names having political, military or religious significance may be used, except for names of political figures prior to the 19th century.
7. Features cannot be named after living people. Persons being so honoured must have been deceased for at least three years.
8. Features cannot be named for any religious figures from Christianity, Judaism, Islam, Hinduism, Buddhism or Confucianism.

MEANINGS OF PLANET AND SATELLITE NAMES

NAME	MEANING
Mercury	Named Mercurius by the Romans because it appears to move so swiftly.
Venus	Roman name for the goddess of love. This planet was considered to be the brightest and most beautiful planet or 'star' in the heavens. Other civilizations have named it for their god(ess) of love and/or war.
Earth	The name Earth comes from the Indo-European base 'er', which produced the Germanic noun 'ertho', and ultimately German 'erde', Dutch 'aarde', Danish and Swedish 'jord', and English 'earth'. Related forms include Greek 'eraze', meaning 'on the ground', and Welsh 'erw', meaning 'a piece of land'.
Moon	Every civilization has had a name for the satellite of Earth that is known, in English, as the Moon. The name is of Anglo-Saxon derivation. The Moon is known as Luna in Italian, Latin, and Spanish, as Lune in French, as Mond in German, and as Selene in Greek.
Mars	Named by the Romans for their god of war because of its red, bloodlike colour. Other civilizations also named this planet from this attribute; for example, the Egyptians named it 'Her Desher', meaning 'the red one'.
Phobos	Inner satellite of Mars. Named for one of the horses that drew Mars' chariot; also called attendant or son of Mars. Greek word means flight.
Deimos	Outer Martian satellite and named for one of Mars' horses/sons/ companions. Deimos means fear in Greek.
Ceres*	The first discovered and largest known asteroid. Discovered by Piazzi in 1801. Named for the old-Italian goddess of agriculture, grain, and the love a mother bears for her child. In later mythology, Ceres is identified with the Greek Demeter. She is the daughter of Saturn and the mother of Proserpina.
Jupiter	The largest and most massive of the planets was named Zeus by the Greeks and Jupiter by the Romans; he was the most important deity in both pantheons. Satellites in the Jovian system are named for Zeus/Jupiter's lovers and descendants.
Galileo discovered Io, Europa, Ganymede, and Callisto in 1610. Galileo suggested that the four be known as 'Medicea Sidera' to honour his patron, but the name was not accepted by other astronomers. Instead, they chose names given to the four satellites by Marius (who claimed to have discovered the Jovian satellites shortly before Galileo) in 1613; the names were of four of Jupiter's illicit loves. (Galileo refused to accept Marius' names; instead he identified the moons by Roman numerals, a secondary designation system that has been adopted for all satellite systems to the present.)	
Io	Io, the daughter of Inachus, was changed by Jupiter into a cow to protect her from Hera's jealous wrath. But Hera recognised Io and sent a gadfly to torment her. Io, maddened by the fly, wandered throughout the Mediterranean region.
Europa	Beautiful daughter of Agenor, king of Tyre, she was seduced by Jupiter, who had assumed the shape of a white bull. When Europa climbed on his back he swam with her to Crete, where she bore several children, including Minos.
Ganymede	Beautiful young boy who was carried to Olympus by Jupiter disguised as an eagle. Ganymede then became the cupbearer of the Olympian gods.
Callisto	Beautiful daughter of Lycaon, she was seduced by Jupiter, who changed her into a bear to protect her from Hera's jealousy.
Amalthea	A naiad (a goat in some accounts, a princess of Crete in others) who suckled Zeus (Jupiter) as a young child.
Himalia	A Rhodian nymph who bore three sons of Zeus.
Elara	Daughter of King Orchomenus, a paramour of Zeus, and the mother of the giant Tityus.
Pasiphaë	Wife of Minos, mother of the Minotaur.
Sinope	Daughter of the river god Asopus and Merope, she was abducted by Apollo.
Lysithea	Daughter of Kadmos, also named Semele, mother of Dionysos by Zeus. According to others, she was the daughter of Evenus and mother of Helenus by Jupiter.
Carme	A nymph and attendant of Artemis; mother, by Zeus, of Britomartis.
Ananke	Goddess of fate and necessity, mother of Adrastea by Zeus.
Leda	Seduced by Zeus in the form of a swan, she was the mother of Pollux and Helen.
Thebe	A nymph abducted by Zeus, she is the namesake of the Greek city of Thebes.
Adrastea	A nymph of Crete to whose care Rhea entrusted the infant Zeus.
Metis	First wife of Zeus. He swallowed her when she became pregnant; Athena was subsequently born from the forehead of Zeus.
Callirrhoe	A daughter of the river god Achelous, wife of Alcmaeon who lost the war for Thebes.
Themisto	Wife of Athamas, King of Thebes. She tried to kill Ino's children, but killed her own by mistake. There is also another Themisto who was involved in a love affair with Zeus.
Megaclite	Daughter of Macareus, who with Zeus gave birth to Thebe and Locrus.
Taygete	One of the Greek Pleiades. Daughter of Atlas, mother of Lacedaemon by Zeus.
Chaldene	Bore the son Solymos with Zeus.
Harpalyke	Daughter and wife of Clymenus. In revenge for this incestuous relationship, she killed the son she bore him, cooked the corpse, and served it to Clymenus. She was transformed into the night bird called Chalkis, and Clymenus hanged himself.
Kalyke	Nymph who bore the handsome son Endymion with Zeus.
Iocaste	Wife of Laius, King of Thebes, and mother of Oedipus. After Laius was killed, Iocaste unknowingly married her own son Oedipus. When she learned that her husband was her son, she killed herself.
Erinome	Daughter of Celes, compelled by Venus to fall in love with Zeus.
Isonoe	A Danaid who bore with Zeus the son Orchomenos or Chrysen.
Praxidike	Greek goddess of punishment of evil actions, justice, and of retribution.
Autonoe	Mother of the Graces by Zeus, according to some authorities.
Thyone	Semele, mother of Dionysos by Zeus. She received the name of Thyone in Hades by Dionysos before he ascended up with her from there to heaven.
Hermippe	Consort of Zeus and mother of Orchomenos by him.
Aitne	A Sicilian nymph and lover of Zeus.
Eurydome	Mother of the Graces by Zeus, according to some authorities.
Euanthe	Mother of the Graces by Zeus, according to some authorities.
Euporie	One of the Horae (seasons), a daughter of Jupiter and Themis.
Orthosie	One of the Horae (seasons), a daughter of Jupiter and Themis.
Sponde	One of the Horae (seasons), daughter of Jupiter.
Kale	One of the Graces, a daughter of Zeus, husband of Hephaistos.
Pasithee	One of the Graces, a daughter of Zeus.
Saturn	Roman name for the Greek Cronos, father of Zeus/Jupiter. Other civilizations have given other names to Saturn, which is the farthest planet from Earth that can be observed by the naked human eye.

MEANINGS OF PLANET AND SATELLITE NAMES

NAME	MEANING
Saturn	Most of Saturn's satellites were named for Titans who, according to Greek mythology, were brothers and sisters of Saturn. In Greek mythology, the Titans were a race of godlike giants who were considered to be the personifications of the forces of nature. They were the twelve children (six sons and six daughters) of Gaia and Uranus. Satellites in the Saturnian system are named for Greco-Roman Titans, descendants of the Titans, the Roman god of the beginning, and giants from Greco-Roman and other mythologies. Gallic, Inuit and Norse names identify three different orbit inclination groups.
Mimas	Named for a Titan felled by Hephaestus (or Ares) in the war between the Titans and Olympian gods.
Enceladus	The Giant Enceladus was crushed by Athene in the battle between the Olympian gods and the Titans. Earth piled on top of him became the island of Sicily.
Tethys	Tethys was the wife of Oceanus and mother of all rivers and Oceanids.
Dione	Dione was the sister of Cronos and mother (by Zeus) of Aphrodite.
Rhea	Daughter of Cronos and mother of Zeus.
Titan	Discovered and named in 1655 by C. Huygens, who first called it 'Luna Saturni'.
Hyperion	A Titan who married his sister Theia and has three children – Helios, Selene and Eos.
Iapetus	A Titan whose wife was Clymene, with whom he had four children – Atlas, Menoetius, Prometheus and Epimetheus.
Phoebe	She married her brother Coeus and was the mother of Leto and Asteria. It is said that she owned the oracle of Delphi before Apollo took it over.
Janus	Named for the two-faced Roman god who could look forward and backward at the same time. Shares the same orbit with Epimetheus but they never actually collide.
Epimetheus	Named for the Greek backward-looking god. Shares the same orbit with Janus but they never actually collide.
Helene	The daughter of Tityrus, and one of the Amazons. A granddaughter of Kronos, for her beauty she triggered off the Trojan War
Telesto	One of 3,000 Oceanides, water nymphs born to Oceanus and Tethys.
Calypso	Daughter of the Titans Oceanus and Tethys and paramour of Odysseus.
Atlas	Held the heavens on his shoulders.
Prometheus	Son of the Titan Iapetus, brother of Atlas and Epimetheus, he gave many gifts to humanity, including fire which he stole from Zeus and the gods.
Pandora	Made of clay by Hephaestus at the request of Zeus. She married Epimetheus and opened the box that loosed a host of plagues upon humanity.
Pan	Son of the Titan Kronos and Rhea. He was half human, half goat – god of pastoralism.
Ymir	Ymir is the primordial Norse giant and the progenitor of the race of frost giants.
Paaliaq	An Inuit giant.
Tarvos	A Gallic giant.
Ijiraq	An Inuit giant.
Suttungr	Named for a Norse giant who kindled flames that destroyed the world.
Kiviuq	An Inuit giant.
Mundilfari	In Norse myth, there was once a giant named Mundilfari who was married to Glaur. Their children were so beautiful that he named his son Mani (Moon) and his daughter Sol (Sun).
Albiorix	'King of the world'. An alternative name of the Gallic god Teutates. He is the god of war, fertility, and wealth.
Skathi	A giantess, called the 'snow-shoe goddess', and the embodiment of winter. She is the wife of the god Njord.
Erriapo	A Gallic giant.
Siarnaq	An Inuit giant.
Thrymr	Named for a Norse giant.
Daphnis	The son of Hermes and a nymph. He was known as a shepherd and flute player. He is regarded as the inventor of bucolic poetry.
Uranus	Uranus was discovered by William Herschel in 1781. Several astronomers, including Flamsteed and Le Monnier, had observed it earlier but had recorded it as a fixed star. Herschel tried unsuccessfully to name his discovery 'Georgian Sidus' after George III; the planet was named by Johann Bode in 1781 for the father of Saturn. Uranus is the only body in the Solar System with moons not named from classical mythology – its moons are named from works by Shakespeare and Alexander Pope. Any future satellites will follow that naming convention.
Ariel	A sylph in Pope's 'Rape of the Lock'.
Umbriel	A malevolent spirit in Pope's 'Rape of the Lock'.

NAME	MEANING
Titania	Queen of the fairies in Shakespeare's 'A Midsummer Night's Dream'.
Oberon	King of the fairies in Shakespeare's 'A Midsummer Night's Dream'.
Miranda	Heroine of Shakespeare's 'The Tempest'.
Cordelia	Daughter of Lear in Shakespeare's 'King Lear'.
Ophelia	Daughter of Polonius, fiance of Hamlet in Shakespeare's 'Hamlet, Prince of Denmark'.
Bianca	Daughter of Baptista, sister of Kate in Shakespeare's 'Taming of the Shrew'.
Cressida	Title character in Shakespeare's 'Troilus and Cressida'.
Desdemona	Wife of Othello in Shakespeare's 'Othello, the Moor of Venice'.
Juliet	Heroine of Shakespeare's 'Romeo and Juliet'.
Portia	Wife of Brutus in Shakespeare's 'Julius Caesar'.
Rosalind	Daughter of the banished duke in Shakespeare's 'As You Like It'.
Belinda	Character in Pope's 'Rape of the Lock'.
Puck	Mischievous spirit in Shakespeare's 'A Midsummer Night's Dream'.
Caliban	Named for the grotesque, brutish slave in Shakespeare's 'The Tempest'.
Sycorax	Named for Caliban's mother in Shakespeare's 'The Tempest'.
Prospero	Named for the rightful Duke of Milan in 'The Tempest'.
Setebos	Setebos was a new-world (South American) deity's name that Shakespeare popularised as Sycorax's god in 'The Tempest'.
Stephano	Named for a drunken butler in 'The Tempest'.
Trinculo	Trinculo is an entertainer without an audience in 'The Tempest'.
Perdita	The daughter of Leontes and Hermione in 'The Winter's Tale'.
Ferdinand	The son of the King of Naples in 'The Tempest'.
Francisco	A lord in 'The Tempest'.
Mab	Queen Mab, a fairy queen from English folklore who is mentioned in 'Romeo and Juliet'.
Cupid	A character in 'Timon of Athens'.
Margaret	The servant of Hero in 'Much Ado About Nothing'.
Neptune	Neptune was actually 'observed' as early as 1690 by John Flamsteed, who thought it was a fixed star. It was 'predicted' by John Couch Adams and Urbain Le Verrier who, independently, were able to account for the irregularities in the motion of Uranus by correctly predicting the orbital elements of a trans-Uranian body. Using the predicted parameters of Le Verrier (Adams never published his predictions), Johann Galle observed the planet in 1846. Galle wanted to name the planet for Le Verrier, but that was not acceptable to the international astronomical community. Instead, this planet is named for the Roman god of the sea. Satellites in the Neptunian system are named for characters from Greek or Roman mythology associated with Neptune /Poseidon orthe oceans.
Triton	Triton is named for the sea-god son of Poseidon (Neptune) and Amphitrite.
Nereid	The Nereids were the fifty daughters of Nereus and Doris and were attendants of Neptune.
Naiad	The name of a group of Greek water nymphs who were guardians of lakes, fountains, springs and rivers.
Thalassa	Greek sea goddess. Mother of Aphrodite in some legends; others say she bore the Telchines.
Despina	Daughter of Poseidon (Neptune) and Demeter.
Galatea	One of the Nereids, attendants of Poseidon.
Larissa	A lover of Poseidon.
Proteus	Greek sea god, son of Oceanus and Tethys.
Psamathe	A Nereid, and with Aeacus the mother of Phocus.
Pluto*	Discovered in 1930 by American astronomer Clyde W. Tombaugh at Lowell Observatory in Flagstaff, Arizona, during a systematic search for a trans-Neptune planet predicted by Percival Lowell and William H. Pickering. Named after Greek god of the underworld who was able to render himself invisible.
Charon	Discovered in 1978 by James W. Christy. Named after the mythological boatman who ferried souls across the river Styx to Pluto for judgement.
Nix	The goddess of night and the mother of Charon. (Sometimes spelt Nyx.)
Hydra	The nine-headed monster that guarded Lake Lerna, one of the entrances to the underworld.
Eris*	Brown, Trujillo, and Rabinowitz discovered Eris on January 5, 2005 in their TNO search programme. Named for the Greek goddess of discord and strife. She is Ares' constant companion and follows him everywhere. Eris is sinister and mean, and her greatest joy is to make trouble.
Dysnomia	The female Spirit of lawlessness.

Note: Moons are listed in order of their discovery.
* Dwarf planet

GEOCENTRIC POSITION OF SUN (EPOCH J2000.0)

Note: positions refer to 0000 WAST

MONTH	DAY	RA			DECLINATION			DISTANCE	CONST.
		h	m	s	°	′	″	(AU)	
January	**1**	**18**	**42**	**23.7**	**-23**	**04**	**50**	**0.983**	**Sgr**
Jan	2	18	46	48.6	-23	00	08	0.983	Sgr
Jan	3	18	51	13.2	-22	54	58	0.983	Sgr
Jan	4	18	55	37.5	-22	49	21	0.983	Sgr
Jan	5	19	00	01.4	-22	43	17	0.983	Sgr
Jan	6	19	04	24.8	-22	36	46	0.983	Sgr
Jan	7	19	08	47.9	-22	29	48	0.983	Sgr
Jan	8	19	13	10.5	-22	22	24	0.983	Sgr
Jan	9	19	17	32.7	-22	14	32	0.983	Sgr
Jan	10	19	21	54.3	-22	06	15	0.983	Sgr
Jan	11	19	26	15.4	-21	57	32	0.983	Sgr
Jan	12	19	30	36.0	-21	48	23	0.983	Sgr
Jan	13	19	34	56.0	-21	38	49	0.983	Sgr
Jan	14	19	39	15.4	-21	28	49	0.984	Sgr
Jan	15	19	43	34.2	-21	18	24	0.984	Sgr
Jan	16	19	47	52.3	-21	07	35	0.984	Sgr
Jan	17	19	52	09.8	-20	56	21	0.984	Sgr
Jan	18	19	56	26.6	-20	44	43	0.984	Sgr
Jan	19	20	00	42.7	-20	32	42	0.984	Sgr
Jan	20	20	04	58.2	-20	20	17	0.984	Sgr
Jan	21	20	09	12.8	-20	07	29	0.984	Cap
Jan	22	20	13	26.7	-19	54	19	0.984	Cap
Jan	23	20	17	39.9	-19	40	46	0.984	Cap
Jan	24	20	21	52.2	-19	26	51	0.984	Cap
Jan	25	20	26	03.8	-19	12	35	0.984	Cap
Jan	26	20	30	14.5	-18	57	58	0.984	Cap
Jan	27	20	34	24.4	-18	42	60	0.985	Cap
Jan	28	20	38	33.5	-18	27	42	0.985	Cap
Jan	29	20	42	41.8	-18	12	04	0.985	Cap
Jan	30	20	46	49.3	-17	56	06	0.985	Cap
Jan	31	20	50	55.9	-17	39	49	0.985	Cap
February	**1**	**20**	**55**	**01.7**	**-17**	**23**	**13**	**0.985**	**Cap**
Feb	2	20	59	06.7	-17	06	19	0.985	Cap
Feb	3	21	03	10.8	-16	49	07	0.985	Cap
Feb	4	21	07	14.2	-16	31	37	0.986	Cap
Feb	5	21	11	16.7	-16	13	50	0.986	Cap
Feb	6	21	15	18.4	-15	55	46	0.986	Cap
Feb	7	21	19	19.4	-15	37	26	0.986	Cap
Feb	8	21	23	19.5	-15	18	49	0.986	Cap
Feb	9	21	27	18.9	-14	59	57	0.986	Cap
Feb	10	21	31	17.5	-14	40	50	0.987	Cap
Feb	11	21	35	15.3	-14	21	27	0.987	Cap
Feb	12	21	39	12.4	-14	01	51	0.987	Cap
Feb	13	21	43	08.7	-13	41	60	0.987	Cap
Feb	14	21	47	04.3	-13	21	56	0.987	Cap
Feb	15	21	50	59.1	-13	01	38	0.988	Cap
Feb	16	21	54	53.2	-12	41	07	0.988	Cap
Feb	17	21	58	46.6	-12	20	25	0.988	Aqr
Feb	18	22	02	39.3	-11	59	30	0.988	Aqr
Feb	19	22	06	31.3	-11	38	24	0.988	Aqr
Feb	20	22	10	22.6	-11	17	07	0.989	Aqr
Feb	21	22	14	13.3	-10	55	39	0.989	Aqr
Feb	22	22	18	03.2	-10	34	01	0.989	Aqr
Feb	23	22	21	52.5	-10	12	14	0.989	Aqr
Feb	24	22	25	41.2	-09	50	17	0.989	Aqr
Feb	25	22	29	29.2	-09	28	12	0.990	Aqr
Feb	26	22	33	16.6	-09	05	58	0.990	Aqr
Feb	27	22	37	03.4	-08	43	36	0.990	Aqr
Feb	28	22	40	49.6	-08	21	06	0.990	Aqr
March	**1**	**22**	**44**	**35.3**	**-07**	**58**	**29**	**0.991**	**Aqr**
Mar	2	22	48	20.4	-07	35	45	0.991	Aqr
Mar	3	22	52	05.1	-07	12	55	0.991	Aqr
Mar	4	22	55	49.2	-06	49	59	0.991	Aqr
Mar	5	22	59	32.9	-06	26	57	0.992	Aqr
Mar	6	23	03	16.1	-06	03	49	0.992	Aqr
Mar	7	23	06	58.9	-05	40	36	0.992	Aqr
Mar	8	23	10	41.2	-05	17	19	0.992	Aqr
Mar	9	23	14	23.2	-04	53	58	0.993	Aqr
Mar	10	23	18	04.9	-04	30	32	0.993	Aqr
Mar	11	23	21	46.2	-04	07	03	0.993	Aqr
Mar	12	23	25	27.1	-03	43	31	0.993	Aqr
Mar	13	23	29	07.8	-03	19	56	0.994	Aqr
Mar	14	23	32	48.2	-02	56	18	0.994	Psc
Mar	15	23	36	28.3	-02	32	39	0.994	Psc
Mar	16	23	40	08.2	-02	08	58	0.995	Psc
Mar	17	23	43	47.9	-01	45	15	0.995	Psc
Mar	18	23	47	27.4	-01	21	31	0.995	Psc
Mar	19	23	51	06.7	-00	57	47	0.995	Psc
Mar	20	23	54	45.8	-00	34	03	0.996	Psc
Mar	21	23	58	24.7	-00	10	20	0.996	Psc
Mar	22	00	02	03.5	+00	13	24	0.996	Psc
Mar	23	00	05	42.2	+00	37	06	0.996	Psc
Mar	24	00	09	20.8	+01	00	46	0.997	Psc
Mar	25	00	12	59.3	+01	24	25	0.997	Psc
Mar	26	00	16	37.8	+01	48	01	0.997	Psc
Mar	27	00	20	16.2	+02	11	35	0.998	Psc
Mar	28	00	23	54.5	+02	35	06	0.998	Psc
Mar	29	00	27	32.9	+02	58	33	0.998	Psc
Mar	30	00	31	11.3	+03	21	57	0.998	Psc
Mar	31	00	34	49.7	+03	45	17	0.999	Psc
April	**1**	**00**	**38**	**28.1**	**+04**	**08**	**33**	**0.999**	**Psc**
Apr	2	00	42	06.7	+04	31	44	0.999	Psc
Apr	3	00	45	45.4	+04	54	51	1.000	Psc
Apr	4	00	49	24.1	+05	17	52	1.000	Psc
Apr	5	00	53	03.1	+05	40	47	1.000	Psc
Apr	6	00	56	42.2	+06	03	37	1.000	Psc
Apr	7	01	00	21.5	+06	26	20	1.001	Psc
Apr	8	01	04	01.0	+06	48	57	1.001	Psc
Apr	9	01	07	40.7	+07	11	27	1.001	Psc
Apr	10	01	11	20.7	+07	33	50	1.002	Psc
Apr	11	01	15	01.0	+07	56	05	1.002	Psc
Apr	12	01	18	41.5	+08	18	12	1.002	Psc
Apr	13	01	22	22.3	+08	40	12	1.002	Psc
Apr	14	01	26	03.5	+09	02	02	1.003	Psc
Apr	15	01	29	45.0	+09	23	44	1.003	Psc
Apr	16	01	33	26.9	+09	45	16	1.003	Psc
Apr	17	01	37	09.1	+10	06	39	1.004	Psc
Apr	18	01	40	51.7	+10	27	52	1.004	Psc
Apr	19	01	44	34.7	+10	48	54	1.004	Psc
Apr	20	01	48	18.1	+11	09	46	1.004	Ari
Apr	21	01	52	01.8	+11	30	26	1.005	Ari
Apr	22	01	55	46.0	+11	50	55	1.005	Ari
Apr	23	01	59	30.6	+12	11	12	1.005	Ari
Apr	24	02	03	15.6	+12	31	17	1.005	Ari
Apr	25	02	07	01.1	+12	51	10	1.006	Ari
Apr	26	02	10	47.0	+13	10	49	1.006	Ari
Apr	27	02	14	33.4	+13	30	16	1.006	Ari
Apr	28	02	18	20.3	+13	49	29	1.007	Ari
Apr	29	02	22	07.6	+14	08	29	1.007	Ari
Apr	30	02	25	55.5	+14	27	14	1.007	Ari
May	**1**	**02**	**29**	**43.9**	**+14**	**45**	**45**	**1.007**	**Ari**
May	2	02	33	32.8	+15	04	02	1.008	Ari

GEOCENTRIC POSITION OF SUN (continued)

Note: positions refer to 0000 WAST

MONTH	DAY	RA h	RA m	RA s	DECLINATION °	DECLINATION ′	DECLINATION ″	DISTANCE (AU)	CONST.
May	3	02	37	22.2	+15	22	03	1.008	Ari
May	4	02	41	12.2	+15	39	50	1.008	Ari
May	5	02	45	02.7	+15	57	20	1.008	Ari
May	6	02	48	53.8	+16	14	35	1.009	Ari
May	7	02	52	45.4	+16	31	34	1.009	Ari
May	8	02	56	37.6	+16	48	17	1.009	Ari
May	9	03	00	30.5	+17	04	43	1.009	Ari
May	10	03	04	23.9	+17	20	52	1.010	Ari
May	11	03	08	17.8	+17	36	43	1.010	Ari
May	12	03	12	12.4	+17	52	17	1.010	Ari
May	13	03	16	07.6	+18	07	33	1.010	Ari
May	14	03	20	03.4	+18	22	31	1.010	Ari
May	15	03	23	59.7	+18	37	10	1.011	Ari
May	16	03	27	56.7	+18	51	30	1.011	Tau
May	17	03	31	54.2	+19	05	32	1.011	Tau
May	18	03	35	52.2	+19	19	13	1.011	Tau
May	19	03	39	50.9	+19	32	36	1.012	Tau
May	20	03	43	50.0	+19	45	38	1.012	Tau
May	21	03	47	49.8	+19	58	19	1.012	Tau
May	22	03	51	50.0	+20	10	41	1.012	Tau
May	23	03	55	50.7	+20	22	41	1.012	Tau
May	24	03	59	52.0	+20	34	21	1.012	Tau
May	25	04	03	53.7	+20	45	39	1.013	Tau
May	26	04	07	56.0	+20	56	36	1.013	Tau
May	27	04	11	58.7	+21	07	11	1.013	Tau
May	28	04	16	01.9	+21	17	24	1.013	Tau
May	29	04	20	05.5	+21	27	15	1.013	Tau
May	30	04	24	09.6	+21	36	44	1.014	Tau
May	31	04	28	14.1	+21	45	50	1.014	Tau
June	**1**	**04**	**32**	**19.1**	**+21**	**54**	**34**	**1.014**	**Tau**
Jun	2	04	36	24.4	+22	02	55	1.014	Tau
Jun	3	04	40	30.2	+22	10	52	1.014	Tau
Jun	4	04	44	36.3	+22	18	27	1.014	Tau
Jun	5	04	48	42.9	+22	25	38	1.014	Tau
Jun	6	04	52	49.7	+22	32	26	1.015	Tau
Jun	7	04	56	56.9	+22	38	50	1.015	Tau
Jun	8	05	01	04.5	+22	44	51	1.015	Tau
Jun	9	05	05	12.3	+22	50	27	1.015	Tau
Jun	10	05	09	20.5	+22	55	40	1.015	Tau
Jun	11	05	13	28.9	+23	00	28	1.015	Tau
Jun	12	05	17	37.6	+23	04	52	1.015	Tau
Jun	13	05	21	46.4	+23	08	52	1.016	Tau
Jun	14	05	25	55.5	+23	12	27	1.016	Tau
Jun	15	05	30	04.8	+23	15	37	1.016	Tau
Jun	16	05	34	14.2	+23	18	23	1.016	Tau
Jun	17	05	38	23.7	+23	20	44	1.016	Tau
Jun	18	05	42	33.2	+23	22	40	1.016	Tau
Jun	19	05	46	42.9	+23	24	12	1.016	Tau
Jun	20	05	50	52.5	+23	25	19	1.016	Tau
Jun	21	05	55	02.2	+23	26	01	1.016	Tau
Jun	22	05	59	11.8	+23	26	18	1.016	Tau
Jun	23	06	03	21.4	+23	26	10	1.016	Gem
Jun	24	06	07	31.0	+23	25	37	1.016	Gem
Jun	25	06	11	40.4	+23	24	40	1.016	Gem
Jun	26	06	15	49.7	+23	23	18	1.016	Gem
Jun	27	06	19	58.9	+23	21	32	1.017	Gem
Jun	28	06	24	07.9	+23	19	20	1.017	Gem
Jun	29	06	28	16.8	+23	16	45	1.017	Gem
Jun	30	06	32	25.4	+23	13	44	1.017	Gem
July	**1**	**06**	**36**	**33.8**	**+23**	**10**	**20**	**1.017**	**Gem**
Jul	2	06	40	42.0	+23	06	31	1.017	Gem

MONTH	DAY	RA h	RA m	RA s	DECLINATION °	DECLINATION ′	DECLINATION ″	DISTANCE (AU)	CONST.
Jul	3	06	44	50.0	+23	02	18	1.017	Gem
Jul	4	06	48	57.6	+22	57	41	1.017	Gem
Jul	5	06	53	05.0	+22	52	40	1.017	Gem
Jul	6	06	57	12.1	+22	47	14	1.017	Gem
Jul	7	07	01	18.9	+22	41	26	1.017	Gem
Jul	8	07	05	25.3	+22	35	13	1.017	Gem
Jul	9	07	09	31.4	+22	28	37	1.017	Gem
Jul	10	07	13	37.1	+22	21	38	1.017	Gem
Jul	11	07	17	42.4	+22	14	15	1.017	Gem
Jul	12	07	21	47.3	+22	06	29	1.017	Gem
Jul	13	07	25	51.8	+21	58	21	1.017	Gem
Jul	14	07	29	55.8	+21	49	50	1.017	Gem
Jul	15	07	33	59.3	+21	40	56	1.017	Gem
Jul	16	07	38	02.4	+21	31	40	1.017	Gem
Jul	17	07	42	04.9	+21	22	02	1.016	Gem
Jul	18	07	46	06.9	+21	12	02	1.016	Gem
Jul	19	07	50	08.4	+21	01	41	1.016	Gem
Jul	20	07	54	09.3	+20	50	59	1.016	Gem
Jul	21	07	58	09.7	+20	39	55	1.016	Gem
Jul	22	08	02	09.5	+20	28	31	1.016	Cnc
Jul	23	08	06	08.7	+20	16	46	1.016	Cnc
Jul	24	08	10	07.3	+20	04	41	1.016	Cnc
Jul	25	08	14	05.3	+19	52	16	1.016	Cnc
Jul	26	08	18	02.7	+19	39	31	1.016	Cnc
Jul	27	08	21	59.5	+19	26	27	1.016	Cnc
Jul	28	08	25	55.7	+19	13	03	1.016	Cnc
Jul	29	08	29	51.2	+18	59	20	1.015	Cnc
Jul	30	08	33	46.2	+18	45	19	1.015	Cnc
Jul	31	08	37	40.6	+18	30	59	1.015	Cnc
August	**1**	**08**	**41**	**34.3**	**+18**	**16**	**21**	**1.015**	**Cnc**
Aug	2	08	45	27.5	+18	01	25	1.015	Cnc
Aug	3	08	49	20.1	+17	46	12	1.015	Cnc
Aug	4	08	53	12.0	+17	30	41	1.015	Cnc
Aug	5	08	57	03.4	+17	14	53	1.015	Cnc
Aug	6	09	00	54.2	+16	58	48	1.014	Cnc
Aug	7	09	04	44.4	+16	42	26	1.014	Cnc
Aug	8	09	08	34.1	+16	25	48	1.014	Cnc
Aug	9	09	12	23.2	+16	08	54	1.014	Cnc
Aug	10	09	16	11.7	+15	51	45	1.014	Cnc
Aug	11	09	19	59.6	+15	34	20	1.014	Cnc
Aug	12	09	23	47.0	+15	16	40	1.014	Leo
Aug	13	09	27	33.8	+14	58	46	1.013	Leo
Aug	14	09	31	20.0	+14	40	37	1.013	Leo
Aug	15	09	35	05.7	+14	22	14	1.013	Leo
Aug	16	09	38	50.9	+14	03	37	1.013	Leo
Aug	17	09	42	35.5	+13	44	47	1.013	Leo
Aug	18	09	46	19.6	+13	25	44	1.012	Leo
Aug	19	09	50	03.1	+13	06	29	1.012	Leo
Aug	20	09	53	46.2	+12	47	01	1.012	Leo
Aug	21	09	57	28.7	+12	27	21	1.012	Leo
Aug	22	10	01	10.7	+12	07	29	1.012	Leo
Aug	23	10	04	52.3	+11	47	26	1.011	Leo
Aug	24	10	08	33.4	+11	27	11	1.011	Leo
Aug	25	10	12	14.0	+11	06	46	1.011	Leo
Aug	26	10	15	54.2	+10	46	11	1.011	Leo
Aug	27	10	19	34.0	+10	25	26	1.011	Leo
Aug	28	10	23	13.4	+10	04	30	1.010	Leo
Aug	29	10	26	52.4	+09	43	25	1.010	Leo
Aug	30	10	30	31.0	+09	22	11	1.010	Leo
Aug	31	10	34	09.3	+09	00	48	1.010	Leo
September	**1**	**10**	**37**	**47.3**	**+08**	**39**	**16**	**1.009**	**Leo**

GEOCENTRIC POSITION OF SUN (continued)

MONTH	DAY	RA h	m	s	DECLINATION °	′	″	DISTANCE (AU)	CONST.
Sep	2	10	41	24.9	+08	17	36	1.009	Leo
Sep	3	10	45	02.3	+07	55	47	1.009	Leo
Sep	4	10	48	39.4	+07	33	51	1.009	Leo
Sep	5	10	52	16.3	+07	11	47	1.009	Leo
Sep	6	10	55	53.0	+06	49	36	1.008	Leo
Sep	7	10	59	29.4	+06	27	19	1.008	Leo
Sep	8	11	03	05.6	+06	04	54	1.008	Leo
Sep	9	11	06	41.7	+05	42	24	1.008	Leo
Sep	10	11	10	17.6	+05	19	48	1.007	Leo
Sep	11	11	13	53.4	+04	57	06	1.007	Leo
Sep	12	11	17	29.0	+04	34	20	1.007	Leo
Sep	13	11	21	04.5	+04	11	28	1.006	Leo
Sep	14	11	24	39.9	+03	48	33	1.006	Leo
Sep	15	11	28	15.2	+03	25	33	1.006	Leo
Sep	16	11	31	50.4	+03	02	29	1.006	Leo
Sep	17	11	35	25.6	+02	39	22	1.005	Leo
Sep	18	11	39	00.8	+02	16	13	1.005	Vir
Sep	19	11	42	36.0	+01	53	00	1.005	Vir
Sep	20	11	46	11.1	+01	29	46	1.005	Vir
Sep	21	11	49	46.3	+01	06	29	1.004	Vir
Sep	22	11	53	21.5	+00	43	11	1.004	Vir
Sep	23	11	56	56.8	+00	19	51	1.004	Vir
Sep	24	12	00	32.2	-00	03	29	1.003	Vir
Sep	25	12	04	07.7	-00	26	50	1.003	Vir
Sep	26	12	07	43.4	-00	50	12	1.003	Vir
Sep	27	12	11	19.2	-01	13	33	1.003	Vir
Sep	28	12	14	55.2	-01	36	55	1.002	Vir
Sep	29	12	18	31.3	-02	00	15	1.002	Vir
Sep	30	12	22	07.8	-02	23	35	1.002	Vir
October	**1**	**12**	**25**	**44.4**	**-02**	**46**	**53**	**1.001**	**Vir**
Oct	2	12	29	21.4	-03	10	10	1.001	Vir
Oct	3	12	32	58.7	-03	33	25	1.001	Vir
Oct	4	12	36	36.3	-03	56	38	1.001	Vir
Oct	5	12	40	14.2	-04	19	48	1.000	Vir
Oct	6	12	43	52.5	-04	42	56	1.000	Vir
Oct	7	12	47	31.2	-05	05	59	1.000	Vir
Oct	8	12	51	10.3	-05	28	60	0.999	Vir
Oct	9	12	54	49.8	-05	51	55	0.999	Vir
Oct	10	12	58	29.7	-06	14	47	0.999	Vir
Oct	11	13	02	10.1	-06	37	34	0.999	Vir
Oct	12	13	05	51.0	-07	00	15	0.998	Vir
Oct	13	13	09	32.3	-07	22	50	0.998	Vir
Oct	14	13	13	14.2	-07	45	20	0.998	Vir
Oct	15	13	16	56.5	-08	07	43	0.997	Vir
Oct	16	13	20	39.4	-08	29	59	0.997	Vir
Oct	17	13	24	22.9	-08	52	08	0.997	Vir
Oct	18	13	28	06.9	-09	14	09	0.997	Vir
Oct	19	13	31	51.5	-09	36	02	0.996	Vir
Oct	20	13	35	36.6	-09	57	46	0.996	Vir
Oct	21	13	39	22.4	-10	19	22	0.996	Vir
Oct	22	13	43	08.8	-10	40	49	0.995	Vir
Oct	23	13	46	55.9	-11	02	06	0.995	Vir
Oct	24	13	50	43.6	-11	23	13	0.995	Vir
Oct	25	13	54	31.9	-11	44	09	0.995	Vir
Oct	26	13	58	21.0	-12	04	55	0.994	Vir
Oct	27	14	02	10.8	-12	25	30	0.994	Vir
Oct	28	14	06	01.3	-12	45	54	0.994	Vir
Oct	29	14	09	52.6	-13	06	05	0.994	Vir
Oct	30	14	13	44.6	-13	26	05	0.993	Vir
Oct	31	14	17	37.5	-13	45	52	0.993	Vir
November	**1**	**14**	**21**	**31.1**	**-14**	**05**	**26**	**0.993**	**Vir**

MONTH	DAY	RA h	m	s	DECLINATION °	′	″	DISTANCE (AU)	CONST.
Nov	2	14	25	25.5	-14	24	46	0.992	Lib
Nov	3	14	29	20.7	-14	43	53	0.992	Lib
Nov	4	14	33	16.8	-15	02	46	0.992	Lib
Nov	5	14	37	13.7	-15	21	24	0.992	Lib
Nov	6	14	41	11.4	-15	39	47	0.992	Lib
Nov	7	14	45	10.0	-15	57	54	0.991	Lib
Nov	8	14	49	09.4	-16	15	45	0.991	Lib
Nov	9	14	53	09.7	-16	33	21	0.991	Lib
Nov	10	14	57	10.8	-16	50	39	0.991	Lib
Nov	11	15	01	12.8	-17	07	40	0.990	Lib
Nov	12	15	05	15.6	-17	24	24	0.990	Lib
Nov	13	15	09	19.2	-17	40	50	0.990	Lib
Nov	14	15	13	23.8	-17	56	57	0.990	Lib
Nov	15	15	17	29.1	-18	12	45	0.989	Lib
Nov	16	15	21	35.3	-18	28	15	0.989	Lib
Nov	17	15	25	42.3	-18	43	24	0.989	Lib
Nov	18	15	29	50.1	-18	58	14	0.989	Lib
Nov	19	15	33	58.7	-19	12	43	0.988	Lib
Nov	20	15	38	08.2	-19	26	52	0.988	Lib
Nov	21	15	42	18.4	-19	40	39	0.988	Lib
Nov	22	15	46	29.5	-19	54	05	0.988	Lib
Nov	23	15	50	41.3	-20	07	10	0.988	Lib
Nov	24	15	54	53.9	-20	19	52	0.987	Lib
Nov	25	15	59	07.3	-20	32	11	0.987	Sco
Nov	26	16	03	21.4	-20	44	08	0.987	Sco
Nov	27	16	07	36.4	-20	55	42	0.987	Sco
Nov	28	16	11	52.0	-21	06	53	0.987	Sco
Nov	29	16	16	08.4	-21	17	40	0.987	Sco
Nov	30	16	20	25.6	-21	28	02	0.986	Sco
December	**1**	**16**	**24**	**43.4**	**-21**	**38**	**01**	**0.986**	**Oph**
Dec	2	16	29	01.9	-21	47	34	0.986	Oph
Dec	3	16	33	21.1	-21	56	43	0.986	Oph
Dec	4	16	37	41.0	-22	05	26	0.986	Oph
Dec	5	16	42	01.4	-22	13	44	0.986	Oph
Dec	6	16	46	22.5	-22	21	36	0.985	Oph
Dec	7	16	50	44.1	-22	29	02	0.985	Oph
Dec	8	16	55	06.3	-22	36	02	0.985	Oph
Dec	9	16	59	28.9	-22	42	35	0.985	Oph
Dec	10	17	03	52.1	-22	48	41	0.985	Oph
Dec	11	17	08	15.7	-22	54	21	0.985	Oph
Dec	12	17	12	39.7	-22	59	33	0.985	Oph
Dec	13	17	17	04.1	-23	04	18	0.985	Oph
Dec	14	17	21	28.8	-23	08	35	0.984	Oph
Dec	15	17	25	53.9	-23	12	25	0.984	Oph
Dec	16	17	30	19.2	-23	15	46	0.984	Oph
Dec	17	17	34	44.8	-23	18	41	0.984	Oph
Dec	18	17	39	10.6	-23	21	07	0.984	Oph
Dec	19	17	43	36.5	-23	23	05	0.984	Oph
Dec	20	17	48	02.6	-23	24	35	0.984	Sgr
Dec	21	17	52	28.8	-23	25	37	0.984	Sgr
Dec	22	17	56	55.0	-23	26	10	0.984	Sgr
Dec	23	18	01	21.3	-23	26	16	0.984	Sgr
Dec	24	18	05	47.7	-23	25	53	0.984	Sgr
Dec	25	18	10	14.0	-23	25	02	0.984	Sgr
Dec	26	18	14	40.2	-23	23	43	0.983	Sgr
Dec	27	18	19	06.4	-23	21	56	0.983	Sgr
Dec	28	18	23	32.5	-23	19	41	0.983	Sgr
Dec	29	18	27	58.5	-23	16	57	0.983	Sgr
Dec	30	18	32	24.3	-23	13	46	0.983	Sgr
Dec	31	18	36	49.9	-23	10	06	0.983	Sgr

GEOCENTRIC POSITION OF MOON (EPOCH J2000.0)

Note: positions refer to 0000 WAST

MONTH	DAY	RA h	RA m	RA s	DECLINATION °	DECLINATION ′	DECLINATION ″	DISTANCE (1,000km)	CONST.
January	**1**	**03**	**58**	**12.6**	**+25**	**26**	**10**	**373.7**	**Tau**
Jan	2	04	59	26.8	+27	46	11	376.1	Tau
Jan	3	06	01	30.8	+28	22	06	379.2	Aur
Jan	4	07	02	13.7	+27	14	42	382.9	Gem
Jan	5	07	59	45.0	+24	36	09	386.9	Gem
Jan	6	08	53	09.9	+20	45	32	391.2	Cnc
Jan	7	09	42	30.0	+16	03	24	395.3	Leo
Jan	8	10	28	25.1	+10	48	10	398.9	Leo
Jan	9	11	11	53.4	+05	14	44	401.8	Leo
Jan	10	11	53	59.7	-00	25	04	403.6	Vir
Jan	11	12	35	49.7	-06	01	30	404.3	Vir
Jan	12	13	18	28.9	-11	25	34	403.7	Vir
Jan	13	14	03	01.1	-16	27	32	401.7	Vir
Jan	14	14	50	25.6	-20	55	48	398.6	Lib
Jan	15	15	41	28.4	-24	35	57	394.5	Lib
Jan	16	16	36	27.8	-27	10	58	389.7	Sco
Jan	17	17	34	55.9	-28	23	17	384.7	Oph
Jan	18	18	35	31.6	-27	58	54	379.7	Sgr
Jan	19	19	36	20.0	-25	52	15	375.2	Sgr
Jan	20	20	35	33.6	-22	08	56	371.5	Cap
Jan	21	21	32	10.2	-17	04	31	368.8	Cap
Jan	22	22	26	03.6	-11	00	41	367.3	Aqr
Jan	23	23	17	51.3	-04	21	18	367.0	Aqr
Jan	24	00	08	35.8	+02	30	10	367.6	Psc
Jan	25	00	59	29.4	+09	11	30	369.0	Psc
Jan	26	01	51	42.4	+15	21	38	371.0	Ari
Jan	27	02	46	11.2	+20	40	12	373.4	Ari
Jan	28	03	43	22.7	+24	47	52	376.1	Tau
Jan	29	04	42	57.0	+27	27	51	378.9	Tau
Jan	30	05	43	41.1	+28	29	12	381.9	Tau
Jan	31	06	43	45.7	+27	49	56	385.1	Gem
February	**1**	**07**	**41**	**25.3**	**+25**	**38**	**03**	**388.4**	**Gem**
Feb	2	08	35	32.9	+22	08	56	391.7	Cnc
Feb	3	09	25	52.4	+17	41	22	395.0	Leo
Feb	4	10	12	47.6	+12	33	45	398.2	Leo
Feb	5	10	57	05.1	+07	02	16	401.0	Leo
Feb	6	11	39	42.1	+01	20	27	403.2	Vir
Feb	7	12	21	38.8	-04	20	27	404.6	Vir
Feb	8	13	03	55.6	-09	50	29	404.9	Vir
Feb	9	13	47	32.4	-14	59	58	404.2	Vir
Feb	10	14	33	26.4	-19	38	23	402.2	Lib
Feb	11	15	22	26.8	-23	33	23	399.0	Lib
Feb	12	16	15	04.3	-26	30	29	394.6	Sco
Feb	13	17	11	16.5	-28	13	39	389.4	Oph
Feb	14	18	10	15.7	-28	27	56	383.6	Sgr
Feb	15	19	10	32.9	-27	03	19	377.7	Sgr
Feb	16	20	10	25.2	-23	58	30	372.2	Cap
Feb	17	21	08	33.4	-19	22	22	367.4	Cap
Feb	18	22	04	25.1	-13	32	32	363.9	Aqr
Feb	19	22	58	15.5	-06	52	20	361.9	Aqr
Feb	20	23	50	52.5	+00	12	14	361.5	Psc
Feb	21	00	43	20.3	+07	14	40	362.7	Psc
Feb	22	01	36	45.3	+13	49	30	365.2	Psc
Feb	23	02	32	02.0	+19	33	06	368.6	Ari
Feb	24	03	29	37.7	+24	04	31	372.7	Tau
Feb	25	04	29	16.3	+27	07	00	377.1	Tau
Feb	26	05	29	53.0	+28	30	23	381.4	Tau
Feb	27	06	29	49.2	+28	13	07	385.6	Aur
Feb	28	07	27	27.2	+26	22	42	389.5	Gem
March	**1**	**08**	**21**	**43.4**	**+23**	**13**	**13**	**393.1**	**Cnc**
Mar	2	09	12	19.5	+19	01	56	396.3	Cnc
Mar	3	09	59	35.0	+14	06	06	399.1	Leo
Mar	4	10	44	12.2	+08	41	27	401.5	Leo
Mar	5	11	27	03.6	+03	01	41	403.5	Leo
Mar	6	12	09	05.0	-02	41	15	405.0	Vir
Mar	7	12	51	12.3	-08	16	28	405.7	Vir
Mar	8	13	34	20.3	-13	33	35	405.7	Vir
Mar	9	14	19	20.7	-18	21	52	404.8	Vir
Mar	10	15	06	58.7	-22	29	36	402.8	Lib
Mar	11	15	57	45.0	-25	43	47	399.7	Sco
Mar	12	16	51	45.2	-27	50	25	395.5	Sco
Mar	13	17	48	29.7	-28	36	05	390.4	Sgr
Mar	14	18	46	53.5	-27	50	25	384.5	Sgr
Mar	15	19	45	33.1	-25	29	02	378.3	Sgr
Mar	16	20	43	14.7	-21	35	12	372.1	Cap
Mar	17	21	39	18.4	-16	19	58	366.5	Cap
Mar	18	22	33	45.9	-10	00	54	362.0	Aqr
Mar	19	23	27	13.3	-03	00	44	359.0	Psc
Mar	20	00	20	38.0	+04	14	13	357.8	Psc
Mar	21	01	15	04.7	+11	15	26	358.6	Psc
Mar	22	02	11	29.9	+17	34	12	361.1	Ari
Mar	23	03	10	24.1	+22	43	47	365.1	Ari
Mar	24	04	11	32.1	+26	22	33	370.1	Tau
Mar	25	05	13	44.3	+28	17	13	375.6	Tau
Mar	26	06	15	12.6	+28	25	21	381.2	Aur
Mar	27	07	14	09.3	+26	55	12	386.6	Gem
Mar	28	08	09	25.2	+24	02	14	391.4	Cnc
Mar	29	09	00	42.0	+20	04	44	395.7	Cnc
Mar	30	09	48	22.4	+15	20	17	399.2	Leo
Mar	31	10	33	12.4	+10	04	21	401.9	Leo
April	**1**	**11**	**16**	**07.5**	**+04**	**30**	**08**	**404.0**	**Leo**
Apr	2	11	58	05.1	-01	10	49	405.4	Vir
Apr	3	12	40	01.6	-06	47	46	406.2	Vir
Apr	4	13	22	50.8	-12	10	07	406.3	Vir
Apr	5	14	07	22.3	-17	06	47	405.7	Vir
Apr	6	14	54	18.4	-21	25	47	404.5	Lib
Apr	7	15	44	07.2	-24	54	09	402.4	Lib
Apr	8	16	36	53.4	-27	18	28	399.5	Sco
Apr	9	17	32	10.4	-28	26	20	395.7	Oph
Apr	10	18	29	00.2	-28	08	22	391.1	Sgr
Apr	11	19	26	08.3	-26	20	19	385.7	Sgr
Apr	12	20	22	27.8	-23	04	07	379.9	Cap
Apr	13	21	17	20.8	-18	27	37	373.9	Cap
Apr	14	22	10	46.9	-12	43	37	368.2	Aqr
Apr	15	23	03	18.9	-06	09	08	363.3	Aqr
Apr	16	23	55	52.6	+00	54	46	359.5	Psc
Apr	17	00	49	35.7	+08	02	56	357.5	Psc
Apr	18	01	45	34.1	+14	46	37	357.3	Psc
Apr	19	02	44	34.1	+20	35	13	359.1	Ari
Apr	20	03	46	37.4	+25	00	08	362.7	Tau
Apr	21	04	50	41.0	+27	39	60	367.6	Tau
Apr	22	05	54	43.5	+28	25	58	373.4	Tau
Apr	23	06	56	27.6	+27	23	32	379.6	Gem
Apr	24	07	54	14.3	+24	49	06	385.7	Gem
Apr	25	08	47	28.9	+21	03	42	391.3	Cnc
Apr	26	09	36	30.5	+16	27	36	396.1	Leo
Apr	27	10	22	09.5	+11	17	57	400.0	Leo
Apr	28	11	05	28.2	+05	48	29	403.0	Leo
Apr	29	11	47	30.4	+00	10	32	404.9	Vir
Apr	30	12	29	17.8	-05	25	51	406.0	Vir
May	**1**	**13**	**11**	**48.3**	**-10**	**50**	**42**	**406.2**	**Vir**
May	2	13	55	55.1	-15	53	23	405.7	Vir

GEOCENTRIC POSITION OF MOON (continued)

MONTH	DAY	RA h	RA m	RA s	DECLINATION °	DECLINATION ′	DECLINATION ″	DISTANCE (1,000km)	CONST.
May	3	14	42	23.1	-20	21	56	404.5	Lib
May	4	15	31	42.9	-24	03	05	402.8	Lib
May	5	16	24	00.9	-26	42	55	400.4	Sco
May	6	17	18	50.7	-28	08	30	397.5	Oph
May	7	18	15	12.5	-28	10	15	394.1	Sgr
May	8	19	11	47.9	-26	44	07	390.1	Sgr
May	9	20	07	25.3	-23	52	28	385.6	Sgr
May	10	21	01	22.7	-19	43	15	380.7	Cap
May	11	21	53	36.6	-14	28	21	375.7	Cap
May	12	22	44	37.9	-08	22	16	370.7	Aqr
May	13	23	35	22.1	-01	41	49	366.2	Psc
May	14	00	26	59.4	+05	13	10	362.6	Psc
May	15	01	20	44.4	+11	59	02	360.2	Psc
May	16	02	17	42.5	+18	08	05	359.4	Ari
May	17	03	18	26.4	+23	10	14	360.3	Ari
May	18	04	22	27.6	+26	37	38	363.0	Tau
May	19	05	28	00.4	+28	11	42	367.2	Tau
May	20	06	32	28.9	+27	49	09	372.6	Gem
May	21	07	33	30.3	+25	42	17	378.5	Gem
May	22	08	29	48.1	+22	12	55	384.6	Cnc
May	23	09	21	17.8	+17	44	43	390.4	Cnc
May	24	10	08	43.1	+12	38	21	395.5	Leo
May	25	10	53	08.9	+07	10	03	399.7	Leo
May	26	11	35	45.2	+01	32	15	402.8	Leo
May	27	12	17	40.1	-04	04	53	404.7	Vir
May	28	12	59	57.5	-09	32	06	405.5	Vir
May	29	13	43	36.8	-14	39	42	405.2	Vir
May	30	14	29	30.1	-19	16	37	404.1	Lib
May	31	15	18	16.1	-23	10	01	402.2	Lib
June	**1**	**16**	**10**	**10.5**	**-26**	**05**	**38**	**399.8**	**Sco**
Jun	2	17	04	54.6	-27	49	21	397.0	Oph
Jun	3	18	01	30.8	-28	09	53	393.8	Sgr
Jun	4	18	58	34.6	-27	01	43	390.5	Sgr
Jun	5	19	54	41.6	-24	26	37	387.0	Sgr
Jun	6	20	48	55.6	-20	33	06	383.3	Cap
Jun	7	21	41	01.9	-15	34	06	379.6	Cap
Jun	8	22	31	24.5	-09	44	49	375.8	Aqr
Jun	9	23	20	55.1	-03	21	31	372.2	Aqr
Jun	10	00	10	42.1	+03	18	23	369.0	Psc
Jun	11	01	02	02.0	+09	55	20	366.3	Psc
Jun	12	01	56	09.4	+16	06	39	364.5	Ari
Jun	13	02	53	59.9	+21	26	14	363.8	Ari
Jun	14	03	55	44.4	+25	26	42	364.4	Tau
Jun	15	05	00	21.6	+27	44	24	366.4	Tau
Jun	16	06	05	36.8	+28	06	50	369.8	Aur
Jun	17	07	08	48.9	+26	37	18	374.2	Gem
Jun	18	08	07	56.5	+23	33	05	379.4	Cnc
Jun	19	09	02	13.6	+19	18	12	384.9	Cnc
Jun	20	09	51	59.2	+14	16	24	390.3	Leo
Jun	21	10	38	09.0	+08	47	26	395.2	Leo
Jun	22	11	21	52.3	+03	06	28	399.3	Leo
Jun	23	12	04	19.7	-02	34	53	402.3	Vir
Jun	24	12	46	39.3	-08	07	02	404.0	Vir
Jun	25	13	29	55.1	-13	20	51	404.6	Vir
Jun	26	14	15	05.1	-18	06	27	403.9	Vir
Jun	27	15	02	57.6	-22	12	14	402.2	Lib
Jun	28	15	54	01.8	-25	24	39	399.6	Sco
Jun	29	16	48	15.2	-27	29	10	396.4	Sco
Jun	30	17	44	54.3	-28	12	35	392.8	Sgr
July	**1**	**18**	**42**	**38.7**	**-27**	**26**	**24**	**389.1**	**Sgr**
Jul	2	19	39	54.4	-25	09	42	385.5	Sgr

MONTH	DAY	RA h	RA m	RA s	DECLINATION °	DECLINATION ′	DECLINATION ″	DISTANCE (1,000km)	CONST.
Jul	3	20	35	26.5	-21	29	33	382.0	Cap
Jul	4	21	28	41.1	-16	39	19	378.9	Cap
Jul	5	22	19	47.8	-10	55	47	376.1	Aqr
Jul	6	23	09	28.8	-04	37	00	373.7	Aqr
Jul	7	23	58	47.0	+01	58	39	371.7	Psc
Jul	8	00	48	55.4	+08	32	15	370.1	Psc
Jul	9	01	41	08.4	+14	43	30	369.0	Psc
Jul	10	02	36	29.2	+20	10	06	368.5	Ari
Jul	11	03	35	30.3	+24	28	09	368.7	Tau
Jul	12	04	37	47.9	+27	14	60	369.8	Tau
Jul	13	05	41	48.0	+28	14	36	371.7	Tau
Jul	14	06	45	08.1	+27	23	09	374.6	Gem
Jul	15	07	45	32.7	+24	50	46	378.2	Gem
Jul	16	08	41	42.5	+20	57	31	382.5	Cnc
Jul	17	09	33	25.6	+16	06	56	387.2	Leo
Jul	18	10	21	17.6	+10	40	50	391.8	Leo
Jul	19	11	06	18.0	+04	57	10	396.1	Leo
Jul	20	11	49	33.6	-00	50	01	399.7	Vir
Jul	21	12	32	11.2	-06	29	35	402.4	Vir
Jul	22	13	15	14.8	-11	51	57	403.9	Vir
Jul	23	13	59	44.5	-16	47	40	404.1	Vir
Jul	24	14	46	33.0	-21	06	20	403.1	Lib
Jul	25	15	36	19.6	-24	35	53	400.9	Lib
Jul	26	16	29	18.8	-27	02	42	397.7	Sco
Jul	27	17	25	08.6	-28	13	06	393.6	Oph
Jul	28	18	22	46.9	-27	56	07	389.2	Sgr
Jul	29	19	20	45.2	-26	06	47	384.6	Sgr
Jul	30	20	17	38.0	-22	48	16	380.2	Cap
Jul	31	21	12	31.7	-18	11	31	376.4	Cap
August	**1**	**22**	**05**	**15.7**	**-12**	**33**	**02**	**373.2**	**Aqr**
Aug	2	22	56	17.5	-06	12	28	370.9	Aqr
Aug	3	23	46	30.1	+00	29	26	369.5	Psc
Aug	4	00	37	00.2	+07	11	30	368.9	Psc
Aug	5	01	28	57.8	+13	32	18	369.0	Psc
Aug	6	02	23	24.8	+19	10	00	369.7	Ari
Aug	7	03	20	59.1	+23	42	33	371.0	Ari
Aug	8	04	21	33.4	+26	49	26	372.6	Tau
Aug	9	05	24	00.9	+28	15	14	374.8	Tau
Aug	10	06	26	25.3	+27	54	03	377.3	Gem
Aug	11	07	26	41.9	+25	51	42	380.3	Gem
Aug	12	08	23	23.6	+22	23	52	383.6	Cnc
Aug	13	09	16	00.8	+17	51	18	387.2	Cnc
Aug	14	10	04	52.6	+12	35	09	391.0	Leo
Aug	15	10	50	46.4	+06	54	15	394.8	Leo
Aug	16	11	34	41.3	+01	04	19	398.3	Leo
Aug	17	12	17	39.0	-04	41	48	401.2	Vir
Aug	18	13	00	39.9	-10	13	09	403.4	Vir
Aug	19	13	44	41.0	-15	19	43	404.5	Vir
Aug	20	14	30	34.1	-19	51	26	404.5	Lib
Aug	21	15	19	00.7	-23	37	17	403.2	Lib
Aug	22	16	10	24.1	-26	25	07	400.7	Sco
Aug	23	17	04	39.2	-28	02	17	397.0	Oph
Aug	24	18	01	05.6	-28	17	24	392.4	Sgr
Aug	25	18	58	33.1	-27	02	59	387.1	Sgr
Aug	26	19	55	42.3	-24	17	53	381.6	Sgr
Aug	27	20	51	31.5	-20	08	18	376.3	Cap
Aug	28	21	45	34.6	-14	47	05	371.6	Cap
Aug	29	22	38	03.4	-08	32	09	367.9	Aqr
Aug	30	23	29	39.0	-01	44	49	365.4	Psc
Aug	31	00	21	20.3	+05	11	28	364.2	Psc
September	**1**	**01**	**14**	**12.5**	**+11**	**52**	**10**	**364.4**	**Psc**

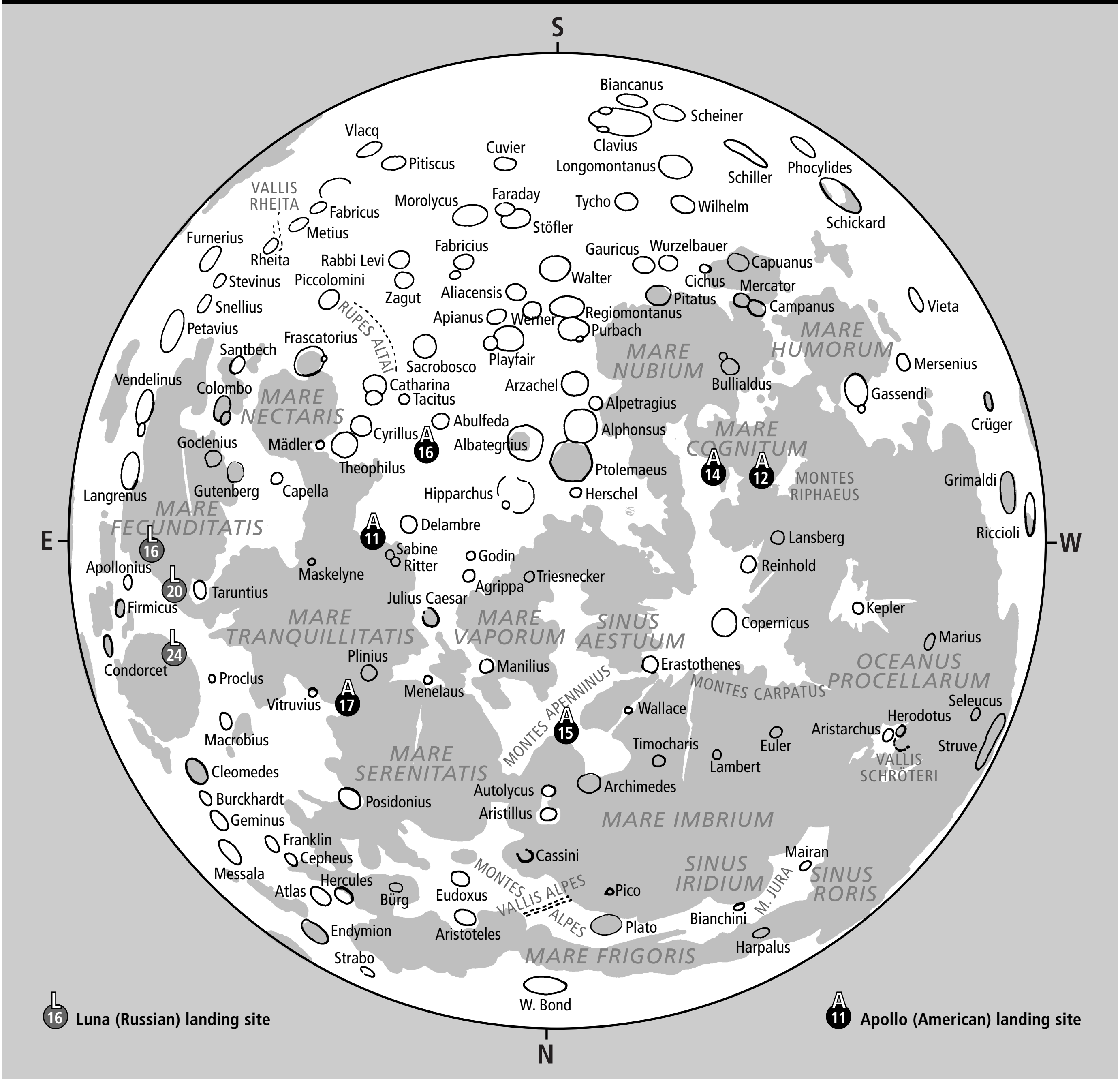
GEOCENTRIC POSITION OF MOON (continued)

Note: positions refer to 0000 WAST

MONTH	DAY	RA			DECLINATION			DISTANCE	CONST.
		h	m	s	°	′	″	(1,000km)	
Sep	2	02	09	15.0	+17	52	24	365.8	Ari
Sep	3	03	07	04.5	+22	48	10	368.1	Ari
Sep	4	04	07	36.5	+26	18	18	371.0	Tau
Sep	5	05	09	51.0	+28	07	38	374.4	Tau
Sep	6	06	12	01.6	+28	10	28	378.0	Aur
Sep	7	07	12	12.0	+26	32	02	381.6	Gem
Sep	8	08	08	58.0	+23	26	36	385.2	Cnc
Sep	9	09	01	48.3	+19	13	09	388.8	Cnc
Sep	10	09	50	57.7	+14	11	24	392.2	Leo
Sep	11	10	37	08.9	+08	39	23	395.5	Leo
Sep	12	11	21	17.3	+02	52	46	398.5	Leo
Sep	13	12	04	20.9	-02	55	03	401.2	Vir
Sep	14	12	47	16.6	-08	32	14	403.4	Vir
Sep	15	13	30	57.9	-13	47	52	404.9	Vir
Sep	16	14	16	12.7	-18	31	19	405.6	Vir
Sep	17	15	03	40.1	-22	31	38	405.3	Lib
Sep	18	15	53	43.9	-25	37	24	403.9	Sco
Sep	19	16	46	24.6	-27	37	05	401.3	Sco
Sep	20	17	41	13.7	-28	20	15	397.5	Oph
Sep	21	18	37	16.5	-27	39	16	392.7	Sgr
Sep	22	19	33	26.4	-25	31	12	387.1	Sgr
Sep	23	20	28	46.6	-21	58	43	381.0	Cap
Sep	24	21	22	47.6	-17	10	04	374.9	Cap
Sep	25	22	15	33.3	-11	18	30	369.2	Aqr
Sep	26	23	07	37.1	-04	41	38	364.5	Aqr
Sep	27	23	59	52.8	+02	18	49	361.2	Psc
Sep	28	00	53	24.1	+09	17	30	359.6	Psc
Sep	29	01	49	12.5	+15	46	24	359.7	Ari
Sep	30	02	47	59.3	+21	16	49	361.5	Ari
October	**1**	**03**	**49**	**43.0**	**+25**	**22**	**30**	**364.7**	**Tau**
Oct	2	04	53	21.9	+27	44	18	368.9	Tau
Oct	3	05	57	00.9	+28	14	26	373.7	Tau
Oct	4	06	58	31.1	+26	58	09	378.7	Gem
Oct	5	07	56	19.6	+24	10	49	383.6	Gem
Oct	6	08	49	52.3	+20	12	36	388.3	Cnc
Oct	7	09	39	26.1	+15	23	41	392.4	Leo
Oct	8	10	25	47.9	+10	01	52	396.1	Leo
Oct	9	11	09	56.4	+04	22	12	399.2	Leo
Oct	10	11	52	52.2	-01	22	26	401.8	Vir
Oct	11	12	35	33.4	-07	00	32	403.9	Vir
Oct	12	13	18	53.6	-12	21	05	405.4	Vir
Oct	13	14	03	40.1	-17	13	05	406.3	Vir
Oct	14	14	50	30.5	-21	25	08	406.5	Lib
Oct	15	15	39	47.0	-24	45	33	405.9	Lib
Oct	16	16	31	29.7	-27	02	54	404.3	Sco
Oct	17	17	25	11.5	-28	07	15	401.8	Oph
Oct	18	18	20	01.2	-27	51	35	398.3	Sgr
Oct	19	19	14	57.0	-26	13	13	393.7	Sgr
Oct	20	20	09	05.6	-23	14	13	388.3	Cap
Oct	21	21	01	58.9	-19	00	56	382.2	Cap
Oct	22	21	53	39.9	-13	43	16	375.9	Cap
Oct	23	22	44	40.2	-07	34	13	369.8	Aqr
Oct	24	23	35	52.7	-00	50	22	364.3	Psc
Oct	25	00	28	24.2	+06	07	24	360.0	Psc
Oct	26	01	23	24.6	+12	53	12	357.4	Psc
Oct	27	02	21	51.5	+18	56	49	356.8	Ari
Oct	28	03	24	04.6	+23	46	34	358.1	Ari
Oct	29	04	29	16.8	+26	54	58	361.2	Tau
Oct	30	05	35	26.6	+28	06	06	365.8	Tau
Oct	31	06	39	55.2	+27	20	27	371.3	Gem
November	**1**	**07**	**40**	**32.8**	**+24**	**53**	**15**	**377.3**	**Gem**

MONTH	DAY	RA			DECLINATION			DISTANCE	CONST.
		h	m	s	°	′	″	(1,000km)	
Nov	2	08	36	20.9	+21	07	27	383.3	Cnc
Nov	3	09	27	29.1	+16	26	31	388.9	Leo
Nov	4	10	14	47.7	+11	10	34	393.9	Leo
Nov	5	10	59	22.9	+05	35	33	398.0	Leo
Nov	6	11	42	23.1	-00	05	50	401.3	Vir
Nov	7	12	24	52.7	-05	42	43	403.8	Vir
Nov	8	13	07	50.6	-11	04	58	405.5	Vir
Nov	9	13	52	08.6	-16	02	06	406.4	Vir
Nov	10	14	38	28.2	-20	22	54	406.7	Lib
Nov	11	15	27	15.3	-23	55	22	406.3	Lib
Nov	12	16	18	32.0	-26	27	27	405.2	Sco
Nov	13	17	11	51.6	-27	48	29	403.5	Oph
Nov	14	18	06	20.1	-27	51	04	401.0	Sgr
Nov	15	19	00	50.1	-26	32	38	397.8	Sgr
Nov	16	19	54	22.2	-23	55	46	393.8	Sgr
Nov	17	20	46	22.9	-20	07	21	389.1	Cap
Nov	18	21	36	51.4	-15	17	06	383.8	Cap
Nov	19	22	26	16.6	-09	36	31	378.1	Aqr
Nov	20	23	15	30.6	-03	18	50	372.3	Psc
Nov	21	00	05	41.1	+03	20	09	366.9	Psc
Nov	22	00	58	04.3	+10	00	33	362.3	Psc
Nov	23	01	53	54.8	+16	17	12	358.9	Ari
Nov	24	02	54	04.6	+21	39	51	357.3	Ari
Nov	25	03	58	30.8	+25	36	31	357.6	Tau
Nov	26	05	05	44.8	+27	41	03	359.9	Tau
Nov	27	06	13	01.0	+27	42	10	363.8	Gem
Nov	28	07	17	21.9	+25	47	43	369.1	Gem
Nov	29	08	16	53.4	+22	19	57	375.2	Cnc
Nov	30	09	11	09.0	+17	46	07	381.6	Cnc
December	**1**	**10**	**00**	**46.3**	**+12**	**31**	**04**	**387.8**	**Leo**
Dec	2	10	46	53.2	+06	54	23	393.3	Leo
Dec	3	11	30	44.6	+01	10	42	398.0	Leo
Dec	4	12	13	32.9	-04	28	39	401.7	Vir
Dec	5	12	56	24.4	-09	54	02	404.2	Vir
Dec	6	13	40	18.2	-14	56	02	405.7	Vir
Dec	7	14	26	03.8	-19	24	27	406.2	Lib
Dec	8	15	14	16.2	-23	07	54	405.8	Lib
Dec	9	16	05	07.7	-25	54	10	404.7	Sco
Dec	10	16	58	19.3	-27	31	35	403.0	Oph
Dec	11	17	52	59.9	-27	51	11	400.8	Sgr
Dec	12	18	47	56.6	-26	48	57	398.2	Sgr
Dec	13	19	41	58.2	-24	26	53	395.2	Sgr
Dec	14	20	34	16.9	-20	52	21	391.7	Cap
Dec	15	21	24	39.9	-16	16	17	387.9	Cap
Dec	16	22	13	28.0	-10	51	19	383.7	Aqr
Dec	17	23	01	27.2	-04	50	51	379.3	Aqr
Dec	18	23	49	41.1	+01	30	49	374.7	Psc
Dec	19	00	39	24.1	+07	57	32	370.3	Psc
Dec	20	01	31	54.9	+14	09	41	366.4	Psc
Dec	21	02	28	23.4	+19	43	06	363.2	Ari
Dec	22	03	29	26.8	+24	09	26	361.3	Tau
Dec	23	04	34	35.1	+27	00	08	360.9	Tau
Dec	24	05	41	49.6	+27	54	20	362.1	Tau
Dec	25	06	48	11.7	+26	47	19	365.0	Gem
Dec	26	07	50	58.8	+23	52	35	369.3	Gem
Dec	27	08	48	46.5	+19	35	35	374.6	Cnc
Dec	28	09	41	33.1	+14	24	22	380.5	Leo
Dec	29	10	30	09.4	+08	43	27	386.6	Leo
Dec	30	11	15	46.9	+02	51	41	392.2	Leo
Dec	31	11	59	40.6	-02	56	52	397.1	Vir

MAP OF THE MOON



MOON PHASES

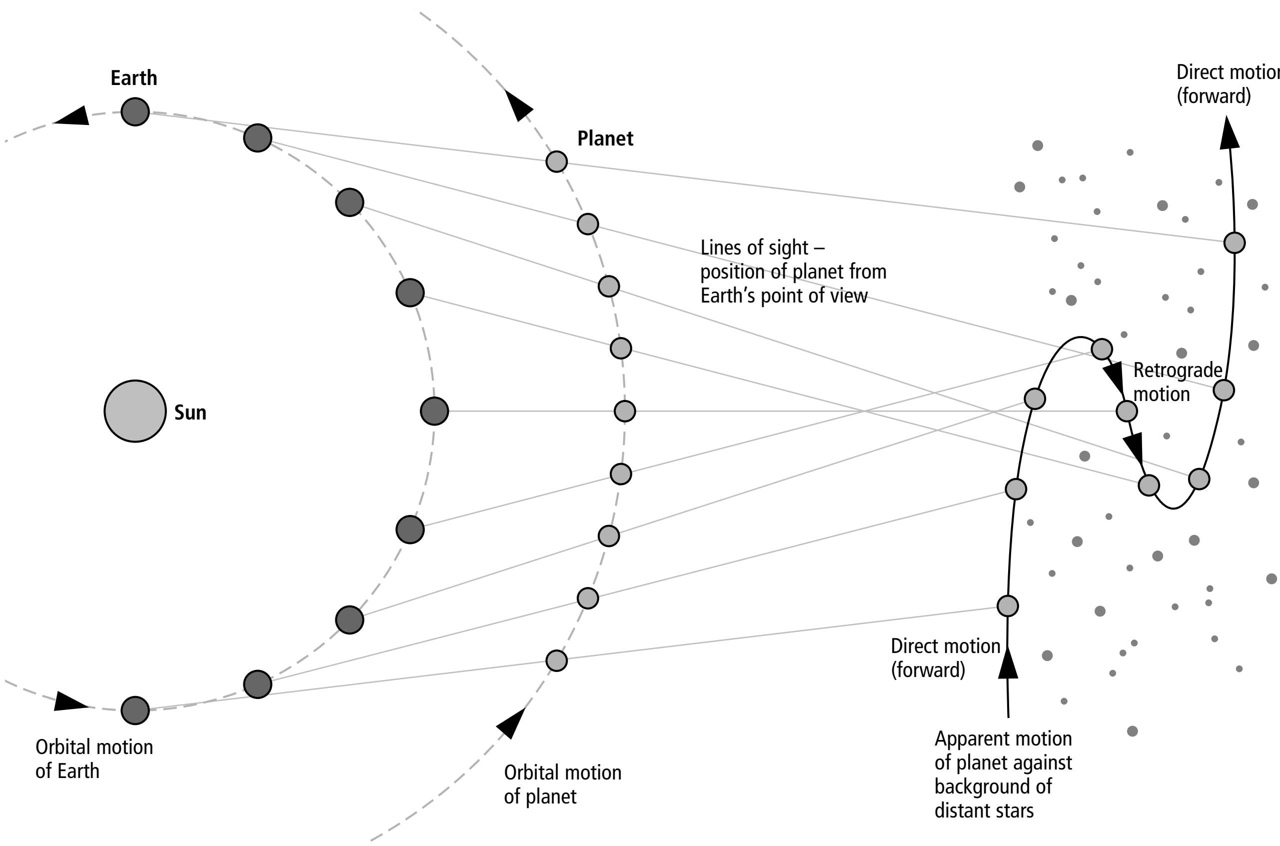
Lunation	NEW MOON Month	d	h m	FIRST QUARTER Month	d	h m	FULL MOON Month	d	h m	LAST QUARTER Month	d	h m
1039							January	3	21 57	January	11	20 44
1040	January	19	12 00	January	26	07 01	February	2	13 45	February	10	17 51
1041	February	18	00 14	February	24	15 56	March	4	07 17	March	12	11 54
1042	March	19	10 42	March	26	02 16	April	3	01 15	April	11	02 04
1043	April	17	19 36	April	24	14 35	May	2	18 09	May	10	12 27
1044	May	17	03 27	May	24	05 02	June	1	09 03	June	8	19 42
1045	June	15	11 13	June	22	21 15	June	30	21 48	July	8	00 53
1046	July	14	20 04	July	22	14 29	July	30	08 48	August	6	05 20
1047	August	13	07 02	August	21	07 54	August	28	18 35	September	4	10 32
1048	September	11	20 44	September	20	00 48	September	27	03 45	October	3	18 06
1049	October	11	13 01	October	19	16 33	October	26	12 51	November	2	05 18
1050	November	10	07 03	November	18	06 32	November	24	22 30	December	1	20 44
1051	December	10	01 40	December	17	18 17	December	24	09 15	December	31	15 51

Moon Facts

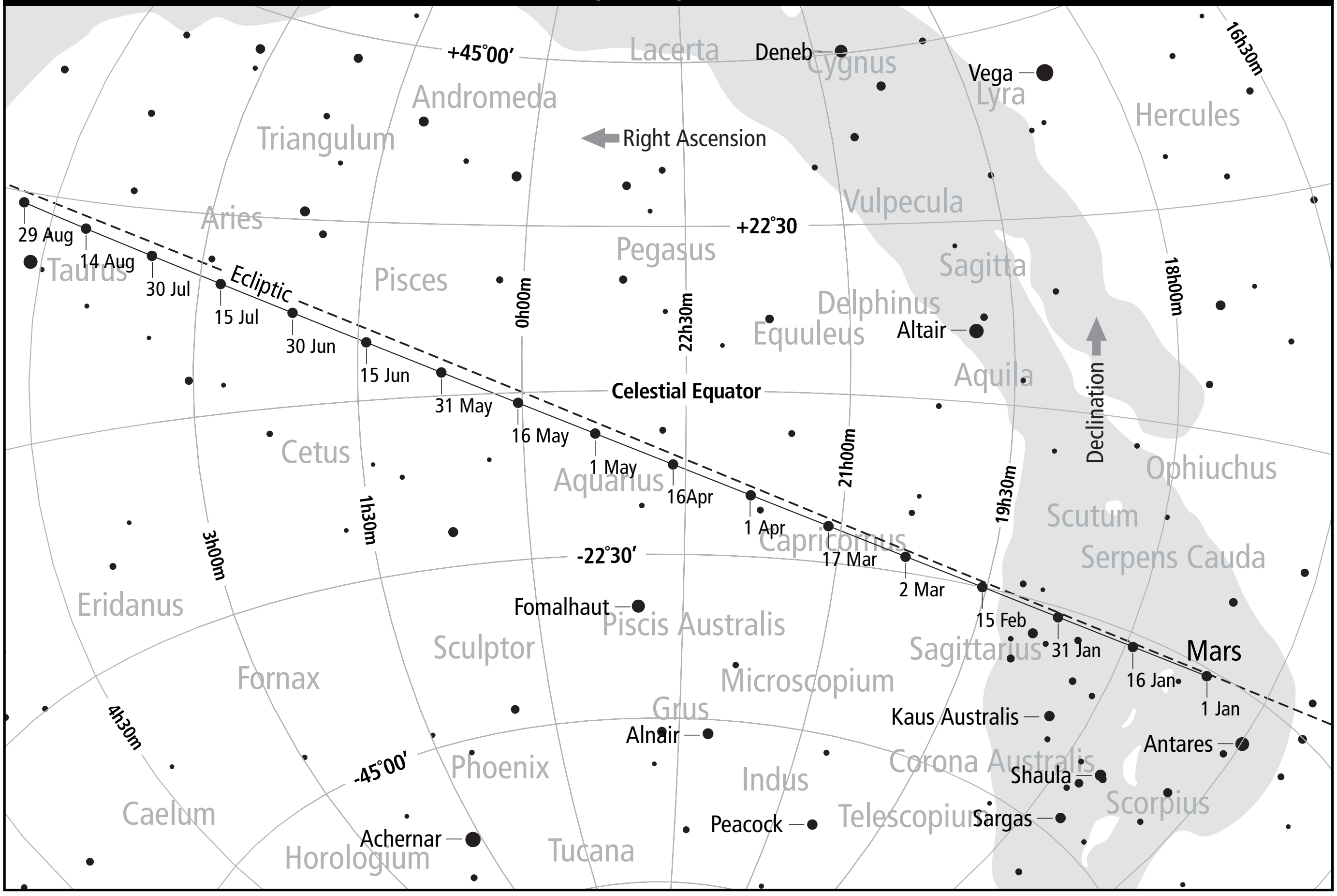
1. The Moon was probably created when an object the size of Mars crashed into Earth, shortly after the Solar System began forming about 4.5 billion years ago.
2. The Moon always shows us the same face. Long ago, the Earth's gravity slowed the Moon's rotation about its axis. Once the Moon's rotation slowed enough to match its orbital period (the time it takes the Moon to go around Earth) the effect steadied. Many of the innermost moons around other planets behave similarly.
3. The Moon's heavily cratered surface is the result of intense bombardment by space rocks between 4.3 billion and 3.8 billion years ago. The craters are scars from this event. They have not changed much because, the Moon is not very geologically active, so earthquakes, volcanoes and mountain-building don't destroy the landscape as they do on Earth, and with virtually no atmosphere there is no wind or rain, so very little erosion occurs.
4. The Moon probably has a small core that is hot and perhaps partially molten, as is Earth's core. It's between 2 and 4 percent of its mass which is tiny compared with Earth, in which the iron core makes up about 30 percent of the planet's mass.
5. Tides on Earth are caused mostly by the Moon (the Sun has a smaller effect). The Moon's gravity pulls on Earth's oceans. High tide aligns with the Moon as Earth spins underneath. Another high tide occurs on the opposite side of the Earth because gravity pulls the Earth toward the Moon more than it pulls the water. At Full Moon and New Moon, the Sun, Earth and Moon are lined up, producing the higher than normal tides (called spring tides, for the way they spring up). When the Moon is at first or last quarter, smaller neap tides form. The Moon's 29.5-day orbit around Earth is not quite circular. When the Moon is closest to Earth (called its perigee), spring tides are even higher, and they're called perigean spring tides. This has another interesting effect: Some of Earth's rotational energy is lost to the Moon, causing our planet to slow down so that the day lengthens by about 1.5 milliseconds every century.
6. The Moon's 29.5-day orbit around Earth is not quite circular. When the Moon is closest to Earth (called its perigee), spring tides are even higher, and they're called perigean spring tides. This has another interesting effect: Some of Earth's rotational energy is lost to the Moon, causing our planet to slow down so that the day lengthens by about 1.5 milliseconds every century.
7. Apollo astronauts used seismometers during their visits to the Moon and discovered small moonquakes originating several kilometres below the surface. They are thought to be caused by the gravitational pull of Earth. Sometimes tiny fractures appear at the surface, and gas escapes.
8. The Moon is moving away from the Earth. Each year, the Moon 'steals' some of Earth's rotational energy, and uses it to propel itself about 38 mm higher in its orbit. When it formed, the Moon was about 22,500 km from Earth, but it's now more than 380,000 km away.
9. The Moon's orbit lies approximately in the same plane as the Earth's about the Sun. At Last Quarter phase the Moon's orbital position is at its furthest ahead of the Earth. The location of the Moon is also within about 5° of the direction that the Earth is heading at that time.

The Wandering Planets

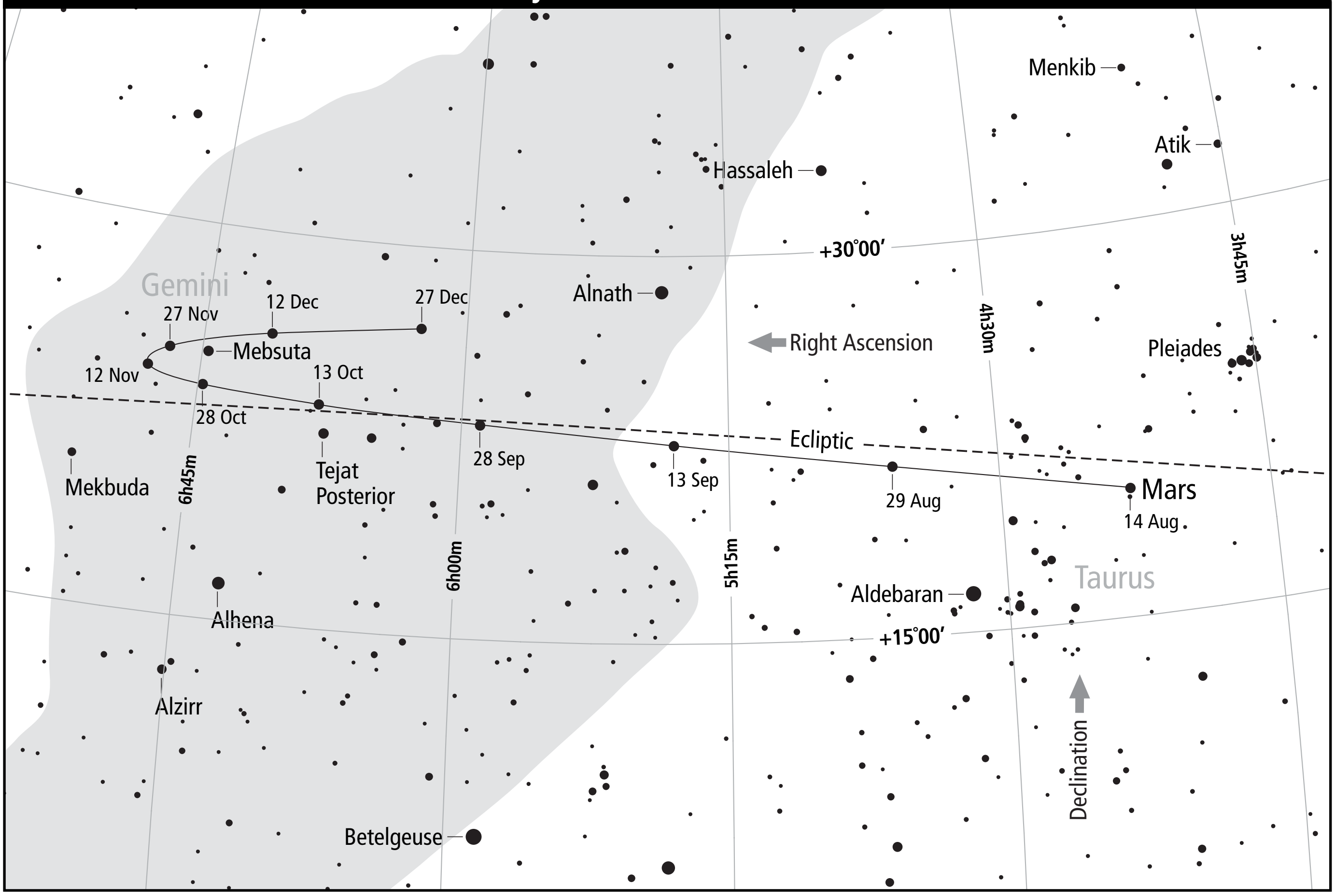
Diagram showing how the sky motion of a planet arises because of its different orbital speed to that of the Earth.



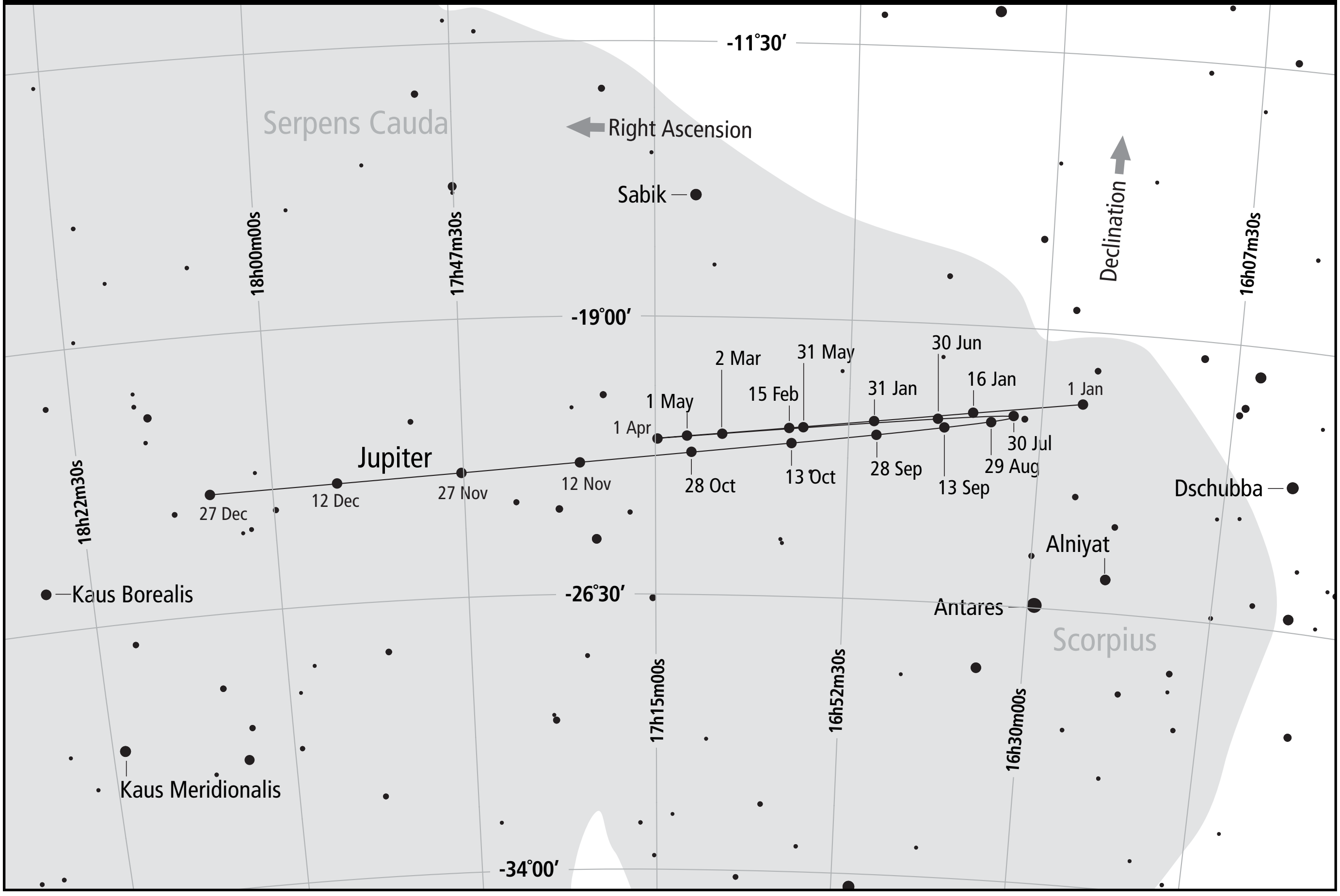
PLANET FINDER: MARS 2007 January-July



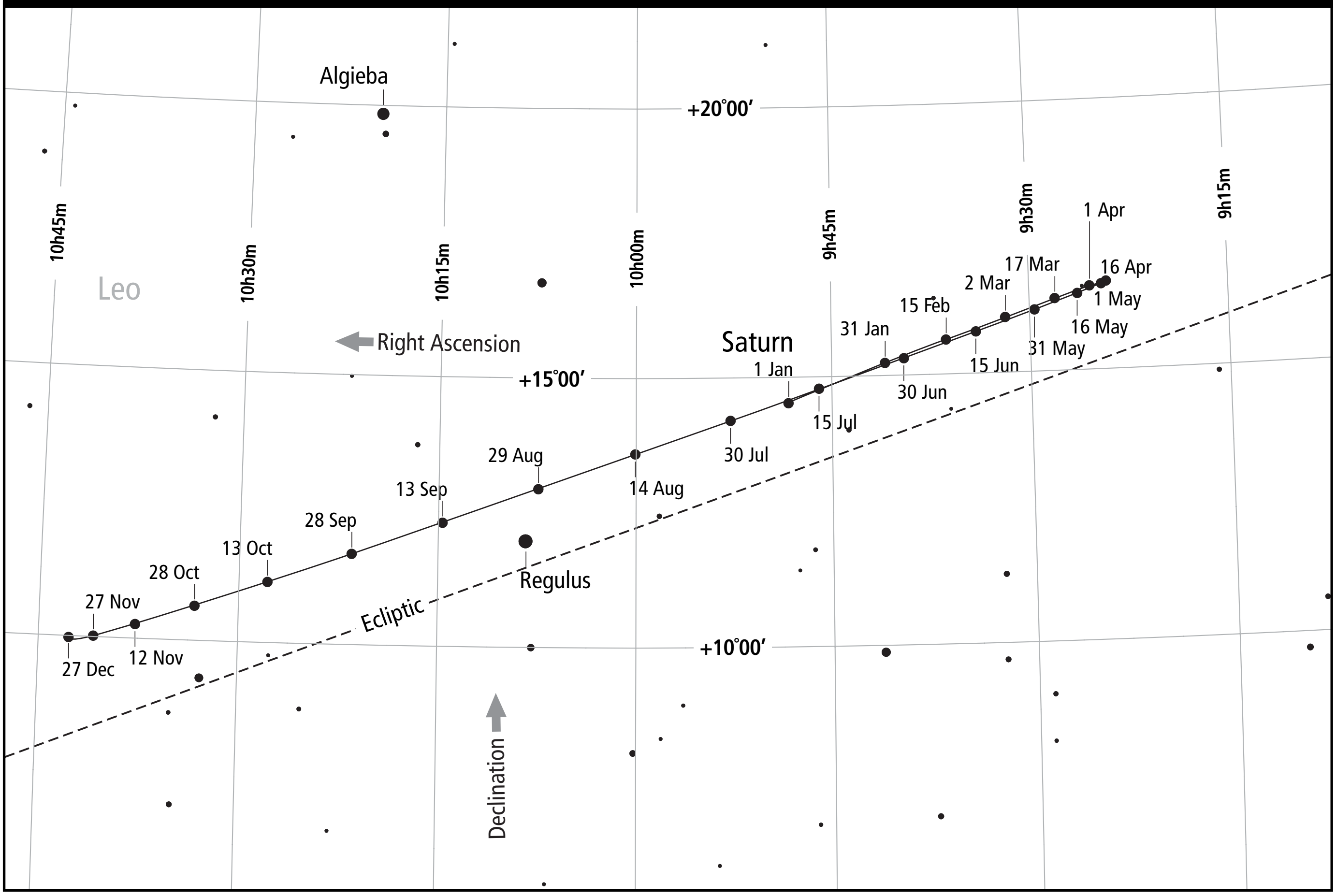
PLANET FINDER: MARS 2007 July-December



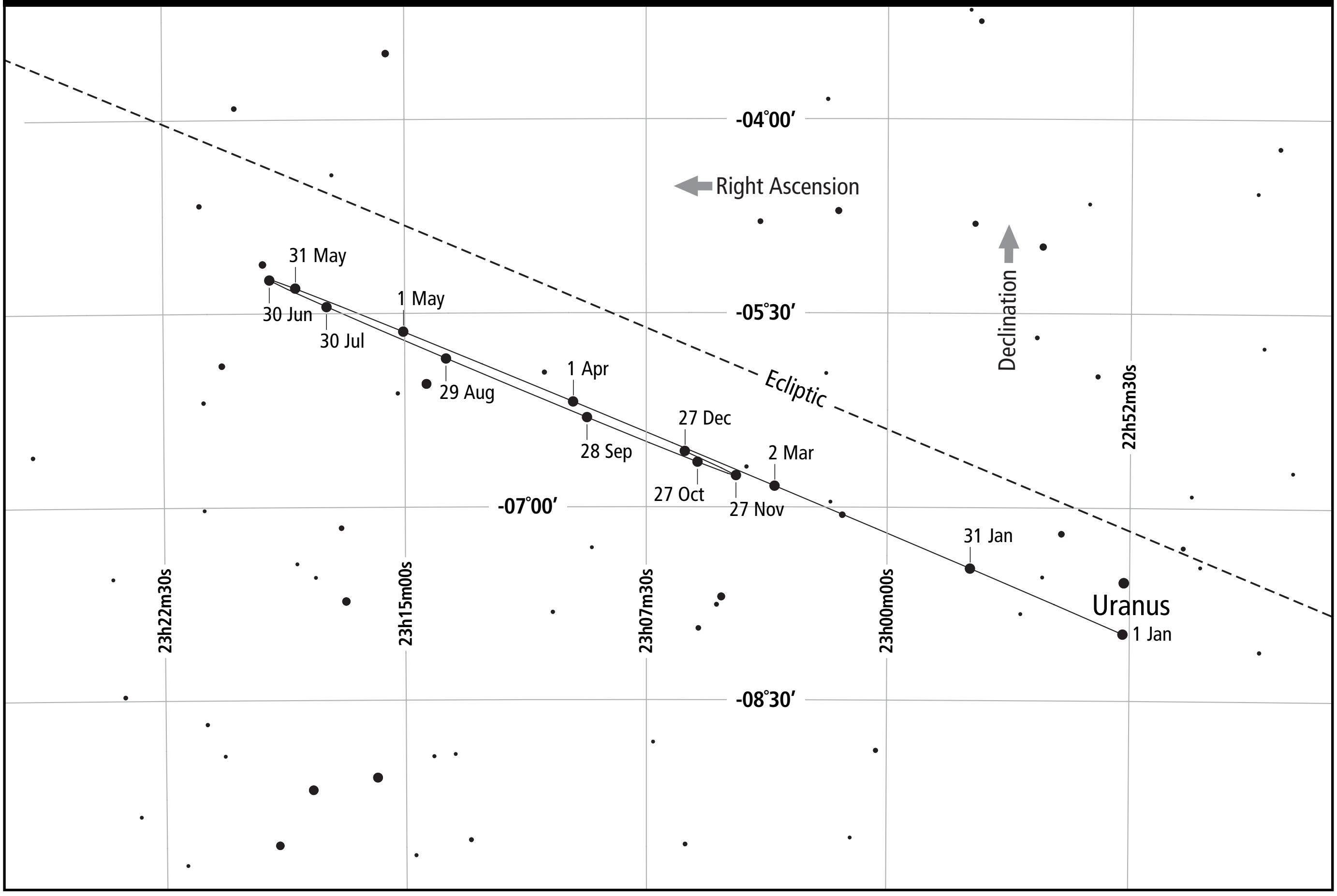
PLANET FINDER: JUPITER 2007



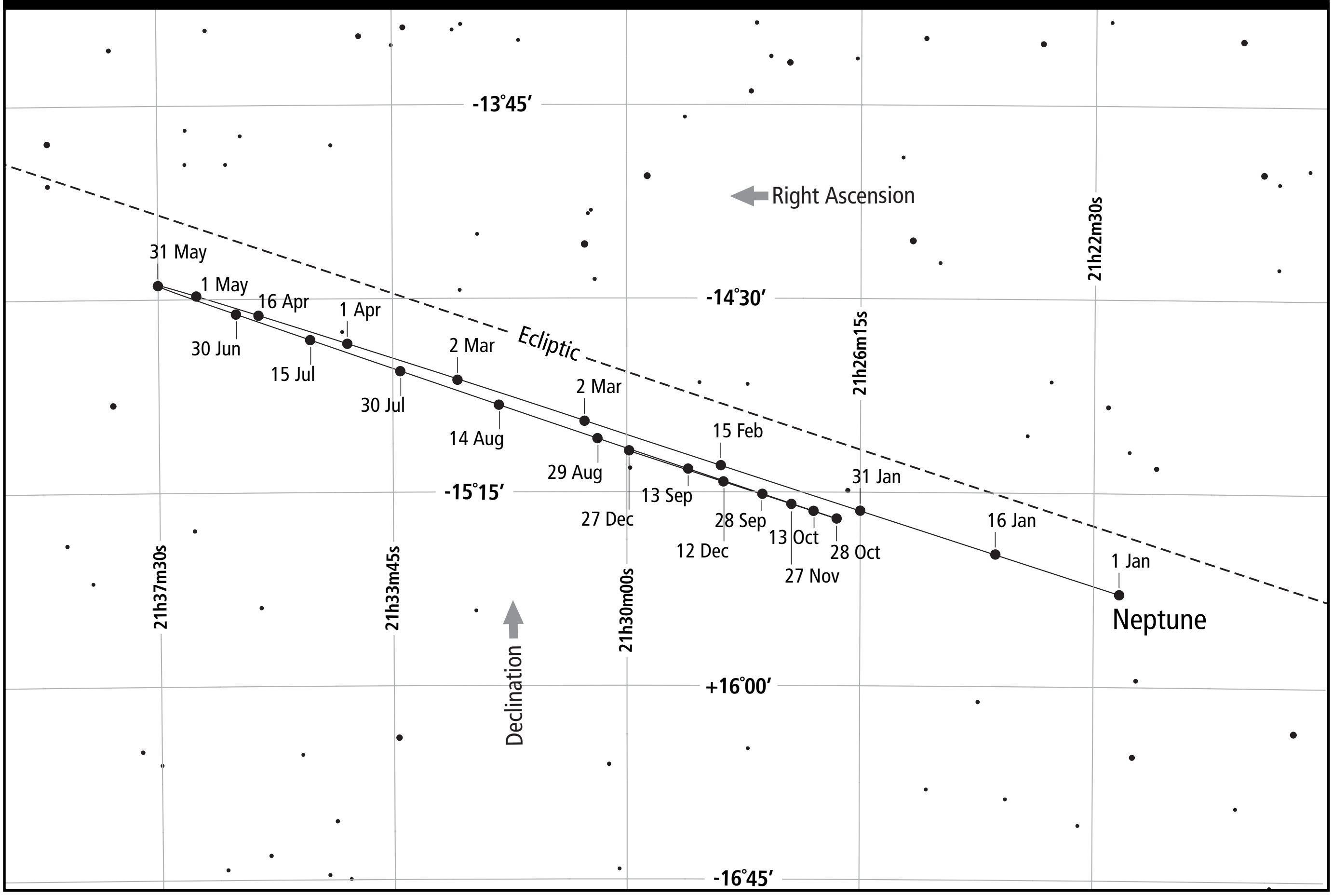
PLANET FINDER: SATURN 2007



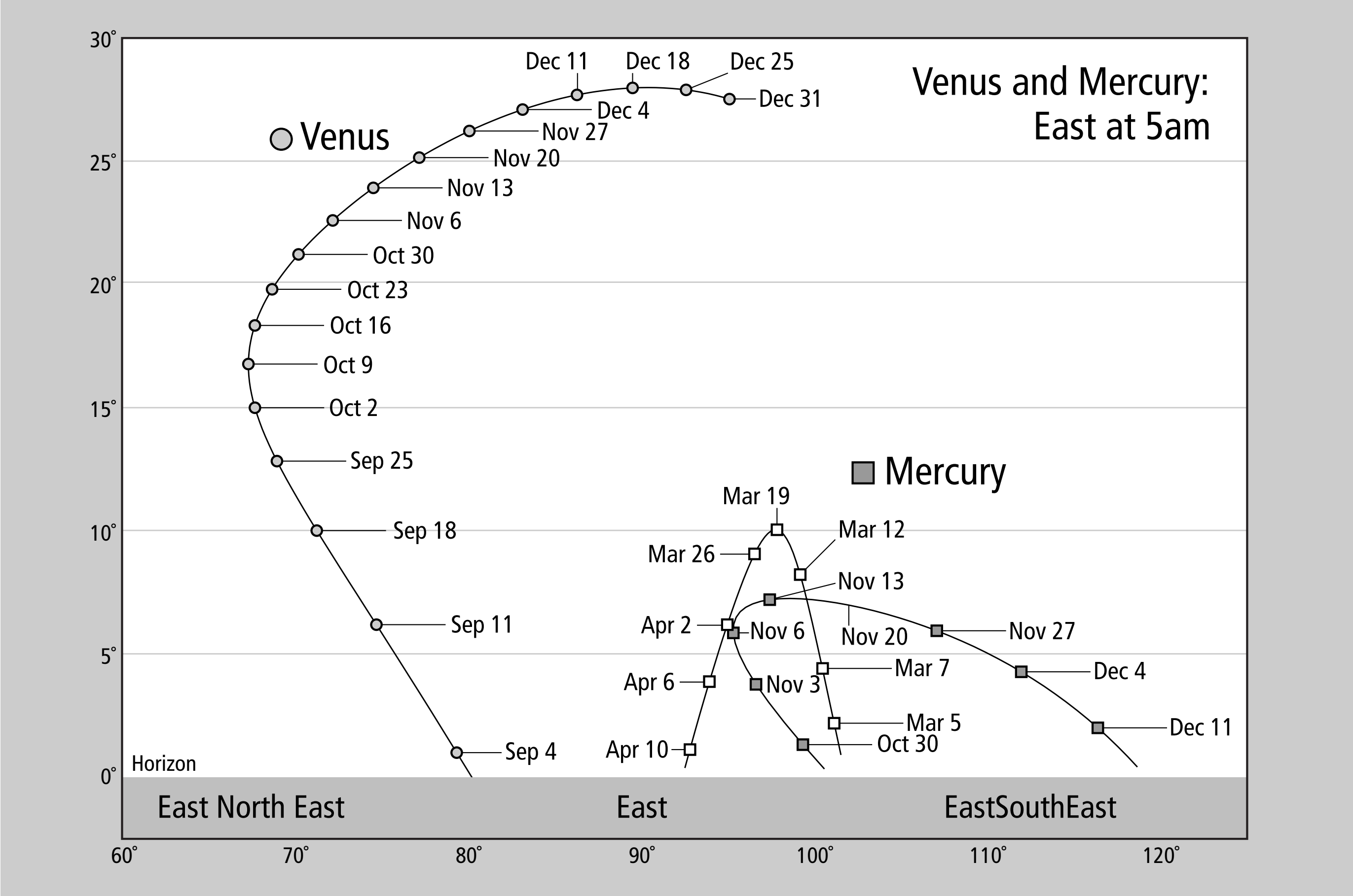
PLANET FINDER: URANUS 2007



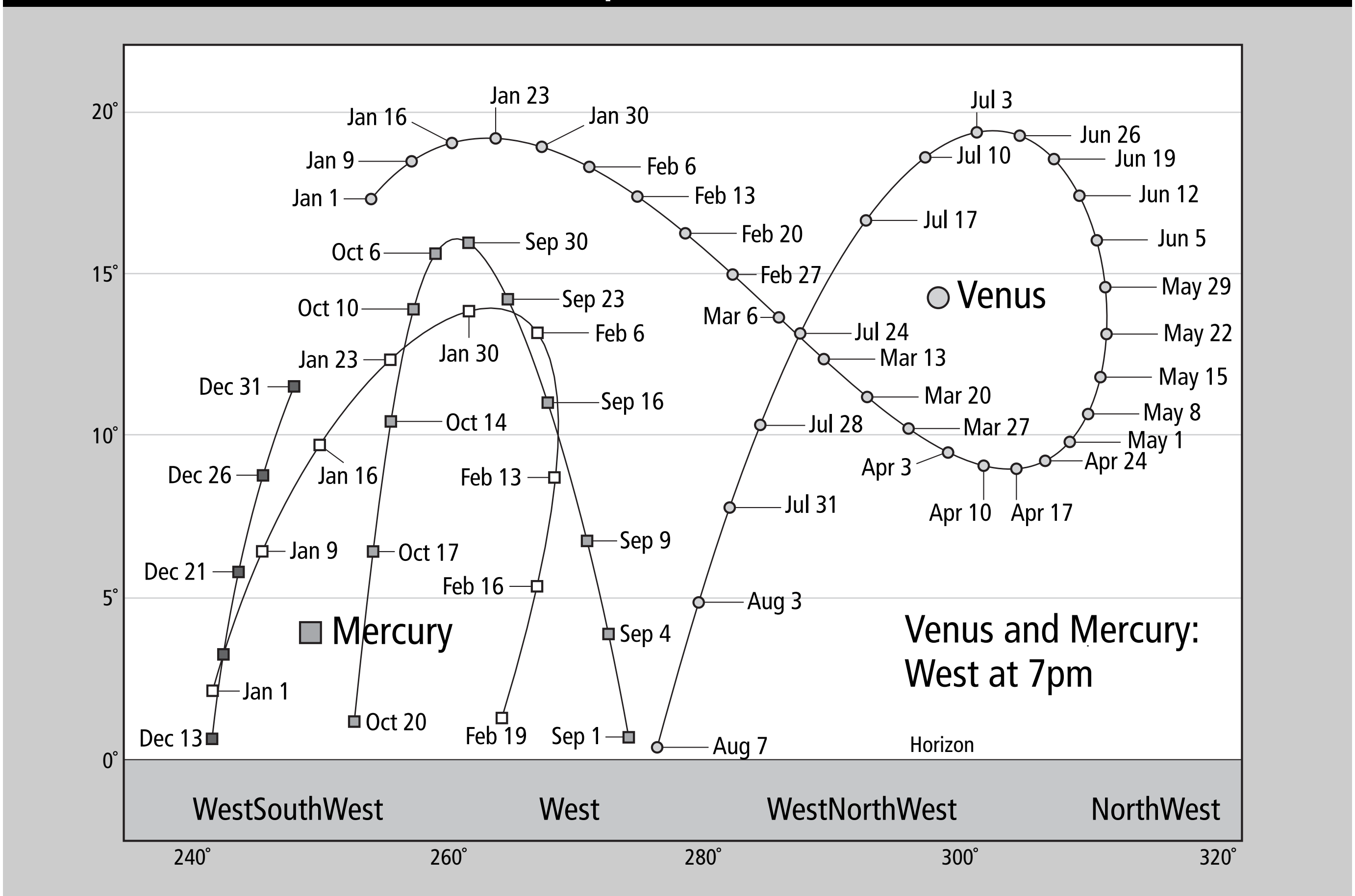
PLANET FINDER: NEPTUNE 2007



VENUS AND MERCURY 2007: EAST 5am



VENUS AND MERCURY 2007: WEST 7pm



GEOCENTRIC PLANET POSITIONS (EPOCH J2000.0) Note: positions refer to 0000 WAST

MTH	DAY	MERCURY RA h m s	MERCURY Declination ° ′ ″	MERCURY Dist. (AU)	MERCURY Cnst.	VENUS RA h m s	VENUS Declination ° ′ ″	VENUS Dist. (AU)	VENUS Cnst.	MARS RA h m s	MARS Declination ° ′ ″	MARS Dist. (AU)	MARS Cnst.	JUPITER RA h m s	JUPITER Declination ° ′ ″	JUPITER Dist. (AU)	JUPITER Cnst.
Jan	1	18 25 56.2	-24 44 34	1.440	Sgr	19 51 07.4	-22 20 04	1.623	Sgr	17 08 07.1	-23 12 10	2.38	Oph	16 25 32.8	-20 57 32	6.18	Oph
Jan	2	18 32 56.1	-24 44 25	1.441	Sgr	19 56 27.4	-22 07 08	1.620	Sgr	17 11 15.1	-23 16 34	2.38	Oph	16 26 24.8	-20 59 30	6.17	Oph
Jan	3	18 39 57.3	-24 42 50	1.441	Sgr	20 01 46.4	-21 53 32	1.617	Sgr	17 14 23.5	-23 20 44	2.38	Oph	16 27 16.7	-21 01 27	6.16	Oph
Jan	4	18 46 59.6	-24 39 51	1.440	Sgr	20 07 04.2	-21 39 18	1.614	Sgr	17 17 32.3	-23 24 42	2.37	Oph	16 28 08.3	-21 03 22	6.15	Oph
Jan	5	18 54 03.0	-24 35 25	1.439	Sgr	20 12 21.0	-21 24 25	1.612	Cap	17 20 41.4	-23 28 25	2.37	Oph	16 28 59.7	-21 05 15	6.14	Oph
Jan	6	19 01 07.3	-24 29 32	1.437	Sgr	20 17 36.5	-21 08 54	1.609	Cap	17 23 50.9	-23 31 54	2.36	Oph	16 29 50.8	-21 07 06	6.13	Oph
Jan	7	19 08 12.4	-24 22 10	1.435	Sgr	20 22 50.9	-20 52 45	1.606	Cap	17 27 00.8	-23 35 10	2.36	Oph	16 30 41.8	-21 08 56	6.12	Oph
Jan	8	19 15 18.2	-24 13 19	1.432	Sgr	20 28 04.0	-20 35 60	1.603	Cap	17 30 11.0	-23 38 11	2.35	Oph	16 31 32.4	-21 10 45	6.11	Oph
Jan	9	19 22 24.6	-24 02 58	1.429	Sgr	20 33 15.9	-20 18 39	1.600	Cap	17 33 21.5	-23 40 58	2.35	Oph	16 32 22.9	-21 12 32	6.10	Oph
Jan	10	19 29 31.4	-23 51 07	1.425	Sgr	20 38 26.6	-20 00 42	1.597	Cap	17 36 32.3	-23 43 32	2.34	Oph	16 33 13.1	-21 14 17	6.09	Oph
Jan	11	19 36 38.4	-23 37 44	1.420	Sgr	20 43 36.0	-19 42 11	1.594	Cap	17 39 43.4	-23 45 50	2.34	Oph	16 34 03.0	-21 16 00	6.08	Oph
Jan	12	19 43 45.6	-23 22 48	1.415	Sgr	20 48 44.1	-19 23 05	1.591	Cap	17 42 54.9	-23 47 55	2.33	Oph	16 34 52.6	-21 17 42	6.07	Oph
Jan	13	19 50 52.8	-23 06 21	1.409	Sgr	20 53 50.9	-19 03 26	1.588	Cap	17 46 06.6	-23 49 45	2.33	Sgr	16 35 42.0	-21 19 23	6.06	Oph
Jan	14	19 57 59.8	-22 48 20	1.402	Sgr	20 58 56.4	-18 43 15	1.585	Cap	17 49 18.5	-23 51 21	2.33	Sgr	16 36 31.1	-21 21 01	6.05	Oph
Jan	15	20 05 06.3	-22 28 46	1.395	Sgr	21 04 00.6	-18 22 32	1.582	Cap	17 52 30.7	-23 52 42	2.32	Sgr	16 37 19.9	-21 22 39	6.04	Oph
Jan	16	20 12 12.2	-22 07 38	1.386	Cap	21 09 03.5	-18 01 17	1.578	Cap	17 55 43.2	-23 53 48	2.32	Sgr	16 38 08.3	-21 24 14	6.03	Oph
Jan	17	20 19 17.3	-21 44 58	1.378	Cap	21 14 05.1	-17 39 32	1.575	Cap	17 58 55.9	-23 54 40	2.31	Sgr	16 38 56.5	-21 25 48	6.01	Oph
Jan	18	20 26 21.3	-21 20 43	1.368	Cap	21 19 05.3	-17 17 18	1.572	Cap	18 02 08.7	-23 55 17	2.31	Sgr	16 39 44.4	-21 27 20	6.00	Oph
Jan	19	20 33 24.0	-20 54 56	1.357	Cap	21 24 04.2	-16 54 35	1.569	Cap	18 05 21.8	-23 55 39	2.30	Sgr	16 40 31.9	-21 28 51	5.99	Oph
Jan	20	20 40 25.0	-20 27 37	1.346	Cap	21 29 01.8	-16 31 23	1.565	Cap	18 08 35.1	-23 55 47	2.30	Sgr	16 41 19.1	-21 30 20	5.98	Oph
Jan	21	20 47 23.9	-19 58 47	1.334	Cap	21 33 58.2	-16 07 44	1.562	Cap	18 11 48.5	-23 55 39	2.29	Sgr	16 42 05.9	-21 31 48	5.97	Oph
Jan	22	20 54 20.4	-19 28 27	1.321	Cap	21 38 53.2	-15 43 39	1.558	Cap	18 15 02.1	-23 55 17	2.29	Sgr	16 42 52.4	-21 33 14	5.95	Oph
Jan	23	21 01 14.1	-18 56 40	1.307	Cap	21 43 46.9	-15 19 08	1.555	Cap	18 18 15.8	-23 54 40	2.28	Sgr	16 43 38.5	-21 34 38	5.94	Oph
Jan	24	21 08 04.3	-18 23 27	1.292	Cap	21 48 39.3	-14 54 12	1.551	Cap	18 21 29.6	-23 53 48	2.28	Sgr	16 44 24.3	-21 36 01	5.93	Oph
Jan	25	21 14 50.6	-17 48 52	1.277	Cap	21 53 30.5	-14 28 52	1.548	Cap	18 24 43.5	-23 52 41	2.27	Sgr	16 45 09.7	-21 37 22	5.92	Oph
Jan	26	21 21 32.2	-17 12 58	1.260	Cap	21 58 20.4	-14 03 09	1.544	Cap	18 27 57.6	-23 51 19	2.27	Sgr	16 45 54.7	-21 38 42	5.90	Oph
Jan	27	21 28 08.5	-16 35 50	1.242	Cap	22 03 09.1	-13 37 03	1.541	Aqr	18 31 11.7	-23 49 42	2.26	Sgr	16 46 39.3	-21 39 60	5.89	Oph
Jan	28	21 34 38.4	-15 57 34	1.223	Cap	22 07 56.6	-13 10 36	1.537	Aqr	18 34 25.8	-23 47 50	2.26	Sgr	16 47 23.6	-21 41 16	5.88	Oph
Jan	29	21 41 01.1	-15 18 17	1.203	Cap	22 12 42.9	-12 43 47	1.533	Aqr	18 37 40.0	-23 45 44	2.25	Sgr	16 48 07.4	-21 42 31	5.86	Oph
Jan	30	21 47 15.4	-14 38 05	1.183	Cap	22 17 28.1	-12 16 39	1.530	Aqr	18 40 54.3	-23 43 22	2.25	Sgr	16 48 50.8	-21 43 45	5.85	Oph
Jan	31	21 53 19.9	-13 57 10	1.161	Cap	22 22 12.1	-11 49 11	1.526	Aqr	18 44 08.6	-23 40 45	2.24	Sgr	16 49 33.8	-21 44 57	5.84	Oph
Feb	1	21 59 13.3	-13 15 41	1.138	Aqr	22 26 55.0	-11 21 25	1.522	Aqr	18 47 22.9	-23 37 54	2.24	Sgr	16 50 16.4	-21 46 08	5.82	Oph
Feb	2	22 04 53.8	-12 33 52	1.114	Aqr	22 31 36.8	-10 53 21	1.518	Aqr	18 50 37.3	-23 34 47	2.23	Sgr	16 50 58.5	-21 47 17	5.81	Oph
Feb	3	22 10 19.7	-11 51 57	1.089	Aqr	22 36 17.6	-10 25 00	1.514	Aqr	18 53 51.6	-23 31 26	2.23	Sgr	16 51 40.2	-21 48 24	5.79	Oph
Feb	4	22 15 29.0	-11 10 13	1.063	Aqr	22 40 57.4	-09 56 23	1.510	Aqr	18 57 05.9	-23 27 50	2.22	Sgr	16 52 21.5	-21 49 31	5.78	Oph
Feb	5	22 20 19.4	-10 28 59	1.037	Aqr	22 45 36.2	-09 27 31	1.506	Aqr	19 00 20.2	-23 23 58	2.22	Sgr	16 53 02.3	-21 50 35	5.77	Oph
Feb	6	22 24 48.7	-09 48 36	1.010	Aqr	22 50 14.1	-08 58 23	1.502	Aqr	19 03 34.5	-23 19 52	2.21	Sgr	16 53 42.7	-21 51 38	5.75	Oph
Feb	7	22 28 54.4	-09 09 25	0.982	Aqr	22 54 51.1	-08 29 02	1.498	Aqr	19 06 48.7	-23 15 32	2.21	Sgr	16 54 22.5	-21 52 40	5.74	Oph
Feb	8	22 32 33.9	-08 31 51	0.954	Aqr	22 59 27.2	-07 59 28	1.494	Aqr	19 10 02.8	-23 10 56	2.20	Sgr	16 55 02.0	-21 53 41	5.72	Oph
Feb	9	22 35 44.9	-07 56 20	0.926	Aqr	23 04 02.5	-07 29 41	1.490	Aqr	19 13 16.9	-23 06 06	2.20	Sgr	16 55 40.9	-21 54 40	5.71	Oph
Feb	10	22 38 24.7	-07 23 17	0.898	Aqr	23 08 37.0	-06 59 42	1.486	Aqr	19 16 30.9	-23 01 01	2.19	Sgr	16 56 19.3	-21 55 37	5.69	Oph
Feb	11	22 40 31.2	-06 53 08	0.870	Aqr	23 13 10.7	-06 29 33	1.482	Aqr	19 19 44.8	-22 55 41	2.19	Sgr	16 56 57.3	-21 56 33	5.68	Oph
Feb	12	22 42 02.2	-06 26 20	0.843	Aqr	23 17 43.7	-05 59 14	1.477	Aqr	19 22 58.6	-22 50 07	2.18	Sgr	16 57 34.7	-21 57 28	5.66	Oph
Feb	13	22 42 56.3	-06 03 17	0.817	Aqr	23 22 16.1	-05 28 45	1.473	Aqr	19 26 12.3	-22 44 18	2.18	Sgr	16 58 11.6	-21 58 22	5.65	Oph
Feb	14	22 43 12.3	-05 44 21	0.791	Aqr	23 26 47.8	-04 58 07	1.469	Aqr	19 29 25.8	-22 38 14	2.17	Sgr	16 58 48.0	-21 59 14	5.63	Oph
Feb	15	22 42 49.9	-05 29 51	0.767	Aqr	23 31 18.9	-04 27 22	1.464	Aqr	19 32 39.2	-22 31 57	2.16	Sgr	16 59 23.8	-22 00 04	5.62	Oph
Feb	16	22 41 49.3	-05 20 00	0.745	Aqr	23 35 49.4	-03 56 29	1.460	Aqr	19 35 52.4	-22 25 25	2.16	Sgr	16 59 59.1	-22 00 54	5.60	Oph
Feb	17	22 40 11.8	-05 14 59	0.724	Aqr	23 40 19.5	-03 25 30	1.456	Aqr	19 39 05.5	-22 18 38	2.15	Sgr	17 00 33.9	-22 01 42	5.59	Oph
Feb	18	22 37 59.6	-05 14 49	0.705	Aqr	23 44 49.0	-02 54 26	1.451	Psc	19 42 18.3	-22 11 38	2.15	Sgr	17 01 08.1	-22 02 28	5.57	Oph
Feb	19	22 35 15.8	-05 19 27	0.688	Aqr	23 49 18.2	-02 23 17	1.447	Psc	19 45 31.0	-22 04 23	2.14	Sgr	17 01 41.7	-22 03 14	5.56	Oph
Feb	20	22 32 04.6	-05 28 41	0.673	Aqr	23 53 46.9	-01 52 03	1.442	Psc	19 48 43.4	-21 56 55	2.14	Sgr	17 02 14.8	-22 03 58	5.54	Oph
Feb	21	22 28 30.8	-05 42 10	0.661	Aqr	23 58 15.3	-01 20 47	1.437	Psc	19 51 55.6	-21 49 13	2.13	Sgr	17 02 47.2	-22 04 41	5.53	Oph
Feb	22	22 24 40.0	-05 59 29	0.651	Aqr	00 02 43.3	-00 49 28	1.433	Psc	19 55 07.6	-21 41 17	2.13	Sgr	17 03 19.1	-22 05 22	5.51	Oph
Feb	23	22 20 38.2	-06 20 06	0.643	Aqr	00 07 11.0	-00 18 07	1.428	Psc	19 58 19.4	-21 33 07	2.12	Sgr	17 03 50.4	-22 06 03	5.49	Oph
Feb	24	22 16 31.7	-06 43 24	0.637	Aqr	00 11 38.5	+00 13 16	1.423	Psc	20 01 30.9	-21 24 44	2.12	Sgr	17 04 21.1	-22 06 42	5.48	Oph
Feb	25	22 12 26.5	-07 08 43	0.634	Aqr	00 16 05.8	+00 44 38	1.419	Psc	20 04 42.1	-21 16 07	2.11	Sgr	17 04 51.1	-22 07 20	5.46	Oph
Feb	26	22 08 28.4	-07 35 23	0.632	Aqr	00 20 33.0	+01 15 60	1.414	Psc	20 07 53.1	-21 07 17	2.11	Cap	17 05 20.6	-22 07 56	5.45	Oph
Feb	27	22 04 42.6	-08 02 47	0.633	Aqr	00 24 60.0	+01 47 20	1.409	Psc	20 11 03.8	-20 58 14	2.10	Cap	17 05 49.4	-22 08 32	5.43	Oph
Feb	28	22 01 13.6	-08 30 19	0.636	Aqr	00 29 26.9	+02 18 39	1.404	Cet	20 14 14.2	-20 48 58	2.10	Cap	17 06 17.6	-22 09 06	5.41	Oph
Mar	1	21 58 05.1	-08 57 25	0.640	Cap	00 33 53.7	+02 49 55	1.399	Psc	20 17 24.3	-20 39 29	2.09	Cap	17 06 45.1	-22 09 39	5.40	Oph
Mar	2	21 55 19.8	-09 23 40	0.646	Cap	00 38 20.6	+03 21 07	1.394	Psc	20 20 34.1	-20 29 46	2.09	Cap	17 07 12.0	-22 10 12	5.38	Oph
Mar	3	21 52 59.8	-09 48 39	0.653	Cap	00 42 47.5	+03 52 16	1.389	Psc	20 23 43.7	-20 19 51	2.08	Cap	17 07 38.3	-22 10 42	5.37	Oph
Mar	4	21 51 06.3	-10 12 05	0.662	Cap	00 47 14.4	+04 23 19	1.384	Psc	20 26 52.9	-20 09 44	2.08	Cap	17 08 03.9	-22 11 12	5.35	Oph
Mar	5	21 49 39.9	-10 33 44	0.672	Cap	00 51 41.5	+04 54 17	1.379	Psc	20 30 01.9	-19 59 24	2.07	Cap	17 08 28.8	-22 11 41	5.33	Oph
Mar	6	21 48 40.6	-10 53 26	0.682	Cap	00 56 08.8	+05 25 09	1.374	Psc	20 33 10.5	-19 48 51	2.06	Cap	17 08 53.1	-22 12 09	5.32	Oph
Mar	7	21 48 08.0	-11 11 05	0.693	Cap	01 00 36.2	+05 55 54	1.368	Psc	20 36 18.8	-19 38 06	2.06	Cap	17 09 16.7	-22 12 35	5.30	Oph
Mar	8	21 48 01.4	-11 26 35	0.706	Cap	01 05 03.9	+06 26 31	1.363	Psc	20 39 26.8	-19 27 09	2.05	Cap	17 09 39.6	-22 13 01	5.28	Oph

GEOCENTRIC PLANET POSITIONS (continued) Note: positions refer to 0000 WAST

MTH	DAY	MERCURY				VENUS				MARS				JUPITER			
		RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.	RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.	RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.	RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.
Mar	9	21 48 19.8	-11 39 56	0.718	Cap	01 09 31.8	+06 57 00	1.358	Psc	20 42 34.5	-19 16 00	2.05	Cap	17 10 01.8	-22 13 25	5.27	Oph
Mar	10	21 49 02.0	-11 51 06	0.732	Cap	01 14 00.1	+07 27 20	1.353	Psc	20 45 41.9	-19 04 40	2.04	Cap	17 10 23.3	-22 13 49	5.25	Oph
Mar	11	21 50 06.7	-12 00 06	0.745	Cap	01 18 28.7	+07 57 30	1.347	Psc	20 48 48.9	-18 53 07	2.04	Cap	17 10 44.2	-22 14 11	5.24	Oph
Mar	12	21 51 32.7	-12 06 59	0.759	Cap	01 22 57.7	+08 27 30	1.342	Psc	20 51 55.6	-18 41 23	2.03	Cap	17 11 04.3	-22 14 32	5.22	Oph
Mar	13	21 53 18.5	-12 11 45	0.773	Cap	01 27 27.2	+08 57 18	1.336	Psc	20 55 02.0	-18 29 27	2.03	Cap	17 11 23.6	-22 14 53	5.20	Oph
Mar	14	21 55 22.9	-12 14 28	0.788	Cap	01 31 57.1	+09 26 54	1.331	Psc	20 58 08.0	-18 17 20	2.02	Cap	17 11 42.3	-22 15 12	5.19	Oph
Mar	15	21 57 44.6	-12 15 10	0.802	Cap	01 36 27.5	+09 56 18	1.325	Psc	21 01 13.6	-18 05 02	2.02	Cap	17 12 00.2	-22 15 30	5.17	Oph
Mar	16	22 00 22.3	-12 13 55	0.817	Aqr	01 40 58.4	+10 25 28	1.320	Psc	21 04 19.0	-17 52 34	2.01	Cap	17 12 17.4	-22 15 48	5.15	Oph
Mar	17	22 03 15.0	-12 10 46	0.832	Aqr	01 45 29.9	+10 54 25	1.314	Psc	21 07 23.9	-17 39 54	2.01	Cap	17 12 33.8	-22 16 04	5.14	Oph
Mar	18	22 06 21.4	-12 05 45	0.847	Aqr	01 50 01.9	+11 23 06	1.309	Ari	21 10 28.5	-17 27 04	2.00	Cap	17 12 49.5	-22 16 20	5.12	Oph
Mar	19	22 09 40.7	-11 58 56	0.861	Aqr	01 54 34.6	+11 51 32	1.303	Ari	21 13 32.7	-17 14 03	2.00	Cap	17 13 04.4	-22 16 34	5.11	Oph
Mar	20	22 13 11.8	-11 50 21	0.876	Aqr	01 59 08.0	+12 19 41	1.297	Ari	21 16 36.6	-17 00 52	1.99	Cap	17 13 18.6	-22 16 48	5.09	Oph
Mar	21	22 16 53.9	-11 40 04	0.891	Aqr	02 03 42.0	+12 47 34	1.291	Ari	21 19 40.1	-16 47 31	1.99	Cap	17 13 31.9	-22 17 00	5.07	Oph
Mar	22	22 20 46.3	-11 28 06	0.906	Aqr	02 08 16.7	+13 15 08	1.286	Ari	21 22 43.2	-16 33 60	1.98	Cap	17 13 44.5	-22 17 12	5.06	Oph
Mar	23	22 24 48.1	-11 14 31	0.920	Aqr	02 12 52.1	+13 42 24	1.280	Ari	21 25 45.9	-16 20 19	1.98	Cap	17 13 56.4	-22 17 23	5.04	Oph
Mar	24	22 28 58.7	-10 59 21	0.935	Aqr	02 17 28.2	+14 09 21	1.274	Ari	21 28 48.2	-16 06 29	1.97	Cap	17 14 07.4	-22 17 33	5.03	Oph
Mar	25	22 33 17.5	-10 42 38	0.949	Aqr	02 22 05.1	+14 35 58	1.268	Ari	21 31 50.2	-15 52 30	1.96	Cap	17 14 17.7	-22 17 42	5.01	Oph
Mar	26	22 37 44.0	-10 24 23	0.964	Aqr	02 26 42.8	+15 02 14	1.262	Ari	21 34 51.8	-15 38 21	1.96	Cap	17 14 27.2	-22 17 50	5.00	Oph
Mar	27	22 42 17.7	-10 04 41	0.978	Aqr	02 31 21.2	+15 28 08	1.256	Ari	21 37 53.0	-15 24 03	1.95	Cap	17 14 35.9	-22 17 57	4.98	Oph
Mar	28	22 46 58.1	-09 43 31	0.992	Aqr	02 36 00.4	+15 53 40	1.250	Ari	21 40 53.9	-15 09 37	1.95	Cap	17 14 43.8	-22 18 04	4.96	Oph
Mar	29	22 51 45.0	-09 20 56	1.006	Aqr	02 40 40.4	+16 18 49	1.244	Ari	21 43 54.4	-14 55 01	1.94	Cap	17 14 50.9	-22 18 09	4.95	Oph
Mar	30	22 56 37.8	-08 56 58	1.020	Aqr	02 45 21.2	+16 43 35	1.237	Ari	21 46 54.5	-14 40 18	1.94	Cap	17 14 57.2	-22 18 14	4.93	Oph
Mar	31	23 01 36.4	-08 31 39	1.034	Aqr	02 50 02.9	+17 07 56	1.231	Ari	21 49 54.2	-14 25 25	1.93	Cap	17 15 02.7	-22 18 18	4.92	Oph
Apr	1	23 06 40.5	-08 04 59	1.048	Aqr	02 54 45.3	+17 31 53	1.225	Ari	21 52 53.6	-14 10 25	1.93	Cap	17 15 07.5	-22 18 21	4.90	Oph
Apr	2	23 11 49.9	-07 37 01	1.061	Aqr	02 59 28.6	+17 55 23	1.219	Ari	21 55 52.7	-13 55 17	1.92	Cap	17 15 11.4	-22 18 24	4.89	Oph
Apr	3	23 17 04.3	-07 07 47	1.075	Aqr	03 04 12.8	+18 18 28	1.212	Ari	21 58 51.4	-13 40 00	1.92	Aqr	17 15 14.5	-22 18 25	4.87	Oph
Apr	4	23 22 23.6	-06 37 17	1.088	Aqr	03 08 57.8	+18 41 05	1.206	Ari	22 01 49.7	-13 24 36	1.91	Aqr	17 15 16.8	-22 18 26	4.86	Oph
Apr	5	23 27 47.7	-06 05 32	1.101	Aqr	03 13 43.7	+19 03 15	1.199	Ari	22 04 47.7	-13 09 05	1.91	Aqr	17 15 18.3	-22 18 26	4.84	Oph
Apr	6	23 33 16.6	-05 32 36	1.114	Aqr	03 18 30.4	+19 24 57	1.193	Ari	22 07 45.3	-12 53 26	1.90	Aqr	17 15 19.0	-22 18 25	4.83	Oph
Apr	7	23 38 50.1	-04 58 28	1.127	Aqr	03 23 17.9	+19 46 09	1.186	Ari	22 10 42.7	-12 37 40	1.90	Aqr	17 15 18.9	-22 18 23	4.81	Oph
Apr	8	23 44 28.2	-04 23 10	1.139	Aqr	03 28 06.3	+20 06 52	1.180	Ari	22 13 39.6	-12 21 47	1.89	Aqr	17 15 18.0	-22 18 20	4.80	Oph
Apr	9	23 50 10.9	-03 46 44	1.152	Aqr	03 32 55.5	+20 27 05	1.173	Tau	22 16 36.3	-12 05 48	1.89	Aqr	17 15 16.2	-22 18 17	4.78	Oph
Apr	10	23 55 58.2	-03 09 11	1.164	Psc	03 37 45.6	+20 46 47	1.167	Tau	22 19 32.6	-11 49 41	1.88	Aqr	17 15 13.7	-22 18 13	4.77	Oph
Apr	11	00 01 50.2	-02 30 32	1.176	Psc	03 42 36.4	+21 05 58	1.160	Tau	22 22 28.6	-11 33 28	1.88	Aqr	17 15 10.3	-22 18 07	4.76	Oph
Apr	12	00 07 46.9	-01 50 49	1.188	Psc	03 47 28.0	+21 24 36	1.153	Tau	22 25 24.3	-11 17 09	1.87	Aqr	17 15 06.2	-22 18 02	4.74	Oph
Apr	13	00 13 48.4	-01 10 03	1.199	Psc	03 52 20.5	+21 42 42	1.147	Tau	22 28 19.6	-11 00 44	1.87	Aqr	17 15 01.2	-22 17 55	4.73	Oph
Apr	14	00 19 54.9	-00 28 17	1.211	Psc	03 57 13.6	+22 00 15	1.140	Tau	22 31 14.6	-10 44 13	1.86	Aqr	17 14 55.4	-22 17 48	4.71	Oph
Apr	15	00 26 06.4	+00 14 29	1.222	Psc	04 02 07.5	+22 17 15	1.133	Tau	22 34 09.4	-10 27 37	1.86	Aqr	17 14 48.9	-22 17 39	4.70	Oph
Apr	16	00 32 23.1	+00 58 13	1.232	Cet	04 07 02.1	+22 33 40	1.126	Tau	22 37 03.8	-10 10 55	1.85	Aqr	17 14 41.5	-22 17 30	4.69	Oph
Apr	17	00 38 45.2	+01 42 51	1.243	Cet	04 11 57.3	+22 49 30	1.119	Tau	22 39 57.8	-09 54 08	1.85	Aqr	17 14 33.3	-22 17 20	4.67	Oph
Apr	18	00 45 12.8	+02 28 24	1.253	Cet	04 16 53.2	+23 04 46	1.112	Tau	22 42 51.6	-09 37 16	1.84	Aqr	17 14 24.3	-22 17 10	4.66	Oph
Apr	19	00 51 46.2	+03 14 47	1.262	Psc	04 21 49.7	+23 19 25	1.106	Tau	22 45 45.1	-09 20 19	1.84	Aqr	17 14 14.5	-22 16 58	4.65	Oph
Apr	20	00 58 25.5	+04 01 59	1.272	Psc	04 26 46.7	+23 33 28	1.099	Tau	22 48 38.3	-09 03 17	1.83	Aqr	17 14 04.0	-22 16 46	4.64	Oph
Apr	21	01 05 11.0	+04 49 56	1.280	Psc	04 31 44.2	+23 46 55	1.091	Tau	22 51 31.1	-08 46 11	1.83	Aqr	17 13 52.6	-22 16 33	4.62	Oph
Apr	22	01 12 02.8	+05 38 35	1.289	Psc	04 36 42.2	+23 59 44	1.084	Tau	22 54 23.7	-08 29 01	1.82	Aqr	17 13 40.5	-22 16 19	4.61	Oph
Apr	23	01 19 01.3	+06 27 53	1.296	Psc	04 41 40.5	+24 11 56	1.077	Tau	22 57 16.0	-08 11 47	1.82	Aqr	17 13 27.7	-22 16 04	4.60	Oph
Apr	24	01 26 06.6	+07 17 45	1.303	Psc	04 46 39.2	+24 23 30	1.070	Tau	23 00 08.0	-07 54 29	1.81	Aqr	17 13 14.0	-22 15 49	4.59	Oph
Apr	25	01 33 18.9	+08 08 07	1.309	Psc	04 51 38.2	+24 34 26	1.063	Tau	23 02 59.7	-07 37 07	1.81	Aqr	17 12 59.7	-22 15 33	4.58	Oph
Apr	26	01 40 38.4	+08 58 54	1.315	Psc	04 56 37.4	+24 44 43	1.056	Tau	23 05 51.1	-07 19 42	1.80	Aqr	17 12 44.6	-22 15 16	4.56	Oph
Apr	27	01 48 05.3	+09 49 60	1.320	Psc	05 01 36.8	+24 54 22	1.048	Tau	23 08 42.3	-07 02 14	1.80	Aqr	17 12 28.7	-22 14 58	4.55	Oph
Apr	28	01 55 39.6	+10 41 17	1.324	Ari	05 06 36.2	+25 03 21	1.041	Tau	23 11 33.3	-06 44 42	1.79	Aqr	17 12 12.2	-22 14 39	4.54	Oph
Apr	29	02 03 21.4	+11 32 39	1.326	Ari	05 11 35.8	+25 11 42	1.034	Tau	23 14 23.9	-06 27 07	1.79	Aqr	17 11 54.9	-22 14 20	4.53	Oph
Apr	30	02 11 10.7	+12 23 57	1.328	Ari	05 16 35.2	+25 19 22	1.027	Tau	23 17 14.4	-06 09 30	1.78	Aqr	17 11 37.0	-22 13 60	4.52	Oph
May	1	02 19 07.4	+13 15 02	1.329	Ari	05 21 34.7	+25 26 24	1.019	Tau	23 20 04.6	-05 51 50	1.78	Aqr	17 11 18.3	-22 13 39	4.51	Oph
May	2	02 27 11.2	+14 05 45	1.328	Ari	05 26 33.9	+25 32 45	1.012	Tau	23 22 54.6	-05 34 07	1.77	Aqr	17 10 59.0	-22 13 17	4.50	Oph
May	3	02 35 21.9	+14 55 54	1.327	Ari	05 31 32.9	+25 38 27	1.004	Tau	23 25 44.4	-05 16 22	1.77	Aqr	17 10 39.0	-22 12 55	4.49	Oph
May	4	02 43 38.9	+15 45 18	1.324	Ari	05 36 31.7	+25 43 28	0.997	Tau	23 28 33.9	-04 58 35	1.76	Aqr	17 10 18.3	-22 12 31	4.48	Oph
May	5	02 52 01.8	+16 33 45	1.319	Ari	05 41 30.1	+25 47 50	0.989	Tau	23 31 23.3	-04 40 46	1.76	Aqr	17 09 57.0	-22 12 07	4.47	Oph
May	6	03 00 29.8	+17 21 03	1.313	Ari	05 46 28.1	+25 51 32	0.982	Tau	23 34 12.4	-04 22 56	1.75	Aqr	17 09 35.1	-22 11 42	4.46	Oph
May	7	03 09 02.0	+18 06 59	1.306	Ari	05 51 25.5	+25 54 34	0.974	Tau	23 37 01.4	-04 05 03	1.75	Aqr	17 09 12.5	-22 11 16	4.45	Oph
May	8	03 17 37.5	+18 51 21	1.297	Ari	05 56 22.4	+25 56 56	0.967	Tau	23 39 50.2	-03 47 10	1.74	Aqr	17 08 49.4	-22 10 50	4.44	Oph
May	9	03 26 15.2	+19 33 58	1.287	Ari	06 01 18.7	+25 58 38	0.959	Gem	23 42 38.8	-03 29 15	1.74	Aqr	17 08 25.6	-22 10 22	4.43	Oph
May	10	03 34 54.0	+20 14 37	1.276	Tau	06 06 14.3	+25 59 41	0.951	Gem	23 45 27.2	-03 11 19	1.73	Psc	17 08 01.2	-22 09 54	4.43	Oph
May	11	03 43 32.5	+20 53 11	1.263	Tau	06 11 09.0	+26 00 03	0.944	Gem	23 48 15.5	-02 53 23	1.73	Psc	17 07 36.3	-22 09 25	4.42	Oph
May	12	03 52 09.5	+21 29 28	1.249	Tau	06 16 03.0	+25 59 47	0.936	Gem	23 51 03.6	-02 35 25	1.72	Psc	17 07 10.9	-22 08 55	4.41	Oph
May	13	04 00 43.7	+22 03 24	1.234	Tau	06 20 56.0	+25 58 51	0.928	Gem	23 53 51.5	-02 17 28	1.72	Psc	17 06 44.9	-22 08 25	4.40	Oph
May	14	04 09 13.9	+22 34 51	1.218	Tau	06 25 48.0	+25 57 16	0.920	Gem	23 56 39.3	-01 59 30	1.71	Psc	17 06 18.3	-22 07 53	4.39	Oph

GEOCENTRIC PLANET POSITIONS (continued)

MTH	DAY	MERCURY RA h m s	MERCURY Declination ° ′ ″	MERCURY Dist. (AU)	MERCURY Cnst.	VENUS RA h m s	VENUS Declination ° ′ ″	VENUS Dist. (AU)	VENUS Cnst.	MARS RA h m s	MARS Declination ° ′ ″	MARS Dist. (AU)	MARS Cnst.	JUPITER RA h m s	JUPITER Declination ° ′ ″	JUPITER Dist. (AU)	JUPITER Cnst.
May	15	04 17 38.8	+23 03 46	1.201	Tau	06 30 38.9	+25 55 03	0.913	Gem	23 59 26.9	-01 41 32	1.71	Psc	17 05 51.3	-22 07 21	4.39	Oph
May	16	04 25 57.2	+23 30 06	1.183	Tau	06 35 28.7	+25 52 11	0.905	Gem	00 02 14.3	-01 23 34	1.70	Psc	17 05 23.8	-22 06 49	4.38	Oph
May	17	04 34 08.0	+23 53 52	1.164	Tau	06 40 17.2	+25 48 41	0.897	Gem	00 05 01.6	-01 05 37	1.70	Psc	17 04 55.8	-22 06 15	4.37	Oph
May	18	04 42 10.2	+24 15 02	1.144	Tau	06 45 04.5	+25 44 33	0.889	Gem	00 07 48.8	-00 47 40	1.69	Psc	17 04 27.4	-22 05 41	4.37	Oph
May	19	04 50 02.9	+24 33 39	1.124	Tau	06 49 50.4	+25 39 48	0.881	Gem	00 10 35.8	-00 29 44	1.69	Psc	17 03 58.6	-22 05 06	4.36	Oph
May	20	04 57 45.2	+24 49 46	1.104	Tau	06 54 34.8	+25 34 25	0.874	Gem	00 13 22.7	-00 11 49	1.68	Psc	17 03 29.3	-22 04 30	4.36	Oph
May	21	05 05 16.3	+25 03 27	1.083	Tau	06 59 17.6	+25 28 26	0.866	Gem	00 16 09.4	+00 06 05	1.68	Psc	17 02 59.7	-22 03 54	4.35	Oph
May	22	05 12 35.5	+25 14 45	1.063	Tau	07 03 58.8	+25 21 52	0.858	Gem	00 18 56.1	+00 23 57	1.67	Psc	17 02 29.7	-22 03 17	4.35	Oph
May	23	05 19 42.2	+25 23 47	1.042	Tau	07 08 38.4	+25 14 41	0.850	Gem	00 21 42.6	+00 41 48	1.67	Psc	17 01 59.4	-22 02 39	4.34	Oph
May	24	05 26 35.8	+25 30 36	1.020	Tau	07 13 16.1	+25 06 56	0.842	Gem	00 24 29.0	+00 59 38	1.66	Psc	17 01 28.8	-22 02 01	4.34	Oph
May	25	05 33 15.8	+25 35 20	0.999	Tau	07 17 52.0	+24 58 36	0.834	Gem	00 27 15.2	+01 17 25	1.66	Cet	17 00 57.8	-22 01 22	4.33	Oph
May	26	05 39 41.7	+25 38 04	0.978	Tau	07 22 26.0	+24 49 42	0.826	Gem	00 30 01.4	+01 35 11	1.65	Cet	17 00 26.6	-22 00 43	4.33	Oph
May	27	05 45 53.1	+25 38 55	0.958	Tau	07 26 58.0	+24 40 15	0.818	Gem	00 32 47.5	+01 52 54	1.65	Cet	16 59 55.1	-22 00 03	4.33	Oph
May	28	05 51 49.5	+25 37 58	0.937	Tau	07 31 28.0	+24 30 15	0.810	Gem	00 35 33.5	+02 10 36	1.64	Cet	16 59 23.4	-21 59 22	4.32	Oph
May	29	05 57 30.6	+25 35 19	0.916	Tau	07 35 55.8	+24 19 44	0.802	Gem	00 38 19.4	+02 28 15	1.64	Cet	16 58 51.5	-21 58 41	4.32	Oph
May	30	06 02 56.0	+25 31 06	0.896	Gem	07 40 21.5	+24 08 41	0.794	Gem	00 41 05.3	+02 45 51	1.63	Psc	16 58 19.4	-21 57 60	4.32	Oph
May	31	06 08 05.3	+25 25 24	0.876	Gem	07 44 44.9	+23 57 07	0.786	Gem	00 43 51.1	+03 03 24	1.63	Psc	16 57 47.2	-21 57 18	4.31	Oph
Jun	1	06 12 58.2	+25 18 19	0.857	Gem	07 49 05.9	+23 45 04	0.777	Gem	00 46 36.8	+03 20 55	1.62	Psc	16 57 14.8	-21 56 35	4.31	Oph
Jun	2	06 17 34.2	+25 09 57	0.838	Gem	07 53 24.7	+23 32 31	0.769	Gem	00 49 22.5	+03 38 23	1.62	Psc	16 56 42.2	-21 55 52	4.31	Oph
Jun	3	06 21 53.1	+25 00 25	0.819	Gem	07 57 40.9	+23 19 30	0.761	Gem	00 52 08.1	+03 55 47	1.62	Psc	16 56 09.6	-21 55 09	4.31	Oph
Jun	4	06 25 54.4	+24 49 48	0.800	Gem	08 01 54.7	+23 06 00	0.753	Cnc	00 54 53.7	+04 13 08	1.61	Psc	16 55 36.9	-21 54 25	4.31	Oph
Jun	5	06 29 37.9	+24 38 12	0.783	Gem	08 06 06.0	+22 52 04	0.745	Cnc	00 57 39.2	+04 30 26	1.61	Psc	16 55 04.1	-21 53 41	4.31	Oph
Jun	6	06 33 03.2	+24 25 42	0.765	Gem	08 10 14.6	+22 37 42	0.737	Cnc	01 00 24.7	+04 47 40	1.60	Psc	16 54 31.3	-21 52 57	4.30	Oph
Jun	7	06 36 10.0	+24 12 25	0.748	Gem	08 14 20.7	+22 22 54	0.729	Cnc	01 03 10.2	+05 04 50	1.60	Psc	16 53 58.5	-21 52 12	4.30	Oph
Jun	8	06 38 58.0	+23 58 25	0.732	Gem	08 18 24.0	+22 07 41	0.721	Cnc	01 05 55.6	+05 21 56	1.59	Psc	16 53 25.7	-21 51 28	4.30	Oph
Jun	9	06 41 26.7	+23 43 48	0.716	Gem	08 22 24.5	+21 52 05	0.713	Cnc	01 08 41.0	+05 38 57	1.59	Psc	16 52 52.9	-21 50 43	4.30	Oph
Jun	10	06 43 36.1	+23 28 40	0.701	Gem	08 26 22.3	+21 36 05	0.705	Cnc	01 11 26.4	+05 55 55	1.58	Psc	16 52 20.2	-21 49 57	4.31	Oph
Jun	11	06 45 25.8	+23 13 06	0.686	Gem	08 30 17.2	+21 19 43	0.696	Cnc	01 14 11.7	+06 12 48	1.58	Psc	16 51 47.5	-21 49 12	4.31	Oph
Jun	12	06 46 55.7	+22 57 11	0.672	Gem	08 34 09.2	+21 02 59	0.688	Cnc	01 16 57.1	+06 29 36	1.57	Psc	16 51 15.0	-21 48 27	4.31	Oph
Jun	13	06 48 05.5	+22 41 01	0.658	Gem	08 37 58.2	+20 45 55	0.680	Cnc	01 19 42.4	+06 46 19	1.57	Psc	16 50 42.5	-21 47 41	4.31	Oph
Jun	14	06 48 55.4	+22 24 40	0.646	Gem	08 41 44.1	+20 28 30	0.672	Cnc	01 22 27.7	+07 02 57	1.56	Psc	16 50 10.2	-21 46 56	4.31	Oph
Jun	15	06 49 25.2	+22 08 14	0.634	Gem	08 45 27.0	+20 10 47	0.664	Cnc	01 25 12.9	+07 19 30	1.56	Psc	16 49 38.1	-21 46 11	4.31	Oph
Jun	16	06 49 35.3	+21 51 48	0.622	Gem	08 49 06.7	+19 52 46	0.656	Cnc	01 27 58.1	+07 35 57	1.55	Psc	16 49 06.2	-21 45 25	4.31	Oph
Jun	17	06 49 25.7	+21 35 28	0.612	Gem	08 52 43.2	+19 34 28	0.648	Cnc	01 30 43.3	+07 52 19	1.55	Psc	16 48 34.5	-21 44 40	4.32	Oph
Jun	18	06 48 57.1	+21 19 19	0.602	Gem	08 56 16.4	+19 15 53	0.640	Cnc	01 33 28.5	+08 08 35	1.54	Psc	16 48 03.1	-21 43 55	4.32	Oph
Jun	19	06 48 09.9	+21 03 26	0.593	Gem	08 59 46.2	+18 57 03	0.632	Cnc	01 36 13.6	+08 24 45	1.54	Psc	16 47 31.9	-21 43 11	4.32	Oph
Jun	20	06 47 05.1	+20 47 55	0.586	Gem	09 03 12.5	+18 37 59	0.624	Cnc	01 38 58.8	+08 40 49	1.53	Psc	16 47 01.0	-21 42 26	4.33	Oph
Jun	21	06 45 43.7	+20 32 51	0.579	Gem	09 06 35.4	+18 18 42	0.616	Cnc	01 41 43.9	+08 56 47	1.53	Psc	16 46 30.4	-21 41 42	4.33	Oph
Jun	22	06 44 06.8	+20 18 19	0.573	Gem	09 09 54.6	+17 59 13	0.608	Cnc	01 44 28.9	+09 12 39	1.52	Psc	16 46 00.1	-21 40 58	4.33	Oph
Jun	23	06 42 16.0	+20 04 26	0.567	Gem	09 13 10.1	+17 39 32	0.600	Cnc	01 47 14.0	+09 28 24	1.52	Psc	16 45 30.2	-21 40 15	4.34	Oph
Jun	24	06 40 13.0	+19 51 16	0.563	Gem	09 16 21.8	+17 19 41	0.592	Cnc	01 49 59.1	+09 44 03	1.51	Psc	16 45 00.6	-21 39 32	4.34	Oph
Jun	25	06 37 59.6	+19 38 56	0.561	Gem	09 19 29.7	+16 59 41	0.584	Cnc	01 52 44.1	+09 59 35	1.51	Psc	16 44 31.5	-21 38 50	4.35	Oph
Jun	26	06 35 38.0	+19 27 30	0.559	Gem	09 22 33.6	+16 39 33	0.576	Leo	01 55 29.1	+10 15 01	1.50	Psc	16 44 02.7	-21 38 08	4.35	Oph
Jun	27	06 33 10.4	+19 17 03	0.558	Gem	09 25 33.5	+16 19 17	0.568	Leo	01 58 14.2	+10 30 19	1.50	Psc	16 43 34.4	-21 37 26	4.36	Oph
Jun	28	06 30 39.2	+19 07 41	0.558	Gem	09 28 29.2	+15 58 56	0.560	Leo	02 00 59.2	+10 45 31	1.49	Ari	16 43 06.4	-21 36 45	4.36	Oph
Jun	29	06 28 06.9	+18 59 28	0.560	Gem	09 31 20.8	+15 38 30	0.552	Leo	02 03 44.2	+11 00 35	1.49	Ari	16 42 39.0	-21 36 05	4.37	Oph
Jun	30	06 25 36.0	+18 52 28	0.563	Gem	09 34 07.9	+15 17 60	0.544	Leo	02 06 29.2	+11 15 32	1.49	Ari	16 42 12.0	-21 35 26	4.38	Oph
Jul	1	06 23 09.1	+18 46 44	0.566	Gem	09 36 50.6	+14 57 27	0.536	Leo	02 09 14.2	+11 30 22	1.48	Ari	16 41 45.5	-21 34 47	4.38	Oph
Jul	2	06 20 48.5	+18 42 19	0.571	Gem	09 39 28.8	+14 36 53	0.529	Leo	02 11 59.2	+11 45 05	1.48	Ari	16 41 19.6	-21 34 09	4.39	Oph
Jul	3	06 18 36.7	+18 39 15	0.578	Ori	09 42 02.3	+14 16 18	0.521	Leo	02 14 44.2	+11 59 40	1.47	Ari	16 40 54.1	-21 33 32	4.40	Oph
Jul	4	06 16 35.8	+18 37 33	0.585	Ori	09 44 31.0	+13 55 44	0.513	Leo	02 17 29.2	+12 14 07	1.47	Ari	16 40 29.2	-21 32 56	4.40	Oph
Jul	5	06 14 47.9	+18 37 13	0.593	Ori	09 46 54.9	+13 35 12	0.506	Leo	02 20 14.2	+12 28 26	1.46	Ari	16 40 04.8	-21 32 21	4.41	Oph
Jul	6	06 13 15.0	+18 38 16	0.603	Ori	09 49 13.7	+13 14 43	0.498	Leo	02 22 59.2	+12 42 38	1.46	Ari	16 39 41.0	-21 31 46	4.42	Oph
Jul	7	06 11 58.6	+18 40 38	0.614	Ori	09 51 27.3	+12 54 18	0.491	Leo	02 25 44.2	+12 56 41	1.45	Ari	16 39 17.7	-21 31 13	4.43	Oph
Jul	8	06 11 00.1	+18 44 18	0.625	Ori	09 53 35.7	+12 33 59	0.483	Leo	02 28 29.1	+13 10 36	1.45	Ari	16 38 55.1	-21 30 41	4.43	Oph
Jul	9	06 10 20.9	+18 49 12	0.638	Ori	09 55 38.7	+12 13 47	0.476	Leo	02 31 14.1	+13 24 23	1.44	Ari	16 38 33.0	-21 30 09	4.44	Oph
Jul	10	06 10 01.9	+18 55 16	0.652	Ori	09 57 36.0	+11 53 42	0.468	Leo	02 33 59.0	+13 38 01	1.44	Ari	16 38 11.6	-21 29 39	4.45	Oph
Jul	11	06 10 04.0	+19 02 25	0.667	Ori	09 59 27.7	+11 33 47	0.461	Leo	02 36 43.9	+13 51 31	1.43	Ari	16 37 50.8	-21 29 10	4.46	Oph
Jul	12	06 10 27.8	+19 10 34	0.683	Ori	10 01 13.4	+11 14 03	0.454	Leo	02 39 28.7	+14 04 52	1.43	Ari	16 37 30.6	-21 28 42	4.47	Oph
Jul	13	06 11 13.9	+19 19 36	0.700	Ori	10 02 53.1	+10 54 32	0.447	Leo	02 42 13.4	+14 18 04	1.42	Ari	16 37 11.1	-21 28 15	4.48	Oph
Jul	14	06 12 22.7	+19 29 24	0.717	Ori	10 04 26.5	+10 35 14	0.440	Leo	02 44 58.1	+14 31 07	1.42	Ari	16 36 52.3	-21 27 50	4.49	Oph
Jul	15	06 13 54.3	+19 39 51	0.736	Ori	10 05 53.5	+10 16 12	0.433	Leo	02 47 42.8	+14 44 02	1.41	Ari	16 36 34.1	-21 27 26	4.50	Oph
Jul	16	06 15 49.1	+19 50 49	0.755	Ori	10 07 13.9	+09 57 27	0.426	Leo	02 50 27.3	+14 56 47	1.41	Ari	16 36 16.6	-21 27 03	4.51	Oph
Jul	17	06 18 07.0	+20 02 09	0.776	Ori	10 08 27.5	+09 39 01	0.419	Leo	02 53 11.8	+15 09 23	1.40	Ari	16 35 59.9	-21 26 41	4.52	Oph
Jul	18	06 20 48.2	+20 13 42	0.797	Gem	10 09 34.0	+09 20 56	0.412	Leo	02 55 56.2	+15 21 50	1.40	Ari	16 35 43.8	-21 26 21	4.53	Oph
Jul	19	06 23 52.5	+20 25 20	0.818	Gem	10 10 33.3	+09 03 14	0.406	Leo	02 58 40.5	+15 34 07	1.39	Ari	16 35 28.5	-21 26 03	4.54	Oph
Jul	20	06 27 19.8	+20 36 51	0.840	Gem	10 11 25.2	+08 45 56	0.399	Leo	03 01 24.7	+15 46 15	1.39	Ari	16 35 13.9	-21 25 45	4.55	Oph

GEOCENTRIC PLANET POSITIONS (continued)

Note: positions refer to 0000 WAST

MTH	DAY	MERCURY RA h m s	MERCURY Declination ° ′ ″	MERCURY Dist. (AU)	MERCURY Cnst.	VENUS RA h m s	VENUS Declination ° ′ ″	VENUS Dist. (AU)	VENUS Cnst.	MARS RA h m s	MARS Declination ° ′ ″	MARS Dist. (AU)	MARS Cnst.	JUPITER RA h m s	JUPITER Declination ° ′ ″	JUPITER Dist. (AU)	JUPITER Cnst.
Jul	21	06 31 10.1	+20 48 07	0.863	Gem	10 12 09.5	+08 29 04	0.393	Leo	03 04 08.8	+15 58 14	1.38	Ari	16 34 60.0	-21 25 29	4.56	Oph
Jul	22	06 35 23.0	+20 58 56	0.887	Gem	10 12 45.9	+08 12 41	0.387	Leo	03 06 52.8	+16 10 03	1.38	Ari	16 34 46.8	-21 25 15	4.57	Oph
Jul	23	06 39 58.4	+21 09 07	0.910	Gem	10 13 14.3	+07 56 49	0.380	Leo	03 09 36.7	+16 21 42	1.37	Ari	16 34 34.4	-21 25 02	4.58	Oph
Jul	24	06 44 55.9	+21 18 30	0.935	Gem	10 13 34.6	+07 41 29	0.374	Leo	03 12 20.4	+16 33 12	1.37	Ari	16 34 22.8	-21 24 51	4.60	Oph
Jul	25	06 50 15.0	+21 26 53	0.959	Gem	10 13 46.4	+07 26 44	0.369	Leo	03 15 04.0	+16 44 32	1.36	Ari	16 34 11.9	-21 24 41	4.61	Oph
Jul	26	06 55 55.3	+21 34 04	0.984	Gem	10 13 49.8	+07 12 36	0.363	Leo	03 17 47.5	+16 55 42	1.36	Ari	16 34 01.8	-21 24 32	4.62	Oph
Jul	27	07 01 56.2	+21 39 51	1.009	Gem	10 13 44.5	+06 59 06	0.357	Leo	03 20 30.8	+17 06 43	1.35	Ari	16 33 52.4	-21 24 25	4.63	Oph
Jul	28	07 08 16.8	+21 44 04	1.033	Gem	10 13 30.4	+06 46 18	0.352	Leo	03 23 14.0	+17 17 34	1.34	Ari	16 33 43.8	-21 24 20	4.64	Oph
Jul	29	07 14 56.4	+21 46 30	1.058	Gem	10 13 07.4	+06 34 14	0.346	Leo	03 25 57.1	+17 28 15	1.34	Tau	16 33 35.9	-21 24 16	4.66	Oph
Jul	30	07 21 53.9	+21 46 58	1.082	Gem	10 12 35.5	+06 22 54	0.341	Sex	03 28 40.0	+17 38 46	1.33	Tau	16 33 28.9	-21 24 14	4.67	Oph
Jul	31	07 29 08.2	+21 45 19	1.106	Gem	10 11 54.6	+06 12 22	0.336	Sex	03 31 22.7	+17 49 07	1.33	Tau	16 33 22.6	-21 24 13	4.68	Oph
Aug	1	07 36 37.7	+21 41 23	1.130	Gem	10 11 04.9	+06 02 40	0.332	Sex	03 34 05.2	+17 59 18	1.32	Tau	16 33 17.0	-21 24 14	4.69	Oph
Aug	2	07 44 21.2	+21 35 02	1.152	Gem	10 10 06.2	+05 53 48	0.327	Sex	03 36 47.6	+18 09 19	1.32	Tau	16 33 12.3	-21 24 17	4.71	Oph
Aug	3	07 52 16.9	+21 26 10	1.174	Gem	10 08 58.8	+05 45 50	0.323	Sex	03 39 29.7	+18 19 10	1.31	Tau	16 33 08.3	-21 24 21	4.72	Oph
Aug	4	08 00 23.0	+21 14 42	1.195	Cnc	10 07 42.7	+05 38 46	0.319	Sex	03 42 11.6	+18 28 51	1.31	Tau	16 33 05.1	-21 24 27	4.73	Oph
Aug	5	08 08 37.8	+21 00 36	1.215	Cnc	10 06 18.3	+05 32 39	0.315	Sex	03 44 53.4	+18 38 21	1.30	Tau	16 33 02.7	-21 24 34	4.75	Oph
Aug	6	08 16 59.2	+20 43 49	1.234	Cnc	10 04 45.7	+05 27 28	0.311	Sex	03 47 34.8	+18 47 42	1.30	Tau	16 33 01.1	-21 24 43	4.76	Oph
Aug	7	08 25 25.5	+20 24 24	1.252	Cnc	10 03 05.4	+05 23 15	0.308	Sex	03 50 16.1	+18 56 52	1.29	Tau	16 33 00.2	-21 24 53	4.77	Oph
Aug	8	08 33 54.7	+20 02 24	1.268	Cnc	10 01 17.6	+05 20 02	0.305	Sex	03 52 57.0	+19 05 53	1.29	Tau	16 33 00.2	-21 25 06	4.79	Oph
Aug	9	08 42 25.0	+19 37 52	1.283	Cnc	09 59 22.9	+05 17 48	0.302	Sex	03 55 37.7	+19 14 42	1.28	Tau	16 33 00.9	-21 25 20	4.80	Oph
Aug	10	08 50 54.9	+19 10 56	1.297	Cnc	09 57 21.7	+05 16 33	0.299	Sex	03 58 18.0	+19 23 22	1.28	Tau	16 33 02.4	-21 25 35	4.82	Oph
Aug	11	08 59 22.8	+18 41 43	1.309	Cnc	09 55 14.6	+05 16 19	0.297	Sex	04 00 58.1	+19 31 51	1.27	Tau	16 33 04.7	-21 25 52	4.83	Oph
Aug	12	09 07 47.4	+18 10 22	1.320	Cnc	09 53 02.3	+05 17 03	0.295	Sex	04 03 37.7	+19 40 10	1.27	Tau	16 33 07.8	-21 26 11	4.84	Oph
Aug	13	09 16 07.5	+17 37 01	1.330	Cnc	09 50 45.4	+05 18 46	0.293	Sex	04 06 17.1	+19 48 19	1.26	Tau	16 33 11.7	-21 26 31	4.86	Oph
Aug	14	09 24 22.1	+17 01 51	1.338	Leo	09 48 24.6	+05 21 25	0.291	Sex	04 08 56.0	+19 56 17	1.25	Tau	16 33 16.3	-21 26 53	4.87	Oph
Aug	15	09 32 30.5	+16 25 01	1.345	Leo	09 46 00.8	+05 25 01	0.290	Sex	04 11 34.6	+20 04 05	1.25	Tau	16 33 21.8	-21 27 16	4.89	Oph
Aug	16	09 40 32.0	+15 46 42	1.351	Leo	09 43 34.8	+05 29 30	0.289	Sex	04 14 12.8	+20 11 43	1.24	Tau	16 33 28.0	-21 27 41	4.90	Oph
Aug	17	09 48 26.2	+15 07 02	1.356	Leo	09 41 07.5	+05 34 50	0.289	Hya	04 16 50.5	+20 19 11	1.24	Tau	16 33 35.0	-21 28 08	4.92	Oph
Aug	18	09 56 12.7	+14 26 10	1.359	Leo	09 38 39.6	+05 40 59	0.288	Hya	04 19 27.8	+20 26 29	1.23	Tau	16 33 42.8	-21 28 36	4.93	Oph
Aug	19	10 03 51.3	+13 44 16	1.362	Leo	09 36 12.2	+05 47 54	0.288	Hya	04 22 04.6	+20 33 36	1.23	Tau	16 33 51.4	-21 29 06	4.95	Oph
Aug	20	10 11 22.0	+13 01 28	1.364	Leo	09 33 46.1	+05 55 30	0.288	Hya	04 24 41.0	+20 40 34	1.22	Tau	16 34 00.7	-21 29 37	4.96	Oph
Aug	21	10 18 44.6	+12 17 54	1.364	Leo	09 31 22.2	+06 03 45	0.289	Hya	04 27 16.9	+20 47 21	1.22	Tau	16 34 10.8	-21 30 09	4.98	Oph
Aug	22	10 25 59.3	+11 33 39	1.364	Leo	09 29 01.5	+06 12 35	0.290	Hya	04 29 52.3	+20 53 59	1.21	Tau	16 34 21.6	-21 30 43	4.99	Oph
Aug	23	10 33 06.1	+10 48 52	1.363	Leo	09 26 44.6	+06 21 56	0.291	Hya	04 32 27.2	+21 00 27	1.20	Tau	16 34 33.3	-21 31 19	5.01	Oph
Aug	24	10 40 05.3	+10 03 39	1.362	Leo	09 24 32.6	+06 31 43	0.292	Leo	04 35 01.6	+21 06 45	1.20	Tau	16 34 45.6	-21 31 56	5.02	Oph
Aug	25	10 46 56.9	+09 18 04	1.359	Leo	09 22 26.0	+06 41 52	0.294	Leo	04 37 35.4	+21 12 53	1.19	Tau	16 34 58.7	-21 32 34	5.04	Oph
Aug	26	10 53 41.3	+08 32 13	1.356	Leo	09 20 25.7	+06 52 20	0.296	Cnc	04 40 08.7	+21 18 51	1.19	Tau	16 35 12.6	-21 33 14	5.05	Oph
Aug	27	11 00 18.6	+07 46 10	1.352	Leo	09 18 32.2	+07 03 01	0.298	Cnc	04 42 41.4	+21 24 40	1.18	Tau	16 35 27.2	-21 33 55	5.07	Oph
Aug	28	11 06 49.1	+07 00 01	1.348	Leo	09 16 46.3	+07 13 52	0.300	Cnc	04 45 13.6	+21 30 20	1.18	Tau	16 35 42.5	-21 34 37	5.08	Oph
Aug	29	11 13 13.0	+06 13 48	1.343	Leo	09 15 08.3	+07 24 49	0.303	Cnc	04 47 45.1	+21 35 50	1.17	Tau	16 35 58.6	-21 35 21	5.10	Oph
Aug	30	11 19 30.6	+05 27 36	1.338	Leo	09 13 38.8	+07 35 48	0.306	Cnc	04 50 16.0	+21 41 10	1.16	Tau	16 36 15.3	-21 36 06	5.11	Oph
Aug	31	11 25 42.1	+04 41 28	1.332	Leo	09 12 18.1	+07 46 44	0.309	Cnc	04 52 46.3	+21 46 22	1.16	Tau	16 36 32.8	-21 36 52	5.13	Oph
Sep	1	11 31 47.7	+03 55 26	1.326	Leo	09 11 06.6	+07 57 36	0.313	Cnc	04 55 15.9	+21 51 24	1.15	Tau	16 36 51.0	-21 37 40	5.14	Oph
Sep	2	11 37 47.8	+03 09 34	1.319	Vir	09 10 04.5	+08 08 18	0.316	Cnc	04 57 44.8	+21 56 16	1.15	Tau	16 37 10.0	-21 38 29	5.16	Oph
Sep	3	11 43 42.4	+02 23 54	1.312	Vir	09 09 12.0	+08 18 49	0.320	Cnc	05 00 13.0	+22 01 00	1.14	Tau	16 37 29.6	-21 39 18	5.17	Oph
Sep	4	11 49 31.9	+01 38 28	1.305	Vir	09 08 29.1	+08 29 05	0.324	Cnc	05 02 40.5	+22 05 35	1.13	Tau	16 37 49.9	-21 40 10	5.19	Oph
Sep	5	11 55 16.4	+00 53 20	1.297	Vir	09 07 56.0	+08 39 04	0.329	Cnc	05 05 07.2	+22 10 01	1.13	Tau	16 38 10.9	-21 41 02	5.20	Oph
Sep	6	12 00 56.1	+00 08 31	1.288	Vir	09 07 32.6	+08 48 44	0.333	Cnc	05 07 33.1	+22 14 18	1.12	Tau	16 38 32.7	-21 41 55	5.22	Oph
Sep	7	12 06 31.2	-00 35 57	1.280	Vir	09 07 19.0	+08 58 03	0.338	Cnc	05 09 58.2	+22 18 27	1.12	Tau	16 38 55.1	-21 42 50	5.23	Oph
Sep	8	12 12 01.8	-01 20 02	1.271	Vir	09 07 14.9	+09 06 58	0.343	Cnc	05 12 22.5	+22 22 27	1.11	Tau	16 39 18.1	-21 43 45	5.25	Oph
Sep	9	12 17 28.1	-02 03 41	1.261	Vir	09 07 20.4	+09 15 28	0.348	Cnc	05 14 45.9	+22 26 19	1.10	Tau	16 39 41.9	-21 44 42	5.26	Oph
Sep	10	12 22 50.1	-02 46 54	1.251	Vir	09 07 35.2	+09 23 32	0.353	Cnc	05 17 08.4	+22 30 03	1.10	Tau	16 40 06.4	-21 45 39	5.28	Oph
Sep	11	12 28 08.0	-03 29 38	1.241	Vir	09 07 59.1	+09 31 08	0.358	Cnc	05 19 29.9	+22 33 38	1.09	Tau	16 40 31.5	-21 46 38	5.29	Oph
Sep	12	12 33 21.8	-04 11 51	1.231	Vir	09 08 32.1	+09 38 16	0.363	Cnc	05 21 50.6	+22 37 06	1.09	Tau	16 40 57.2	-21 47 37	5.31	Oph
Sep	13	12 38 31.7	-04 53 32	1.220	Vir	09 09 13.8	+09 44 53	0.369	Cnc	05 24 10.2	+22 40 25	1.08	Tau	16 41 23.7	-21 48 37	5.32	Oph
Sep	14	12 43 37.5	-05 34 38	1.209	Vir	09 10 04.1	+09 50 60	0.375	Cnc	05 26 28.9	+22 43 38	1.07	Tau	16 41 50.7	-21 49 39	5.34	Oph
Sep	15	12 48 39.5	-06 15 09	1.197	Vir	09 11 02.7	+09 56 35	0.380	Cnc	05 28 46.5	+22 46 42	1.07	Tau	16 42 18.5	-21 50 41	5.36	Oph
Sep	16	12 53 37.4	-06 55 01	1.186	Vir	09 12 09.3	+10 01 38	0.386	Cnc	05 31 03.0	+22 49 40	1.06	Tau	16 42 46.8	-21 51 43	5.37	Oph
Sep	17	12 58 31.4	-07 34 14	1.173	Vir	09 13 23.8	+10 06 08	0.392	Cnc	05 33 18.5	+22 52 30	1.06	Tau	16 43 15.8	-21 52 47	5.39	Oph
Sep	18	13 03 21.2	-08 12 45	1.161	Vir	09 14 45.9	+10 10 04	0.399	Cnc	05 35 32.9	+22 55 14	1.05	Tau	16 43 45.4	-21 53 51	5.40	Oph
Sep	19	13 08 06.9	-08 50 32	1.148	Vir	09 16 15.3	+10 13 27	0.405	Cnc	05 37 46.2	+22 57 51	1.04	Tau	16 44 15.7	-21 54 56	5.42	Oph
Sep	20	13 12 48.3	-09 27 33	1.135	Vir	09 17 51.9	+10 16 15	0.411	Cnc	05 39 58.3	+23 00 21	1.04	Tau	16 44 46.5	-21 56 02	5.43	Oph
Sep	21	13 17 25.3	-10 03 46	1.122	Vir	09 19 35.2	+10 18 29	0.417	Cnc	05 42 09.3	+23 02 45	1.03	Tau	16 45 17.9	-21 57 09	5.44	Oph
Sep	22	13 21 57.5	-10 39 09	1.108	Vir	09 21 25.2	+10 20 08	0.424	Cnc	05 44 19.0	+23 05 02	1.02	Tau	16 45 50.0	-21 58 15	5.46	Oph
Sep	23	13 26 24.8	-11 13 38	1.094	Vir	09 23 21.6	+10 21 11	0.430	Leo	05 46 27.6	+23 07 14	1.02	Tau	16 46 22.6	-21 59 23	5.47	Oph
Sep	24	13 30 46.9	-11 47 11	1.080	Vir	09 25 24.0	+10 21 39	0.437	Leo	05 48 34.9	+23 09 20	1.01	Tau	16 46 55.8	-22 00 31	5.49	Oph
Sep	25	13 35 03.4	-12 19 45	1.065	Vir	09 27 32.4	+10 21 32	0.444	Leo	05 50 40.9	+23 11 20	1.01	Tau	16 47 29.6	-22 01 39	5.50	Oph

GEOCENTRIC PLANET POSITIONS (continued)

MTH	DAY	MERCURY RA h m s	MERCURY Declination ° ′ ″	MERCURY Dist. (AU)	MERCURY Cnst.	VENUS RA h m s	VENUS Declination ° ′ ″	VENUS Dist. (AU)	VENUS Cnst.	MARS RA h m s	MARS Declination ° ′ ″	MARS Dist. (AU)	MARS Cnst.	JUPITER RA h m s	JUPITER Declination ° ′ ″	JUPITER Dist. (AU)	JUPITER Cnst.
Sep	26	13 39 13.9	-12 51 17	1.050	Vir	09 29 46.5	+10 20 48	0.451	Leo	05 52 45.6	+23 13 15	1.00	Tau	16 48 04.0	-22 02 48	5.52	Oph
Sep	27	13 43 18.0	-13 21 44	1.035	Vir	09 32 06.0	+10 19 29	0.457	Leo	05 54 49.0	+23 15 05	0.99	Tau	16 48 38.9	-22 03 58	5.53	Oph
Sep	28	13 47 15.1	-13 51 01	1.019	Vir	09 34 30.8	+10 17 34	0.464	Leo	05 56 51.0	+23 16 50	0.99	Tau	16 49 14.4	-22 05 07	5.55	Oph
Sep	29	13 51 04.6	-14 19 05	1.003	Vir	09 37 00.6	+10 15 03	0.471	Leo	05 58 51.7	+23 18 30	0.98	Tau	16 49 50.4	-22 06 18	5.56	Oph
Sep	30	13 54 45.8	-14 45 50	0.987	Vir	09 39 35.3	+10 11 56	0.478	Leo	06 00 50.9	+23 20 06	0.97	Gem	16 50 26.9	-22 07 28	5.58	Oph
Oct	1	13 58 18.0	-15 11 13	0.971	Vir	09 42 14.6	+10 08 14	0.485	Leo	06 02 48.6	+23 21 37	0.97	Gem	16 51 04.0	-22 08 39	5.59	Oph
Oct	2	14 01 40.2	-15 35 06	0.954	Vir	09 44 58.3	+10 03 56	0.492	Leo	06 04 44.9	+23 23 04	0.96	Gem	16 51 41.7	-22 09 50	5.60	Oph
Oct	3	14 04 51.5	-15 57 25	0.937	Vir	09 47 46.2	+09 59 02	0.499	Leo	06 06 39.6	+23 24 28	0.95	Gem	16 52 19.8	-22 11 01	5.62	Oph
Oct	4	14 07 50.8	-16 18 02	0.920	Vir	09 50 38.2	+09 53 34	0.507	Leo	06 08 32.7	+23 25 48	0.95	Gem	16 52 58.5	-22 12 12	5.63	Oph
Oct	5	14 10 36.9	-16 36 49	0.903	Vir	09 53 34.0	+09 47 30	0.514	Leo	06 10 24.2	+23 27 04	0.94	Gem	16 53 37.7	-22 13 24	5.64	Oph
Oct	6	14 13 08.4	-16 53 39	0.885	Vir	09 56 33.5	+09 40 52	0.521	Leo	06 12 14.1	+23 28 17	0.94	Gem	16 54 17.5	-22 14 36	5.66	Oph
Oct	7	14 15 23.8	-17 08 21	0.868	Vir	09 59 36.5	+09 33 40	0.528	Leo	06 14 02.2	+23 29 28	0.93	Gem	16 54 57.7	-22 15 48	5.67	Oph
Oct	8	14 17 21.7	-17 20 45	0.850	Vir	10 02 42.8	+09 25 54	0.536	Leo	06 15 48.6	+23 30 36	0.92	Gem	16 55 38.4	-22 16 59	5.69	Oph
Oct	9	14 19 00.3	-17 30 39	0.833	Vir	10 05 52.3	+09 17 35	0.543	Leo	06 17 33.2	+23 31 41	0.92	Gem	16 56 19.6	-22 18 11	5.70	Oph
Oct	10	14 20 17.9	-17 37 51	0.816	Vir	10 09 04.9	+09 08 43	0.550	Leo	06 19 15.9	+23 32 45	0.91	Gem	16 57 01.3	-22 19 23	5.71	Oph
Oct	11	14 21 12.5	-17 42 07	0.798	Vir	10 12 20.3	+08 59 18	0.558	Leo	06 20 56.8	+23 33 47	0.90	Gem	16 57 43.5	-22 20 35	5.73	Oph
Oct	12	14 21 42.4	-17 43 11	0.782	Vir	10 15 38.5	+08 49 21	0.565	Leo	06 22 35.8	+23 34 47	0.90	Gem	16 58 26.1	-22 21 47	5.74	Oph
Oct	13	14 21 45.7	-17 40 49	0.765	Vir	10 18 59.3	+08 38 52	0.572	Leo	06 24 12.8	+23 35 46	0.89	Gem	16 59 09.3	-22 22 59	5.75	Oph
Oct	14	14 21 20.8	-17 34 45	0.750	Vir	10 22 22.5	+08 27 52	0.580	Leo	06 25 47.8	+23 36 45	0.88	Gem	16 59 52.8	-22 24 10	5.76	Oph
Oct	15	14 20 26.3	-17 24 43	0.735	Vir	10 25 48.2	+08 16 21	0.587	Leo	06 27 20.7	+23 37 42	0.88	Gem	17 00 36.9	-22 25 22	5.78	Oph
Oct	16	14 19 01.3	-17 10 29	0.721	Vir	10 29 16.1	+08 04 20	0.595	Leo	06 28 51.6	+23 38 40	0.87	Gem	17 01 21.4	-22 26 33	5.79	Oph
Oct	17	14 17 05.2	-16 51 50	0.708	Vir	10 32 46.2	+07 51 49	0.602	Leo	06 30 20.4	+23 39 37	0.87	Gem	17 02 06.3	-22 27 44	5.80	Oph
Oct	18	14 14 38.6	-16 28 40	0.696	Vir	10 36 18.4	+07 38 49	0.610	Leo	06 31 47.0	+23 40 34	0.86	Gem	17 02 51.6	-22 28 54	5.81	Oph
Oct	19	14 11 42.6	-16 00 58	0.686	Vir	10 39 52.5	+07 25 20	0.617	Leo	06 33 11.4	+23 41 32	0.85	Gem	17 03 37.4	-22 30 05	5.83	Oph
Oct	20	14 08 19.8	-15 28 50	0.678	Vir	10 43 28.5	+07 11 23	0.624	Leo	06 34 33.5	+23 42 31	0.85	Gem	17 04 23.6	-22 31 14	5.84	Oph
Oct	21	14 04 33.8	-14 52 35	0.672	Vir	10 47 06.3	+06 56 57	0.632	Leo	06 35 53.4	+23 43 31	0.84	Gem	17 05 10.2	-22 32 24	5.85	Oph
Oct	22	14 00 29.6	-14 12 43	0.668	Vir	10 50 45.8	+06 42 05	0.640	Leo	06 37 10.9	+23 44 32	0.83	Gem	17 05 57.2	-22 33 33	5.86	Oph
Oct	23	13 56 13.3	-13 29 57	0.667	Vir	10 54 27.0	+06 26 45	0.647	Leo	06 38 26.1	+23 45 34	0.83	Gem	17 06 44.6	-22 34 42	5.87	Oph
Oct	24	13 51 52.3	-12 45 13	0.669	Vir	10 58 09.8	+06 10 60	0.655	Leo	06 39 38.8	+23 46 39	0.82	Gem	17 07 32.4	-22 35 50	5.88	Oph
Oct	25	13 47 34.2	-11 59 36	0.673	Vir	11 01 54.1	+05 54 48	0.662	Leo	06 40 49.1	+23 47 45	0.81	Gem	17 08 20.5	-22 36 58	5.90	Oph
Oct	26	13 43 27.0	-11 14 21	0.680	Vir	11 05 39.9	+05 38 12	0.670	Leo	06 41 56.8	+23 48 54	0.81	Gem	17 09 09.1	-22 38 05	5.91	Oph
Oct	27	13 39 38.5	-10 30 41	0.690	Vir	11 09 27.1	+05 21 10	0.677	Leo	06 43 02.0	+23 50 05	0.80	Gem	17 09 58.0	-22 39 12	5.92	Oph
Oct	28	13 36 15.8	-09 49 49	0.703	Vir	11 13 15.7	+05 03 45	0.685	Leo	06 44 04.6	+23 51 20	0.80	Gem	17 10 47.2	-22 40 18	5.93	Oph
Oct	29	13 33 24.5	-09 12 47	0.718	Vir	11 17 05.6	+04 45 56	0.692	Leo	06 45 04.5	+23 52 37	0.79	Gem	17 11 36.9	-22 41 24	5.94	Oph
Oct	30	13 31 09.3	-08 40 28	0.736	Vir	11 20 56.8	+04 27 45	0.700	Leo	06 46 01.7	+23 53 58	0.78	Gem	17 12 26.9	-22 42 29	5.95	Oph
Oct	31	13 29 33.1	-08 13 29	0.756	Vir	11 24 49.2	+04 09 11	0.707	Leo	06 46 56.0	+23 55 22	0.78	Gem	17 13 17.2	-22 43 33	5.96	Oph
Nov	1	13 28 37.6	-07 52 15	0.778	Vir	11 28 42.8	+03 50 16	0.715	Leo	06 47 47.5	+23 56 51	0.77	Gem	17 14 07.9	-22 44 37	5.97	Oph
Nov	2	13 28 22.9	-07 36 55	0.802	Vir	11 32 37.5	+03 30 60	0.722	Leo	06 48 36.1	+23 58 23	0.77	Gem	17 14 58.9	-22 45 40	5.98	Oph
Nov	3	13 28 48.1	-07 27 27	0.826	Vir	11 36 33.4	+03 11 23	0.730	Leo	06 49 21.7	+24 00 00	0.76	Gem	17 15 50.3	-22 46 42	5.99	Oph
Nov	4	13 29 51.6	-07 23 39	0.852	Vir	11 40 30.3	+02 51 28	0.737	Vir	06 50 04.2	+24 01 42	0.75	Gem	17 16 42.0	-22 47 43	6.00	Oph
Nov	5	13 31 31.0	-07 25 11	0.879	Vir	11 44 28.2	+02 31 14	0.745	Vir	06 50 43.7	+24 03 28	0.75	Gem	17 17 34.0	-22 48 44	6.01	Oph
Nov	6	13 33 43.5	-07 31 41	0.906	Vir	11 48 27.1	+02 10 42	0.753	Vir	06 51 19.9	+24 05 20	0.74	Gem	17 18 26.3	-22 49 44	6.02	Oph
Nov	7	13 36 26.1	-07 42 40	0.933	Vir	11 52 27.0	+01 49 53	0.760	Vir	06 51 53.0	+24 07 17	0.74	Gem	17 19 18.9	-22 50 43	6.03	Oph
Nov	8	13 39 35.9	-07 57 39	0.960	Vir	11 56 27.9	+01 28 48	0.768	Vir	06 52 22.7	+24 09 19	0.73	Gem	17 20 11.8	-22 51 41	6.04	Oph
Nov	9	13 43 09.9	-08 16 11	0.987	Vir	12 00 29.6	+01 07 27	0.775	Vir	06 52 49.1	+24 11 27	0.72	Gem	17 21 05.1	-22 52 38	6.04	Oph
Nov	10	13 47 05.3	-08 37 46	1.013	Vir	12 04 32.3	+00 45 51	0.783	Vir	06 53 12.2	+24 13 41	0.72	Gem	17 21 58.6	-22 53 34	6.05	Oph
Nov	11	13 51 19.5	-09 01 59	1.039	Vir	12 08 35.9	+00 24 01	0.790	Vir	06 53 31.8	+24 16 00	0.71	Gem	17 22 52.4	-22 54 29	6.06	Oph
Nov	12	13 55 50.2	-09 28 25	1.064	Vir	12 12 40.4	+00 01 57	0.797	Vir	06 53 47.9	+24 18 26	0.71	Gem	17 23 46.4	-22 55 24	6.07	Oph
Nov	13	14 00 35.2	-09 56 41	1.088	Vir	12 16 45.7	-00 20 19	0.805	Vir	06 54 00.6	+24 20 57	0.70	Gem	17 24 40.8	-22 56 17	6.08	Oph
Nov	14	14 05 32.7	-10 26 27	1.112	Vir	12 20 51.9	-00 42 47	0.812	Vir	06 54 09.6	+24 23 35	0.70	Gem	17 25 35.3	-22 57 10	6.09	Oph
Nov	15	14 10 41.1	-10 57 24	1.135	Vir	12 24 59.0	-01 05 26	0.820	Vir	06 54 15.1	+24 26 19	0.69	Gem	17 26 30.2	-22 58 01	6.09	Oph
Nov	16	14 15 58.9	-11 29 16	1.157	Vir	12 29 06.9	-01 28 16	0.827	Vir	06 54 16.9	+24 29 09	0.69	Gem	17 27 25.3	-22 58 51	6.10	Oph
Nov	17	14 21 25.0	-12 01 49	1.178	Vir	12 33 15.6	-01 51 15	0.835	Vir	06 54 15.0	+24 32 04	0.68	Gem	17 28 20.6	-22 59 40	6.11	Oph
Nov	18	14 26 58.2	-12 34 50	1.198	Lib	12 37 25.2	-02 14 23	0.842	Vir	06 54 09.4	+24 35 06	0.68	Gem	17 29 16.2	-23 00 29	6.11	Oph
Nov	19	14 32 37.8	-13 08 07	1.217	Lib	12 41 35.7	-02 37 40	0.849	Vir	06 54 00.2	+24 38 14	0.67	Gem	17 30 12.0	-23 01 16	6.12	Oph
Nov	20	14 38 22.9	-13 41 31	1.235	Lib	12 45 47.0	-03 01 04	0.857	Vir	06 53 47.1	+24 41 28	0.67	Gem	17 31 08.0	-23 02 01	6.13	Oph
Nov	21	14 44 13.0	-14 14 54	1.253	Lib	12 49 59.1	-03 24 35	0.864	Vir	06 53 30.3	+24 44 47	0.66	Gem	17 32 04.2	-23 02 46	6.13	Oph
Nov	22	14 50 07.4	-14 48 06	1.269	Lib	12 54 12.2	-03 48 11	0.871	Vir	06 53 09.8	+24 48 12	0.66	Gem	17 33 00.7	-23 03 30	6.14	Oph
Nov	23	14 56 05.8	-15 21 02	1.285	Lib	12 58 26.1	-04 11 53	0.879	Vir	06 52 45.4	+24 51 42	0.65	Gem	17 33 57.3	-23 04 12	6.15	Oph
Nov	24	15 02 07.8	-15 53 36	1.300	Lib	13 02 41.0	-04 35 40	0.886	Vir	06 52 17.2	+24 55 16	0.65	Gem	17 34 54.1	-23 04 53	6.15	Oph
Nov	25	15 08 13.1	-16 25 42	1.314	Lib	13 06 56.8	-04 59 30	0.893	Vir	06 51 45.3	+24 58 56	0.64	Gem	17 35 51.1	-23 05 33	6.16	Oph
Nov	26	15 14 21.4	-16 57 16	1.327	Lib	13 11 13.5	-05 23 23	0.901	Vir	06 51 09.5	+25 02 40	0.64	Gem	17 36 48.3	-23 06 12	6.16	Oph
Nov	27	15 20 32.6	-17 28 13	1.339	Lib	13 15 31.1	-05 47 19	0.908	Vir	06 50 29.9	+25 06 28	0.64	Gem	17 37 45.7	-23 06 50	6.17	Oph
Nov	28	15 26 46.5	-17 58 31	1.351	Lib	13 19 49.7	-06 11 15	0.915	Vir	06 49 46.5	+25 10 20	0.63	Gem	17 38 43.3	-23 07 26	6.17	Oph
Nov	29	15 33 03.0	-18 28 05	1.362	Lib	13 24 09.2	-06 35 13	0.922	Vir	06 48 59.3	+25 14 16	0.63	Gem	17 39 41.0	-23 08 01	6.18	Oph
Nov	30	15 39 21.9	-18 56 53	1.372	Lib	13 28 29.8	-06 59 10	0.929	Vir	06 48 08.4	+25 18 14	0.63	Gem	17 40 38.9	-23 08 34	6.18	Oph
Dec	1	15 45 43.1	-19 24 51	1.382	Lib	13 32 51.3	-07 23 06	0.937	Vir	06 47 13.7	+25 22 15	0.62	Gem	17 41 36.9	-23 09 07	6.19	Oph

GEOCENTRIC PLANET POSITIONS (continued) Note: positions refer to 0000 WAST

MTH	DAY	MERCURY				VENUS				MARS				JUPITER			
		RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.	RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.	RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.	RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.
Dec	2	15 52 06.6	-19 51 58	1.391	Lib	13 37 13.9	-07 47 01	0.944	Vir	06 46 15.3	+25 26 17	0.62	Gem	17 42 35.1	-23 09 38	6.19	Oph
Dec	3	15 58 32.4	-20 18 10	1.399	Lib	13 41 37.4	-08 10 52	0.951	Vir	06 45 13.3	+25 30 22	0.62	Gem	17 43 33.5	-23 10 08	6.20	Oph
Dec	4	16 05 00.3	-20 43 26	1.407	Sco	13 46 02.0	-08 34 40	0.958	Vir	06 44 07.7	+25 34 27	0.61	Gem	17 44 32.0	-23 10 36	6.20	Sgr
Dec	5	16 11 30.4	-21 07 44	1.413	Sco	13 50 27.6	-08 58 24	0.965	Vir	06 42 58.6	+25 38 33	0.61	Gem	17 45 30.6	-23 11 03	6.21	Sgr
Dec	6	16 18 02.6	-21 31 02	1.420	Sco	13 54 54.3	-09 22 03	0.972	Vir	06 41 46.1	+25 42 38	0.61	Gem	17 46 29.3	-23 11 29	6.21	Sgr
Dec	7	16 24 36.8	-21 53 18	1.425	Oph	13 59 22.0	-09 45 35	0.979	Vir	06 40 30.4	+25 46 42	0.60	Gem	17 47 28.2	-23 11 53	6.21	Sgr
Dec	8	16 31 13.1	-22 14 30	1.430	Oph	14 03 50.8	-10 09 01	0.986	Vir	06 39 11.4	+25 50 45	0.60	Gem	17 48 27.2	-23 12 16	6.21	Sgr
Dec	9	16 37 51.5	-22 34 36	1.435	Oph	14 08 20.7	-10 32 18	0.993	Vir	06 37 49.4	+25 54 46	0.60	Gem	17 49 26.2	-23 12 38	6.22	Sgr
Dec	10	16 44 31.8	-22 53 36	1.439	Oph	14 12 51.6	-10 55 28	1.000	Vir	06 36 24.5	+25 58 44	0.60	Gem	17 50 25.4	-23 12 58	6.22	Sgr
Dec	11	16 51 14.0	-23 11 27	1.442	Oph	14 17 23.7	-11 18 27	1.007	Vir	06 34 56.9	+26 02 39	0.60	Gem	17 51 24.7	-23 13 17	6.22	Sgr
Dec	12	16 57 58.2	-23 28 08	1.445	Oph	14 21 56.9	-11 41 17	1.014	Lib	06 33 26.6	+26 06 29	0.59	Gem	17 52 24.1	-23 13 34	6.22	Sgr
Dec	13	17 04 44.3	-23 43 38	1.447	Oph	14 26 31.3	-12 03 56	1.021	Lib	06 31 53.9	+26 10 15	0.59	Gem	17 53 23.5	-23 13 50	6.23	Sgr
Dec	14	17 11 32.1	-23 57 55	1.448	Oph	14 31 06.8	-12 26 22	1.028	Lib	06 30 19.0	+26 13 55	0.59	Gem	17 54 23.0	-23 14 04	6.23	Sgr
Dec	15	17 18 21.8	-24 10 58	1.449	Oph	14 35 43.4	-12 48 36	1.035	Lib	06 28 42.1	+26 17 29	0.59	Gem	17 55 22.6	-23 14 17	6.23	Sgr
Dec	16	17 25 13.3	-24 22 45	1.450	Oph	14 40 21.2	-13 10 37	1.042	Lib	06 27 03.3	+26 20 56	0.59	Gem	17 56 22.2	-23 14 29	6.23	Sgr
Dec	17	17 32 06.3	-24 33 16	1.449	Oph	14 45 00.2	-13 32 23	1.049	Lib	06 25 22.8	+26 24 17	0.59	Gem	17 57 21.9	-23 14 39	6.23	Sgr
Dec	18	17 39 01.1	-24 42 28	1.449	Oph	14 49 40.4	-13 53 54	1.055	Lib	06 23 40.9	+26 27 29	0.59	Gem	17 58 21.7	-23 14 48	6.23	Sgr
Dec	19	17 45 57.3	-24 50 21	1.447	Sgr	14 54 21.8	-14 15 09	1.062	Lib	06 21 57.9	+26 30 34	0.59	Gem	17 59 21.5	-23 14 55	6.23	Sgr
Dec	20	17 52 55.0	-24 56 53	1.446	Sgr	14 59 04.4	-14 36 08	1.069	Lib	06 20 13.8	+26 33 29	0.59	Gem	18 00 21.3	-23 15 01	6.23	Sgr
Dec	21	17 59 54.0	-25 02 03	1.443	Sgr	15 03 48.2	-14 56 49	1.076	Lib	06 18 29.0	+26 36 16	0.59	Gem	18 01 21.1	-23 15 05	6.23	Sgr
Dec	22	18 06 54.3	-25 05 49	1.440	Sgr	15 08 33.3	-15 17 12	1.082	Lib	06 16 43.6	+26 38 54	0.59	Gem	18 02 21.0	-23 15 08	6.23	Sgr
Dec	23	18 13 55.8	-25 08 12	1.436	Sgr	15 13 19.5	-15 37 15	1.089	Lib	06 14 57.9	+26 41 22	0.59	Gem	18 03 20.8	-23 15 10	6.23	Sgr
Dec	24	18 20 58.3	-25 09 09	1.432	Sgr	15 18 07.1	-15 56 59	1.096	Lib	06 13 12.1	+26 43 40	0.59	Gem	18 04 20.7	-23 15 10	6.23	Sgr
Dec	25	18 28 01.7	-25 08 39	1.427	Sgr	15 22 55.9	-16 16 22	1.102	Lib	06 11 26.5	+26 45 48	0.59	Gem	18 05 20.6	-23 15 08	6.23	Sgr
Dec	26	18 35 05.9	-25 06 42	1.422	Sgr	15 27 46.0	-16 35 24	1.109	Lib	06 09 41.1	+26 47 46	0.59	Gem	18 06 20.5	-23 15 05	6.23	Sgr
Dec	27	18 42 10.6	-25 03 16	1.416	Sgr	15 32 37.3	-16 54 03	1.116	Lib	06 07 56.3	+26 49 33	0.60	Gem	18 07 20.4	-23 15 01	6.23	Sgr
Dec	28	18 49 15.8	-24 58 20	1.409	Sgr	15 37 29.9	-17 12 20	1.122	Lib	06 06 12.2	+26 51 11	0.60	Gem	18 08 20.2	-23 14 55	6.23	Sgr
Dec	29	18 56 21.3	-24 51 54	1.402	Sgr	15 42 23.7	-17 30 12	1.129	Lib	06 04 29.1	+26 52 39	0.60	Gem	18 09 20.1	-23 14 48	6.23	Sgr
Dec	30	19 03 26.8	-24 43 56	1.394	Sgr	15 47 18.8	-17 47 40	1.135	Lib	06 02 47.2	+26 53 56	0.60	Gem	18 10 19.9	-23 14 40	6.23	Sgr
Dec	31	19 10 32.1	-24 34 27	1.385	Sgr	15 52 15.1	-18 04 42	1.142	Lib	06 01 06.7	+26 55 04	0.60	Gem	18 11 19.7	-23 14 30	6.23	Sgr

GEOCENTRIC PLANET POSITIONS (EPOCH J2000.0) Note: positions refer to 0000 WAST

MTH	DAY	SATURN				URANUS				NEPTUNE			
		RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.	RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.	RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.
Jan	1	09 48 21.1	+14 31 54	8.45	Leo	22 52 38.4	-07 58 32	20.5	Aqr	21 22 04.8	-15 38 41	30.8	Cap
Jan	2	09 48 10.5	+14 33 00	8.44	Leo	22 52 46.0	-07 57 43	20.5	Aqr	21 22 12.3	-15 38 06	30.8	Cap
Jan	3	09 47 59.6	+14 34 08	8.43	Leo	22 52 53.7	-07 56 54	20.6	Aqr	21 22 19.8	-15 37 31	30.8	Cap
Jan	4	09 47 48.3	+14 35 18	8.42	Leo	22 53 01.6	-07 56 04	20.6	Aqr	21 22 27.5	-15 36 56	30.8	Cap
Jan	5	09 47 36.7	+14 36 30	8.41	Leo	22 53 09.6	-07 55 12	20.6	Aqr	21 22 35.2	-15 36 20	30.9	Cap
Jan	6	09 47 24.7	+14 37 43	8.40	Leo	22 53 17.8	-07 54 20	20.6	Aqr	21 22 43.0	-15 35 44	30.9	Cap
Jan	7	09 47 12.4	+14 38 58	8.39	Leo	22 53 26.1	-07 53 27	20.6	Aqr	21 22 50.8	-15 35 08	30.9	Cap
Jan	8	09 46 59.8	+14 40 14	8.38	Leo	22 53 34.5	-07 52 33	20.6	Aqr	21 22 58.7	-15 34 32	30.9	Cap
Jan	9	09 46 46.8	+14 41 32	8.37	Leo	22 53 43.1	-07 51 39	20.7	Aqr	21 23 06.7	-15 33 55	30.9	Cap
Jan	10	09 46 33.4	+14 42 52	8.36	Leo	22 53 51.9	-07 50 43	20.7	Aqr	21 23 14.8	-15 33 17	30.9	Cap
Jan	11	09 46 19.8	+14 44 13	8.35	Leo	22 54 00.8	-07 49 47	20.7	Aqr	21 23 22.9	-15 32 40	30.9	Cap
Jan	12	09 46 05.9	+14 45 35	8.34	Leo	22 54 09.8	-07 48 49	20.7	Aqr	21 23 31.0	-15 32 02	30.9	Cap
Jan	13	09 45 51.6	+14 46 59	8.33	Leo	22 54 19.0	-07 47 51	20.7	Aqr	21 23 39.3	-15 31 24	30.9	Cap
Jan	14	09 45 37.1	+14 48 24	8.32	Leo	22 54 28.3	-07 46 52	20.7	Aqr	21 23 47.5	-15 30 46	30.9	Cap
Jan	15	09 45 22.2	+14 49 50	8.31	Leo	22 54 37.7	-07 45 53	20.7	Aqr	21 23 55.9	-15 30 07	30.9	Cap
Jan	16	09 45 07.1	+14 51 17	8.30	Leo	22 54 47.3	-07 44 52	20.7	Aqr	21 24 04.2	-15 29 28	30.9	Cap
Jan	17	09 44 51.7	+14 52 46	8.30	Leo	22 54 56.9	-07 43 51	20.8	Aqr	21 24 12.7	-15 28 49	31.0	Cap
Jan	18	09 44 36.0	+14 54 16	8.29	Leo	22 55 06.7	-07 42 49	20.8	Aqr	21 24 21.2	-15 28 09	31.0	Cap
Jan	19	09 44 20.1	+14 55 47	8.28	Leo	22 55 16.7	-07 41 46	20.8	Aqr	21 24 29.7	-15 27 30	31.0	Cap
Jan	20	09 44 03.9	+14 57 19	8.28	Leo	22 55 26.7	-07 40 43	20.8	Aqr	21 24 38.3	-15 26 50	31.0	Cap
Jan	21	09 43 47.5	+14 58 52	8.27	Leo	22 55 36.9	-07 39 39	20.8	Aqr	21 24 46.9	-15 26 10	31.0	Cap
Jan	22	09 43 30.9	+15 00 26	8.26	Leo	22 55 47.2	-07 38 34	20.8	Aqr	21 24 55.5	-15 25 30	31.0	Cap
Jan	23	09 43 14.1	+15 02 00	8.26	Leo	22 55 57.6	-07 37 28	20.8	Aqr	21 25 04.2	-15 24 49	31.0	Cap
Jan	24	09 42 57.0	+15 03 36	8.25	Leo	22 56 08.1	-07 36 22	20.8	Aqr	21 25 12.9	-15 24 09	31.0	Cap
Jan	25	09 42 39.8	+15 05 12	8.25	Leo	22 56 18.7	-07 35 15	20.9	Aqr	21 25 21.7	-15 23 28	31.0	Cap
Jan	26	09 42 22.3	+15 06 49	8.24	Leo	22 56 29.4	-07 34 08	20.9	Aqr	21 25 30.5	-15 22 47	31.0	Cap
Jan	27	09 42 04.7	+15 08 26	8.24	Leo	22 56 40.2	-07 32 60	20.9	Aqr	21 25 39.3	-15 22 06	31.0	Cap
Jan	28	09 41 46.9	+15 10 04	8.23	Leo	22 56 51.2	-07 31 51	20.9	Aqr	21 25 48.1	-15 21 24	31.0	Cap
Jan	29	09 41 29.0	+15 11 43	8.23	Leo	22 57 02.2	-07 30 42	20.9	Aqr	21 25 57.0	-15 20 43	31.0	Cap
Jan	30	09 41 10.9	+15 13 22	8.22	Leo	22 57 13.3	-07 29 32	20.9	Aqr	21 26 05.8	-15 20 02	31.0	Cap

GEOCENTRIC PLANET POSITIONS (continued)

MTH	DAY	SATURN RA h	m	s	Declination °	′	″	Dist. (AU)	Cnst.	URANUS RA h	m	s	Declination °	′	″	Dist. (AU)	Cnst.	NEPTUNE RA h	m	s	Declination °	′	″	Dist. (AU)	Cnst.
Jan	31	09	40	52.6	+15	15	01	8.22	Leo	22	57	24.5	-07	28	21	20.9	Aqr	21	26	14.7	-15	19	20	31.0	Cap
Feb	1	09	40	34.3	+15	16	41	8.22	Leo	22	57	35.8	-07	27	10	20.9	Aqr	21	26	23.7	-15	18	38	31.0	Cap
Feb	2	09	40	15.8	+15	18	21	8.21	Leo	22	57	47.2	-07	25	59	20.9	Aqr	21	26	32.6	-15	17	56	31.0	Cap
Feb	3	09	39	57.2	+15	20	01	8.21	Leo	22	57	58.6	-07	24	47	20.9	Aqr	21	26	41.5	-15	17	15	31.0	Cap
Feb	4	09	39	38.6	+15	21	42	8.21	Leo	22	58	10.2	-07	23	35	20.9	Aqr	21	26	50.5	-15	16	33	31.0	Cap
Feb	5	09	39	19.8	+15	23	23	8.21	Leo	22	58	21.8	-07	22	22	21.0	Aqr	21	26	59.5	-15	15	51	31.0	Cap
Feb	6	09	39	01.0	+15	25	03	8.20	Leo	22	58	33.5	-07	21	08	21.0	Aqr	21	27	08.4	-15	15	09	31.0	Cap
Feb	7	09	38	42.1	+15	26	44	8.20	Leo	22	58	45.3	-07	19	54	21.0	Aqr	21	27	17.4	-15	14	26	31.0	Cap
Feb	8	09	38	23.1	+15	28	25	8.20	Leo	22	58	57.1	-07	18	40	21.0	Aqr	21	27	26.4	-15	13	44	31.0	Cap
Feb	9	09	38	04.1	+15	30	05	8.20	Leo	22	59	09.0	-07	17	26	21.0	Aqr	21	27	35.4	-15	13	02	31.0	Cap
Feb	10	09	37	45.0	+15	31	46	8.20	Leo	22	59	21.0	-07	16	10	21.0	Aqr	21	27	44.4	-15	12	20	31.0	Cap
Feb	11	09	37	26.0	+15	33	26	8.20	Leo	22	59	33.1	-07	14	55	21.0	Aqr	21	27	53.3	-15	11	38	31.0	Cap
Feb	12	09	37	06.9	+15	35	06	8.20	Leo	22	59	45.2	-07	13	39	21.0	Aqr	21	28	02.3	-15	10	55	31.0	Cap
Feb	13	09	36	47.8	+15	36	46	8.20	Leo	22	59	57.3	-07	12	23	21.0	Aqr	21	28	11.3	-15	10	13	31.0	Cap
Feb	14	09	36	28.8	+15	38	25	8.20	Leo	23	00	09.6	-07	11	06	21.0	Aqr	21	28	20.3	-15	09	31	31.0	Cap
Feb	15	09	36	09.7	+15	40	04	8.20	Leo	23	00	21.8	-07	09	50	21.0	Aqr	21	28	29.2	-15	08	49	31.0	Cap
Feb	16	09	35	50.7	+15	41	43	8.20	Leo	23	00	34.2	-07	08	32	21.0	Aqr	21	28	38.2	-15	08	07	31.0	Cap
Feb	17	09	35	31.7	+15	43	21	8.21	Leo	23	00	46.5	-07	07	15	21.0	Aqr	21	28	47.1	-15	07	25	31.0	Cap
Feb	18	09	35	12.8	+15	44	58	8.21	Leo	23	00	59.0	-07	05	57	21.0	Aqr	21	28	56.0	-15	06	43	31.0	Cap
Feb	19	09	34	54.0	+15	46	35	8.21	Leo	23	01	11.4	-07	04	39	21.0	Aqr	21	29	04.9	-15	06	01	31.0	Cap
Feb	20	09	34	35.2	+15	48	11	8.21	Leo	23	01	23.9	-07	03	21	21.0	Aqr	21	29	13.7	-15	05	19	31.0	Cap
Feb	21	09	34	16.5	+15	49	46	8.22	Leo	23	01	36.5	-07	02	02	21.1	Aqr	21	29	22.6	-15	04	37	31.0	Cap
Feb	22	09	33	57.9	+15	51	21	8.22	Leo	23	01	49.1	-07	00	44	21.1	Aqr	21	29	31.4	-15	03	56	31.0	Cap
Feb	23	09	33	39.5	+15	52	54	8.22	Leo	23	02	01.7	-06	59	25	21.1	Aqr	21	29	40.2	-15	03	14	31.0	Cap
Feb	24	09	33	21.1	+15	54	27	8.23	Leo	23	02	14.3	-06	58	06	21.1	Aqr	21	29	48.9	-15	02	33	31.0	Cap
Feb	25	09	33	02.9	+15	55	59	8.23	Leo	23	02	27.0	-06	56	47	21.1	Aqr	21	29	57.7	-15	01	52	31.0	Cap
Feb	26	09	32	44.8	+15	57	30	8.24	Leo	23	02	39.7	-06	55	28	21.1	Aqr	21	30	06.4	-15	01	11	31.0	Cap
Feb	27	09	32	26.9	+15	58	59	8.24	Leo	23	02	52.4	-06	54	08	21.1	Aqr	21	30	15.0	-15	00	30	31.0	Cap
Feb	28	09	32	09.2	+16	00	28	8.25	Leo	23	03	05.1	-06	52	49	21.1	Aqr	21	30	23.6	-14	59	49	31.0	Cap
Mar	1	09	31	51.6	+16	01	56	8.25	Leo	23	03	17.8	-06	51	29	21.1	Aqr	21	30	32.2	-14	59	08	31.0	Cap
Mar	2	09	31	34.2	+16	03	22	8.26	Leo	23	03	30.6	-06	50	10	21.1	Aqr	21	30	40.7	-14	58	28	31.0	Cap
Mar	3	09	31	17.0	+16	04	47	8.26	Leo	23	03	43.3	-06	48	50	21.1	Aqr	21	30	49.2	-14	57	48	31.0	Cap
Mar	4	09	30	60.0	+16	06	11	8.27	Leo	23	03	56.1	-06	47	31	21.1	Aqr	21	30	57.7	-14	57	08	31.0	Cap
Mar	5	09	30	43.2	+16	07	34	8.28	Leo	23	04	08.9	-06	46	11	21.1	Aqr	21	31	06.1	-14	56	28	31.0	Cap
Mar	6	09	30	26.6	+16	08	55	8.28	Leo	23	04	21.6	-06	44	51	21.1	Aqr	21	31	14.4	-14	55	49	31.0	Cap
Mar	7	09	30	10.3	+16	10	15	8.29	Leo	23	04	34.4	-06	43	31	21.1	Aqr	21	31	22.7	-14	55	09	30.9	Cap
Mar	8	09	29	54.1	+16	11	34	8.30	Leo	23	04	47.2	-06	42	12	21.1	Aqr	21	31	31.0	-14	54	30	30.9	Cap
Mar	9	09	29	38.3	+16	12	51	8.31	Leo	23	04	59.9	-06	40	52	21.1	Aqr	21	31	39.2	-14	53	51	30.9	Cap
Mar	10	09	29	22.6	+16	14	07	8.31	Leo	23	05	12.7	-06	39	33	21.1	Aqr	21	31	47.3	-14	53	13	30.9	Cap
Mar	11	09	29	07.3	+16	15	21	8.32	Leo	23	05	25.4	-06	38	13	21.1	Aqr	21	31	55.4	-14	52	34	30.9	Cap
Mar	12	09	28	52.2	+16	16	34	8.33	Leo	23	05	38.2	-06	36	54	21.1	Aqr	21	32	03.4	-14	51	56	30.9	Cap
Mar	13	09	28	37.3	+16	17	45	8.34	Leo	23	05	50.9	-06	35	35	21.1	Aqr	21	32	11.4	-14	51	19	30.9	Cap
Mar	14	09	28	22.8	+16	18	54	8.35	Leo	23	06	03.6	-06	34	16	21.1	Aqr	21	32	19.3	-14	50	41	30.9	Cap
Mar	15	09	28	08.6	+16	20	02	8.36	Leo	23	06	16.3	-06	32	57	21.1	Aqr	21	32	27.1	-14	50	04	30.9	Cap
Mar	16	09	27	54.6	+16	21	09	8.37	Leo	23	06	28.9	-06	31	38	21.1	Aqr	21	32	34.9	-14	49	27	30.9	Cap
Mar	17	09	27	41.0	+16	22	13	8.38	Leo	23	06	41.6	-06	30	19	21.1	Aqr	21	32	42.5	-14	48	51	30.9	Cap
Mar	18	09	27	27.7	+16	23	16	8.39	Leo	23	06	54.2	-06	29	01	21.1	Aqr	21	32	50.2	-14	48	14	30.8	Cap
Mar	19	09	27	14.7	+16	24	18	8.40	Leo	23	07	06.7	-06	27	42	21.1	Aqr	21	32	57.7	-14	47	39	30.8	Cap
Mar	20	09	27	02.0	+16	25	17	8.41	Leo	23	07	19.3	-06	26	24	21.1	Aqr	21	33	05.2	-14	47	03	30.8	Cap
Mar	21	09	26	49.7	+16	26	15	8.42	Leo	23	07	31.8	-06	25	07	21.1	Aqr	21	33	12.6	-14	46	28	30.8	Cap
Mar	22	09	26	37.7	+16	27	11	8.43	Leo	23	07	44.2	-06	23	49	21.0	Aqr	21	33	19.9	-14	45	53	30.8	Cap
Mar	23	09	26	26.0	+16	28	05	8.44	Leo	23	07	56.6	-06	22	32	21.0	Aqr	21	33	27.2	-14	45	19	30.8	Cap
Mar	24	09	26	14.7	+16	28	57	8.45	Leo	23	08	09.0	-06	21	15	21.0	Aqr	21	33	34.3	-14	44	45	30.8	Cap
Mar	25	09	26	03.8	+16	29	47	8.46	Leo	23	08	21.3	-06	19	58	21.0	Aqr	21	33	41.4	-14	44	11	30.8	Cap
Mar	26	09	25	53.3	+16	30	35	8.48	Leo	23	08	33.6	-06	18	42	21.0	Aqr	21	33	48.4	-14	43	38	30.8	Cap
Mar	27	09	25	43.1	+16	31	22	8.49	Leo	23	08	45.8	-06	17	26	21.0	Aqr	21	33	55.3	-14	43	05	30.8	Cap
Mar	28	09	25	33.3	+16	32	06	8.50	Leo	23	08	58.0	-06	16	11	21.0	Aqr	21	34	02.2	-14	42	33	30.7	Cap
Mar	29	09	25	23.8	+16	32	49	8.51	Leo	23	09	10.1	-06	14	56	21.0	Aqr	21	34	08.9	-14	42	01	30.7	Cap
Mar	30	09	25	14.8	+16	33	30	8.52	Leo	23	09	22.1	-06	13	41	21.0	Aqr	21	34	15.5	-14	41	29	30.7	Cap
Mar	31	09	25	06.1	+16	34	09	8.54	Leo	23	09	34.1	-06	12	26	21.0	Aqr	21	34	22.1	-14	40	58	30.7	Cap
Apr	1	09	24	57.9	+16	34	45	8.55	Leo	23	09	46.0	-06	11	12	21.0	Aqr	21	34	28.6	-14	40	28	30.7	Cap
Apr	2	09	24	50.0	+16	35	20	8.56	Leo	23	09	57.8	-06	09	59	21.0	Aqr	21	34	34.9	-14	39	57	30.7	Cap
Apr	3	09	24	42.5	+16	35	53	8.58	Leo	23	10	09.6	-06	08	46	21.0	Aqr	21	34	41.2	-14	39	28	30.7	Cap
Apr	4	09	24	35.4	+16	36	24	8.59	Leo	23	10	21.3	-06	07	33	21.0	Aqr	21	34	47.4	-14	38	58	30.7	Cap
Apr	5	09	24	28.7	+16	36	53	8.60	Leo	23	10	33.0	-06	06	21	21.0	Aqr	21	34	53.5	-14	38	30	30.6	Cap
Apr	6	09	24	22.4	+16	37	20	8.62	Leo	23	10	44.5	-06	05	10	21.0	Aqr	21	34	59.5	-14	38	01	30.6	Cap
Apr	7	09	24	16.6	+16	37	45	8.63	Leo	23	10	56.0	-06	03	58	20.9	Aqr	21	35	05.4	-14	37	33	30.6	Cap

GEOCENTRIC PLANET POSITIONS (EPOCH J2000.0) Note: positions refer to 0000 WAST

		SATURN				URANUS				NEPTUNE			
MTH	DAY	RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.	RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.	RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.
Apr	8	09 24 11.1	+16 38 07	8.65	Leo	23 11 07.4	-06 02 48	20.9	Aqr	21 35 11.1	-14 37 06	30.6	Cap
Apr	9	09 24 06.1	+16 38 28	8.66	Leo	23 11 18.7	-06 01 38	20.9	Aqr	21 35 16.8	-14 36 39	30.6	Cap
Apr	10	09 24 01.4	+16 38 47	8.68	Leo	23 11 30.0	-06 00 28	20.9	Aqr	21 35 22.4	-14 36 13	30.6	Cap
Apr	11	09 23 57.2	+16 39 04	8.69	Leo	23 11 41.1	-05 59 19	20.9	Aqr	21 35 27.9	-14 35 47	30.6	Cap
Apr	12	09 23 53.4	+16 39 19	8.71	Leo	23 11 52.2	-05 58 11	20.9	Aqr	21 35 33.2	-14 35 22	30.5	Cap
Apr	13	09 23 50.1	+16 39 31	8.72	Leo	23 12 03.1	-05 57 03	20.9	Aqr	21 35 38.5	-14 34 57	30.5	Cap
Apr	14	09 23 47.1	+16 39 42	8.74	Leo	23 12 14.0	-05 55 56	20.9	Aqr	21 35 43.7	-14 34 33	30.5	Cap
Apr	15	09 23 44.6	+16 39 51	8.75	Leo	23 12 24.8	-05 54 49	20.9	Aqr	21 35 48.7	-14 34 09	30.5	Cap
Apr	16	09 23 42.5	+16 39 57	8.77	Leo	23 12 35.5	-05 53 43	20.9	Aqr	21 35 53.6	-14 33 46	30.5	Cap
Apr	17	09 23 40.8	+16 40 02	8.78	Leo	23 12 46.0	-05 52 38	20.9	Aqr	21 35 58.5	-14 33 23	30.5	Cap
Apr	18	09 23 39.6	+16 40 04	8.80	Leo	23 12 56.5	-05 51 33	20.8	Aqr	21 36 03.2	-14 33 01	30.4	Cap
Apr	19	09 23 38.8	+16 40 05	8.81	Leo	23 13 06.9	-05 50 30	20.8	Aqr	21 36 07.8	-14 32 39	30.4	Cap
Apr	20	09 23 38.4	+16 40 03	8.83	Leo	23 13 17.1	-05 49 26	20.8	Aqr	21 36 12.2	-14 32 19	30.4	Cap
Apr	21	09 23 38.5	+16 39 59	8.84	Leo	23 13 27.3	-05 48 24	20.8	Aqr	21 36 16.6	-14 31 58	30.4	Cap
Apr	22	09 23 39.0	+16 39 54	8.86	Leo	23 13 37.3	-05 47 22	20.8	Aqr	21 36 20.8	-14 31 38	30.4	Cap
Apr	23	09 23 39.9	+16 39 46	8.88	Leo	23 13 47.2	-05 46 21	20.8	Aqr	21 36 25.0	-14 31 19	30.4	Cap
Apr	24	09 23 41.2	+16 39 36	8.89	Leo	23 13 57.1	-05 45 21	20.8	Aqr	21 36 29.0	-14 31 01	30.4	Cap
Apr	25	09 23 43.0	+16 39 24	8.91	Leo	23 14 06.7	-05 44 21	20.8	Aqr	21 36 32.9	-14 30 42	30.3	Cap
Apr	26	09 23 45.2	+16 39 10	8.92	Leo	23 14 16.3	-05 43 22	20.8	Aqr	21 36 36.6	-14 30 25	30.3	Cap
Apr	27	09 23 47.8	+16 38 54	8.94	Leo	23 14 25.8	-05 42 24	20.7	Aqr	21 36 40.3	-14 30 08	30.3	Cap
Apr	28	09 23 50.9	+16 38 37	8.96	Leo	23 14 35.1	-05 41 27	20.7	Aqr	21 36 43.8	-14 29 52	30.3	Cap
Apr	29	09 23 54.3	+16 38 17	8.97	Leo	23 14 44.3	-05 40 31	20.7	Aqr	21 36 47.2	-14 29 36	30.3	Cap
Apr	30	09 23 58.2	+16 37 55	8.99	Leo	23 14 53.3	-05 39 35	20.7	Aqr	21 36 50.5	-14 29 21	30.3	Cap
May	1	09 24 02.5	+16 37 31	9.01	Leo	23 15 02.3	-05 38 41	20.7	Aqr	21 36 53.7	-14 29 07	30.2	Cap
May	2	09 24 07.3	+16 37 05	9.02	Leo	23 15 11.1	-05 37 47	20.7	Aqr	21 36 56.7	-14 28 53	30.2	Cap
May	3	09 24 12.4	+16 36 37	9.04	Leo	23 15 19.8	-05 36 54	20.7	Aqr	21 36 59.6	-14 28 40	30.2	Cap
May	4	09 24 17.9	+16 36 08	9.05	Leo	23 15 28.3	-05 36 02	20.6	Aqr	21 37 02.4	-14 28 27	30.2	Cap
May	5	09 24 23.9	+16 35 36	9.07	Leo	23 15 36.7	-05 35 10	20.6	Aqr	21 37 05.1	-14 28 15	30.2	Cap
May	6	09 24 30.3	+16 35 02	9.09	Leo	23 15 45.0	-05 34 20	20.6	Aqr	21 37 07.6	-14 28 04	30.2	Cap
May	7	09 24 37.1	+16 34 27	9.10	Leo	23 15 53.2	-05 33 30	20.6	Aqr	21 37 10.0	-14 27 53	30.1	Cap
May	8	09 24 44.3	+16 33 50	9.12	Leo	23 16 01.2	-05 32 42	20.6	Aqr	21 37 12.3	-14 27 43	30.1	Cap
May	9	09 24 51.9	+16 33 10	9.14	Leo	23 16 09.0	-05 31 54	20.6	Aqr	21 37 14.5	-14 27 33	30.1	Cap
May	10	09 24 59.9	+16 32 29	9.15	Leo	23 16 16.7	-05 31 07	20.6	Aqr	21 37 16.5	-14 27 24	30.1	Cap
May	11	09 25 08.3	+16 31 46	9.17	Leo	23 16 24.3	-05 30 21	20.5	Aqr	21 37 18.4	-14 27 16	30.1	Cap
May	12	09 25 17.1	+16 31 01	9.19	Leo	23 16 31.7	-05 29 37	20.5	Aqr	21 37 20.2	-14 27 09	30.1	Cap
May	13	09 25 26.3	+16 30 14	9.20	Leo	23 16 39.0	-05 28 53	20.5	Aqr	21 37 21.9	-14 27 02	30.0	Cap
May	14	09 25 35.9	+16 29 25	9.22	Leo	23 16 46.1	-05 28 10	20.5	Aqr	21 37 23.4	-14 26 55	30.0	Cap
May	15	09 25 45.9	+16 28 35	9.24	Leo	23 16 53.1	-05 27 28	20.5	Aqr	21 37 24.8	-14 26 50	30.0	Cap
May	16	09 25 56.2	+16 27 42	9.25	Leo	23 16 59.9	-05 26 47	20.5	Aqr	21 37 26.1	-14 26 44	30.0	Cap
May	17	09 26 07.0	+16 26 48	9.27	Leo	23 17 06.6	-05 26 07	20.5	Aqr	21 37 27.2	-14 26 40	30.0	Cap
May	18	09 26 18.1	+16 25 52	9.29	Leo	23 17 13.1	-05 25 28	20.4	Aqr	21 37 28.2	-14 26 36	30.0	Cap
May	19	09 26 29.7	+16 24 54	9.30	Leo	23 17 19.4	-05 24 50	20.4	Aqr	21 37 29.1	-14 26 33	29.9	Cap
May	20	09 26 41.6	+16 23 54	9.32	Leo	23 17 25.6	-05 24 13	20.4	Aqr	21 37 29.9	-14 26 31	29.9	Cap
May	21	09 26 53.9	+16 22 53	9.34	Leo	23 17 31.6	-05 23 37	20.4	Aqr	21 37 30.5	-14 26 29	29.9	Cap
May	22	09 27 06.5	+16 21 49	9.35	Leo	23 17 37.5	-05 23 02	20.4	Aqr	21 37 31.0	-14 26 28	29.9	Cap
May	23	09 27 19.5	+16 20 44	9.37	Leo	23 17 43.2	-05 22 28	20.4	Aqr	21 37 31.4	-14 26 27	29.9	Cap
May	24	09 27 32.9	+16 19 37	9.39	Leo	23 17 48.7	-05 21 55	20.3	Aqr	21 37 31.6	-14 26 27	29.9	Cap
May	25	09 27 46.6	+16 18 29	9.40	Leo	23 17 54.1	-05 21 23	20.3	Aqr	21 37 31.7	-14 26 28	29.8	Cap
May	26	09 28 00.7	+16 17 19	9.42	Leo	23 17 59.3	-05 20 53	20.3	Aqr	21 37 31.7	-14 26 29	29.8	Cap
May	27	09 28 15.2	+16 16 07	9.43	Leo	23 18 04.3	-05 20 23	20.3	Aqr	21 37 31.6	-14 26 31	29.8	Cap
May	28	09 28 29.9	+16 14 53	9.45	Leo	23 18 09.2	-05 19 55	20.3	Aqr	21 37 31.3	-14 26 34	29.8	Cap
May	29	09 28 45.1	+16 13 38	9.47	Leo	23 18 13.9	-05 19 27	20.3	Aqr	21 37 30.9	-14 26 37	29.8	Cap
May	30	09 29 00.5	+16 12 21	9.48	Leo	23 18 18.4	-05 19 01	20.3	Aqr	21 37 30.4	-14 26 41	29.8	Cap
May	31	09 29 16.3	+16 11 03	9.50	Leo	23 18 22.8	-05 18 35	20.2	Aqr	21 37 29.7	-14 26 45	29.7	Cap
Jun	1	09 29 32.5	+16 09 42	9.51	Leo	23 18 27.0	-05 18 11	20.2	Aqr	21 37 29.0	-14 26 50	29.7	Cap
Jun	2	09 29 48.9	+16 08 21	9.53	Leo	23 18 31.0	-05 17 48	20.2	Aqr	21 37 28.1	-14 26 56	29.7	Cap
Jun	3	09 30 05.7	+16 06 57	9.54	Leo	23 18 34.9	-05 17 26	20.2	Aqr	21 37 27.0	-14 27 02	29.7	Cap
Jun	4	09 30 22.8	+16 05 33	9.56	Leo	23 18 38.6	-05 17 05	20.2	Aqr	21 37 25.9	-14 27 09	29.7	Cap
Jun	5	09 30 40.2	+16 04 06	9.57	Leo	23 18 42.1	-05 16 45	20.2	Aqr	21 37 24.6	-14 27 16	29.7	Cap
Jun	6	09 30 58.0	+16 02 38	9.59	Leo	23 18 45.4	-05 16 27	20.1	Aqr	21 37 23.3	-14 27 25	29.6	Cap
Jun	7	09 31 16.0	+16 01 09	9.60	Leo	23 18 48.6	-05 16 09	20.1	Aqr	21 37 21.7	-14 27 33	29.6	Cap
Jun	8	09 31 34.3	+15 59 38	9.62	Leo	23 18 51.5	-05 15 53	20.1	Aqr	21 37 20.1	-14 27 43	29.6	Cap
Jun	9	09 31 53.0	+15 58 05	9.63	Leo	23 18 54.3	-05 15 37	20.1	Aqr	21 37 18.4	-14 27 52	29.6	Cap
Jun	10	09 32 11.9	+15 56 31	9.65	Leo	23 18 57.0	-05 15 23	20.1	Aqr	21 37 16.5	-14 28 03	29.6	Cap
Jun	11	09 32 31.2	+15 54 56	9.66	Leo	23 18 59.4	-05 15 10	20.1	Aqr	21 37 14.5	-14 28 14	29.6	Cap
Jun	12	09 32 50.7	+15 53 19	9.68	Leo	23 19 01.7	-05 14 58	20.0	Aqr	21 37 12.4	-14 28 26	29.6	Cap
Jun	13	09 33 10.5	+15 51 40	9.69	Leo	23 19 03.8	-05 14 47	20.0	Aqr	21 37 10.2	-14 28 38	29.5	Cap

GEOCENTRIC PLANET POSITIONS (continued)

MTH	DAY	SATURN RA (h m s)	SATURN Declination (° ′ ″)	SATURN Dist. (AU)	SATURN Cnst.	URANUS RA (h m s)	URANUS Declination (° ′ ″)	URANUS Dist. (AU)	URANUS Cnst.	NEPTUNE RA (h m s)	NEPTUNE Declination (° ′ ″)	NEPTUNE Dist. (AU)	NEPTUNE Cnst.
Jun	14	09 33 30.7	+15 50 00	9.71	Leo	23 19 05.7	-05 14 38	20.0	Aqr	21 37 07.8	-14 28 51	29.5	Cap
Jun	15	09 33 51.0	+15 48 19	9.72	Leo	23 19 07.4	-05 14 29	20.0	Aqr	21 37 05.4	-14 29 04	29.5	Cap
Jun	16	09 34 11.7	+15 46 36	9.74	Leo	23 19 09.0	-05 14 22	20.0	Aqr	21 37 02.8	-14 29 18	29.5	Cap
Jun	17	09 34 32.6	+15 44 52	9.75	Leo	23 19 10.4	-05 14 16	20.0	Aqr	21 37 00.1	-14 29 33	29.5	Cap
Jun	18	09 34 53.8	+15 43 07	9.76	Leo	23 19 11.6	-05 14 11	19.9	Aqr	21 36 57.3	-14 29 48	29.5	Cap
Jun	19	09 35 15.3	+15 41 20	9.78	Leo	23 19 12.6	-05 14 07	19.9	Aqr	21 36 54.4	-14 30 03	29.4	Cap
Jun	20	09 35 37.0	+15 39 32	9.79	Leo	23 19 13.4	-05 14 04	19.9	Aqr	21 36 51.4	-14 30 19	29.4	Cap
Jun	21	09 35 59.0	+15 37 42	9.80	Leo	23 19 14.1	-05 14 02	19.9	Aqr	21 36 48.2	-14 30 36	29.4	Cap
Jun	22	09 36 21.2	+15 35 51	9.82	Leo	23 19 14.5	-05 14 02	19.9	Aqr	21 36 45.0	-14 30 53	29.4	Cap
Jun	23	09 36 43.7	+15 33 59	9.83	Leo	23 19 14.8	-05 14 02	19.9	Aqr	21 36 41.7	-14 31 11	29.4	Cap
Jun	24	09 37 06.4	+15 32 06	9.84	Leo	23 19 14.9	-05 14 04	19.8	Aqr	21 36 38.2	-14 31 29	29.4	Cap
Jun	25	09 37 29.3	+15 30 11	9.85	Leo	23 19 14.9	-05 14 07	19.8	Aqr	21 36 34.7	-14 31 48	29.4	Cap
Jun	26	09 37 52.4	+15 28 16	9.87	Leo	23 19 14.6	-05 14 11	19.8	Aqr	21 36 31.0	-14 32 07	29.4	Cap
Jun	27	09 38 15.8	+15 26 19	9.88	Leo	23 19 14.2	-05 14 16	19.8	Aqr	21 36 27.3	-14 32 27	29.3	Cap
Jun	28	09 38 39.4	+15 24 20	9.89	Leo	23 19 13.6	-05 14 23	19.8	Aqr	21 36 23.4	-14 32 47	29.3	Cap
Jun	29	09 39 03.3	+15 22 21	9.90	Leo	23 19 12.8	-05 14 30	19.8	Aqr	21 36 19.5	-14 33 08	29.3	Cap
Jun	30	09 39 27.3	+15 20 21	9.91	Leo	23 19 11.9	-05 14 38	19.7	Aqr	21 36 15.4	-14 33 29	29.3	Cap
Jul	1	09 39 51.6	+15 18 19	9.93	Leo	23 19 10.8	-05 14 48	19.7	Aqr	21 36 11.3	-14 33 50	29.3	Cap
Jul	2	09 40 16.0	+15 16 16	9.94	Leo	23 19 09.5	-05 14 59	19.7	Aqr	21 36 07.0	-14 34 12	29.3	Cap
Jul	3	09 40 40.7	+15 14 12	9.95	Leo	23 19 08.0	-05 15 10	19.7	Aqr	21 36 02.7	-14 34 35	29.3	Cap
Jul	4	09 41 05.5	+15 12 07	9.96	Leo	23 19 06.3	-05 15 23	19.7	Aqr	21 35 58.3	-14 34 58	29.3	Cap
Jul	5	09 41 30.6	+15 10 01	9.97	Leo	23 19 04.5	-05 15 37	19.7	Aqr	21 35 53.8	-14 35 21	29.3	Cap
Jul	6	09 41 55.8	+15 07 54	9.98	Leo	23 19 02.5	-05 15 52	19.6	Aqr	21 35 49.2	-14 35 45	29.2	Cap
Jul	7	09 42 21.2	+15 05 46	9.99	Leo	23 19 00.4	-05 16 08	19.6	Aqr	21 35 44.5	-14 36 09	29.2	Cap
Jul	8	09 42 46.8	+15 03 37	10.00	Leo	23 18 58.0	-05 16 26	19.6	Aqr	21 35 39.8	-14 36 33	29.2	Cap
Jul	9	09 43 12.6	+15 01 27	10.01	Leo	23 18 55.5	-05 16 44	19.6	Aqr	21 35 34.9	-14 36 58	29.2	Cap
Jul	10	09 43 38.6	+14 59 15	10.02	Leo	23 18 52.8	-05 17 03	19.6	Aqr	21 35 30.0	-14 37 24	29.2	Cap
Jul	11	09 44 04.7	+14 57 03	10.03	Leo	23 18 50.0	-05 17 24	19.6	Aqr	21 35 25.0	-14 37 49	29.2	Cap
Jul	12	09 44 31.0	+14 54 50	10.04	Leo	23 18 47.0	-05 17 45	19.6	Aqr	21 35 19.9	-14 38 15	29.2	Cap
Jul	13	09 44 57.4	+14 52 36	10.05	Leo	23 18 43.8	-05 18 07	19.5	Aqr	21 35 14.7	-14 38 42	29.2	Cap
Jul	14	09 45 24.0	+14 50 21	10.06	Leo	23 18 40.5	-05 18 31	19.5	Aqr	21 35 09.5	-14 39 09	29.2	Cap
Jul	15	09 45 50.8	+14 48 05	10.07	Leo	23 18 37.0	-05 18 55	19.5	Aqr	21 35 04.2	-14 39 36	29.2	Cap
Jul	16	09 46 17.7	+14 45 48	10.08	Leo	23 18 33.3	-05 19 21	19.5	Aqr	21 34 58.8	-14 40 03	29.1	Cap
Jul	17	09 46 44.8	+14 43 30	10.09	Leo	23 18 29.4	-05 19 47	19.5	Aqr	21 34 53.4	-14 40 31	29.1	Cap
Jul	18	09 47 12.0	+14 41 12	10.10	Leo	23 18 25.5	-05 20 15	19.5	Aqr	21 34 47.9	-14 40 59	29.1	Cap
Jul	19	09 47 39.3	+14 38 52	10.10	Leo	23 18 21.3	-05 20 43	19.5	Aqr	21 34 42.3	-14 41 27	29.1	Cap
Jul	20	09 48 06.8	+14 36 32	10.11	Leo	23 18 17.0	-05 21 13	19.4	Aqr	21 34 36.7	-14 41 56	29.1	Cap
Jul	21	09 48 34.4	+14 34 11	10.12	Leo	23 18 12.5	-05 21 43	19.4	Aqr	21 34 31.0	-14 42 25	29.1	Cap
Jul	22	09 49 02.1	+14 31 50	10.13	Leo	23 18 07.9	-05 22 15	19.4	Aqr	21 34 25.3	-14 42 54	29.1	Cap
Jul	23	09 49 29.9	+14 29 27	10.13	Leo	23 18 03.2	-05 22 47	19.4	Aqr	21 34 19.5	-14 43 23	29.1	Cap
Jul	24	09 49 57.9	+14 27 04	10.14	Leo	23 17 58.3	-05 23 20	19.4	Aqr	21 34 13.6	-14 43 53	29.1	Cap
Jul	25	09 50 25.9	+14 24 40	10.15	Leo	23 17 53.2	-05 23 54	19.4	Aqr	21 34 07.7	-14 44 22	29.1	Cap
Jul	26	09 50 54.1	+14 22 16	10.15	Leo	23 17 48.0	-05 24 29	19.4	Aqr	21 34 01.8	-14 44 52	29.1	Cap
Jul	27	09 51 22.4	+14 19 50	10.16	Leo	23 17 42.7	-05 25 05	19.4	Aqr	21 33 55.8	-14 45 23	29.1	Cap
Jul	28	09 51 50.7	+14 17 25	10.17	Leo	23 17 37.2	-05 25 41	19.3	Aqr	21 33 49.8	-14 45 53	29.1	Cap
Jul	29	09 52 19.2	+14 14 58	10.17	Leo	23 17 31.6	-05 26 19	19.3	Aqr	21 33 43.7	-14 46 24	29.1	Cap
Jul	30	09 52 47.7	+14 12 31	10.18	Leo	23 17 25.8	-05 26 57	19.3	Aqr	21 33 37.6	-14 46 54	29.1	Cap
Jul	31	09 53 16.3	+14 10 03	10.18	Leo	23 17 19.9	-05 27 36	19.3	Aqr	21 33 31.5	-14 47 25	29.1	Cap
Aug	1	09 53 45.0	+14 07 35	10.19	Leo	23 17 13.9	-05 28 16	19.3	Aqr	21 33 25.3	-14 47 56	29.1	Cap
Aug	2	09 54 13.8	+14 05 06	10.19	Leo	23 17 07.8	-05 28 57	19.3	Aqr	21 33 19.1	-14 48 27	29.1	Cap
Aug	3	09 54 42.7	+14 02 37	10.20	Leo	23 17 01.5	-05 29 38	19.3	Aqr	21 33 12.8	-14 48 59	29.0	Cap
Aug	4	09 55 11.6	+14 00 07	10.20	Leo	23 16 55.1	-05 30 20	19.3	Aqr	21 33 06.6	-14 49 30	29.0	Cap
Aug	5	09 55 40.6	+13 57 37	10.21	Leo	23 16 48.6	-05 31 03	19.3	Aqr	21 33 00.3	-14 50 02	29.0	Cap
Aug	6	09 56 09.7	+13 55 06	10.21	Leo	23 16 42.0	-05 31 47	19.3	Aqr	21 32 53.9	-14 50 33	29.0	Cap
Aug	7	09 56 38.8	+13 52 35	10.21	Leo	23 16 35.2	-05 32 31	19.2	Aqr	21 32 47.6	-14 51 05	29.0	Cap
Aug	8	09 57 08.0	+13 50 03	10.22	Leo	23 16 28.3	-05 33 16	19.2	Aqr	21 32 41.3	-14 51 37	29.0	Cap
Aug	9	09 57 37.2	+13 47 31	10.22	Leo	23 16 21.3	-05 34 02	19.2	Aqr	21 32 34.9	-14 52 08	29.0	Cap
Aug	10	09 58 06.5	+13 44 58	10.23	Leo	23 16 14.2	-05 34 48	19.2	Aqr	21 32 28.5	-14 52 40	29.0	Cap
Aug	11	09 58 35.8	+13 42 26	10.23	Leo	23 16 07.0	-05 35 35	19.2	Aqr	21 32 22.1	-14 53 12	29.0	Cap
Aug	12	09 59 05.1	+13 39 52	10.23	Leo	23 15 59.7	-05 36 23	19.2	Aqr	21 32 15.7	-14 53 44	29.0	Cap
Aug	13	09 59 34.5	+13 37 19	10.23	Leo	23 15 52.3	-05 37 11	19.2	Aqr	21 32 09.3	-14 54 16	29.0	Cap
Aug	14	10 00 04.0	+13 34 45	10.24	Leo	23 15 44.8	-05 37 60	19.2	Aqr	21 32 02.9	-14 54 48	29.0	Cap
Aug	15	10 00 33.4	+13 32 11	10.24	Leo	23 15 37.2	-05 38 49	19.2	Aqr	21 31 56.4	-14 55 20	29.0	Cap
Aug	16	10 01 02.9	+13 29 36	10.24	Leo	23 15 29.5	-05 39 39	19.2	Aqr	21 31 50.0	-14 55 52	29.0	Cap
Aug	17	10 01 32.4	+13 27 02	10.24	Leo	23 15 21.7	-05 40 29	19.2	Aqr	21 31 43.6	-14 56 23	29.0	Cap
Aug	18	10 02 01.9	+13 24 27	10.24	Leo	23 15 13.9	-05 41 20	19.2	Aqr	21 31 37.2	-14 56 55	29.0	Cap
Aug	19	10 02 31.4	+13 21 52	10.24	Leo	23 15 05.9	-05 42 11	19.2	Aqr	21 31 30.8	-14 57 27	29.0	Cap

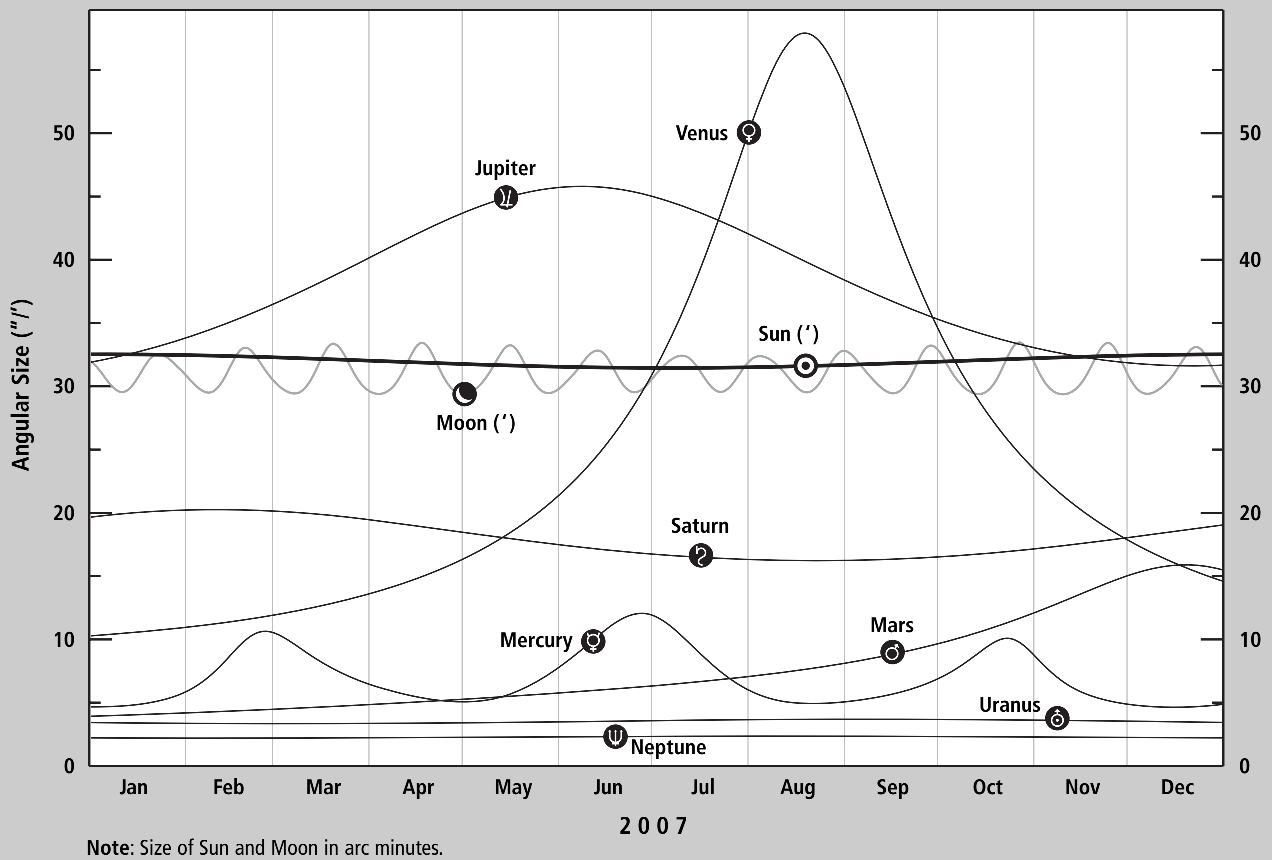
GEOCENTRIC PLANET POSITIONS (EPOCH J2000.0) Note: positions refer to 0000 WAST

MTH	DAY	SATURN RA			SATURN Declination			SATURN Dist. (AU)	SATURN Cnst.	URANUS RA			URANUS Declination			URANUS Dist. (AU)	URANUS Cnst.	NEPTUNE RA			NEPTUNE Declination			NEPTUNE Dist. (AU)	NEPTUNE Cnst.
		h	m	s	°	′	″			h	m	s	°	′	″			h	m	s	°	′	″		
Aug	20	10	03	00.9	+13	19	17	10.24	Leo	23	14	57.9	-05	43	03	19.1	Aqr	21	31	24.4	-14	57	58	29.0	Cap
Aug	21	10	03	30.4	+13	16	41	10.24	Leo	23	14	49.8	-05	43	55	19.1	Aqr	21	31	18.1	-14	58	30	29.0	Cap
Aug	22	10	03	59.9	+13	14	06	10.24	Leo	23	14	41.6	-05	44	48	19.1	Aqr	21	31	11.7	-14	59	01	29.0	Cap
Aug	23	10	04	29.4	+13	11	31	10.24	Leo	23	14	33.4	-05	45	41	19.1	Aqr	21	31	05.4	-14	59	32	29.0	Cap
Aug	24	10	04	58.9	+13	08	55	10.24	Leo	23	14	25.1	-05	46	34	19.1	Aqr	21	30	59.1	-15	00	04	29.0	Cap
Aug	25	10	05	28.4	+13	06	20	10.24	Leo	23	14	16.7	-05	47	28	19.1	Aqr	21	30	52.8	-15	00	35	29.1	Cap
Aug	26	10	05	57.8	+13	03	44	10.24	Leo	23	14	08.3	-05	48	22	19.1	Aqr	21	30	46.5	-15	01	05	29.1	Cap
Aug	27	10	06	27.3	+13	01	08	10.24	Leo	23	13	59.8	-05	49	16	19.1	Aqr	21	30	40.3	-15	01	36	29.1	Cap
Aug	28	10	06	56.7	+12	58	33	10.24	Leo	23	13	51.2	-05	50	10	19.1	Aqr	21	30	34.1	-15	02	07	29.1	Cap
Aug	29	10	07	26.0	+12	55	57	10.24	Leo	23	13	42.7	-05	51	05	19.1	Aqr	21	30	27.9	-15	02	37	29.1	Cap
Aug	30	10	07	55.4	+12	53	22	10.24	Leo	23	13	34.0	-05	52	00	19.1	Aqr	21	30	21.8	-15	03	07	29.1	Cap
Aug	31	10	08	24.7	+12	50	46	10.24	Leo	23	13	25.4	-05	52	55	19.1	Aqr	21	30	15.7	-15	03	37	29.1	Cap
Sep	1	10	08	53.9	+12	48	11	10.23	Leo	23	13	16.7	-05	53	51	19.1	Aqr	21	30	09.6	-15	04	07	29.1	Cap
Sep	2	10	09	23.1	+12	45	36	10.23	Leo	23	13	07.9	-05	54	46	19.1	Aqr	21	30	03.6	-15	04	36	29.1	Cap
Sep	3	10	09	52.3	+12	43	01	10.23	Leo	23	12	59.1	-05	55	42	19.1	Aqr	21	29	57.7	-15	05	05	29.1	Cap
Sep	4	10	10	21.4	+12	40	26	10.22	Leo	23	12	50.3	-05	56	38	19.1	Aqr	21	29	51.7	-15	05	34	29.1	Cap
Sep	5	10	10	50.5	+12	37	52	10.22	Leo	23	12	41.5	-05	57	34	19.1	Aqr	21	29	45.9	-15	06	03	29.1	Cap
Sep	6	10	11	19.5	+12	35	17	10.22	Leo	23	12	32.6	-05	58	30	19.1	Aqr	21	29	40.0	-15	06	32	29.1	Cap
Sep	7	10	11	48.4	+12	32	43	10.21	Leo	23	12	23.8	-05	59	26	19.1	Aqr	21	29	34.3	-15	06	60	29.1	Cap
Sep	8	10	12	17.3	+12	30	09	10.21	Leo	23	12	14.9	-06	00	22	19.1	Aqr	21	29	28.6	-15	07	28	29.1	Cap
Sep	9	10	12	46.0	+12	27	36	10.21	Leo	23	12	06.0	-06	01	18	19.1	Aqr	21	29	22.9	-15	07	55	29.1	Cap
Sep	10	10	13	14.8	+12	25	03	10.20	Leo	23	11	57.1	-06	02	14	19.1	Aqr	21	29	17.3	-15	08	23	29.1	Cap
Sep	11	10	13	43.4	+12	22	30	10.20	Leo	23	11	48.2	-06	03	10	19.1	Aqr	21	29	11.8	-15	08	50	29.1	Cap
Sep	12	10	14	11.9	+12	19	58	10.19	Leo	23	11	39.3	-06	04	06	19.1	Aqr	21	29	06.3	-15	09	16	29.2	Cap
Sep	13	10	14	40.4	+12	17	26	10.19	Leo	23	11	30.4	-06	05	01	19.1	Aqr	21	29	00.9	-15	09	43	29.2	Cap
Sep	14	10	15	08.7	+12	14	54	10.18	Leo	23	11	21.5	-06	05	57	19.1	Aqr	21	28	55.6	-15	10	09	29.2	Cap
Sep	15	10	15	37.0	+12	12	23	10.18	Leo	23	11	12.7	-06	06	53	19.1	Aqr	21	28	50.3	-15	10	34	29.2	Cap
Sep	16	10	16	05.1	+12	09	52	10.17	Leo	23	11	03.8	-06	07	48	19.1	Aqr	21	28	45.2	-15	10	59	29.2	Cap
Sep	17	10	16	33.2	+12	07	22	10.17	Leo	23	10	55.0	-06	08	43	19.1	Aqr	21	28	40.0	-15	11	24	29.2	Cap
Sep	18	10	17	01.1	+12	04	53	10.16	Leo	23	10	46.2	-06	09	38	19.1	Aqr	21	28	35.0	-15	11	49	29.2	Cap
Sep	19	10	17	28.9	+12	02	24	10.15	Leo	23	10	37.4	-06	10	33	19.1	Aqr	21	28	30.1	-15	12	13	29.2	Cap
Sep	20	10	17	56.6	+11	59	56	10.15	Leo	23	10	28.6	-06	11	27	19.1	Aqr	21	28	25.2	-15	12	36	29.2	Cap
Sep	21	10	18	24.1	+11	57	28	10.14	Leo	23	10	19.9	-06	12	22	19.1	Aqr	21	28	20.4	-15	12	59	29.2	Cap
Sep	22	10	18	51.6	+11	55	01	10.13	Leo	23	10	11.3	-06	13	15	19.1	Aqr	21	28	15.8	-15	13	22	29.3	Cap
Sep	23	10	19	18.9	+11	52	35	10.12	Leo	23	10	02.6	-06	14	09	19.1	Aqr	21	28	11.1	-15	13	45	29.3	Cap
Sep	24	10	19	46.0	+11	50	09	10.12	Leo	23	09	54.1	-06	15	02	19.1	Aqr	21	28	06.6	-15	14	06	29.3	Cap
Sep	25	10	20	13.0	+11	47	44	10.11	Leo	23	09	45.5	-06	15	55	19.1	Aqr	21	28	02.2	-15	14	28	29.3	Cap
Sep	26	10	20	39.9	+11	45	20	10.10	Leo	23	09	37.1	-06	16	47	19.1	Aqr	21	27	57.9	-15	14	49	29.3	Cap
Sep	27	10	21	06.6	+11	42	57	10.09	Leo	23	09	28.6	-06	17	39	19.1	Aqr	21	27	53.7	-15	15	09	29.3	Cap
Sep	28	10	21	33.2	+11	40	35	10.08	Leo	23	09	20.3	-06	18	31	19.1	Aqr	21	27	49.5	-15	15	29	29.3	Cap
Sep	29	10	21	59.6	+11	38	13	10.08	Leo	23	09	12.0	-06	19	22	19.1	Aqr	21	27	45.5	-15	15	49	29.3	Cap
Sep	30	10	22	25.9	+11	35	52	10.07	Leo	23	09	03.8	-06	20	13	19.2	Aqr	21	27	41.5	-15	16	08	29.3	Cap
Oct	1	10	22	52.0	+11	33	32	10.06	Leo	23	08	55.6	-06	21	03	19.2	Aqr	21	27	37.7	-15	16	26	29.4	Cap
Oct	2	10	23	17.9	+11	31	13	10.05	Leo	23	08	47.5	-06	21	52	19.2	Aqr	21	27	34.0	-15	16	44	29.4	Cap
Oct	3	10	23	43.7	+11	28	55	10.04	Leo	23	08	39.5	-06	22	41	19.2	Aqr	21	27	30.3	-15	17	02	29.4	Cap
Oct	4	10	24	09.2	+11	26	38	10.03	Leo	23	08	31.6	-06	23	30	19.2	Aqr	21	27	26.8	-15	17	19	29.4	Cap
Oct	5	10	24	34.6	+11	24	22	10.02	Leo	23	08	23.8	-06	24	18	19.2	Aqr	21	27	23.4	-15	17	36	29.4	Cap
Oct	6	10	24	59.8	+11	22	07	10.01	Leo	23	08	16.0	-06	25	05	19.2	Aqr	21	27	20.1	-15	17	51	29.4	Cap
Oct	7	10	25	24.9	+11	19	53	10.00	Leo	23	08	08.4	-06	25	52	19.2	Aqr	21	27	16.9	-15	18	07	29.4	Cap
Oct	8	10	25	49.7	+11	17	40	9.99	Leo	23	08	00.8	-06	26	38	19.2	Aqr	21	27	13.8	-15	18	22	29.5	Cap
Oct	9	10	26	14.3	+11	15	28	9.98	Leo	23	07	53.3	-06	27	23	19.2	Aqr	21	27	10.8	-15	18	36	29.5	Cap
Oct	10	10	26	38.8	+11	13	18	9.97	Leo	23	07	46.0	-06	28	08	19.2	Aqr	21	27	08.0	-15	18	50	29.5	Cap
Oct	11	10	27	03.0	+11	11	08	9.96	Leo	23	07	38.7	-06	28	52	19.2	Aqr	21	27	05.2	-15	19	03	29.5	Cap
Oct	12	10	27	27.0	+11	09	00	9.95	Leo	23	07	31.6	-06	29	35	19.2	Aqr	21	27	02.6	-15	19	16	29.5	Cap
Oct	13	10	27	50.8	+11	06	53	9.93	Leo	23	07	24.5	-06	30	18	19.3	Aqr	21	27	00.1	-15	19	28	29.5	Cap
Oct	14	10	28	14.3	+11	04	48	9.92	Leo	23	07	17.6	-06	30	59	19.3	Aqr	21	26	57.7	-15	19	39	29.5	Cap
Oct	15	10	28	37.7	+11	02	43	9.91	Leo	23	07	10.8	-06	31	40	19.3	Aqr	21	26	55.5	-15	19	50	29.6	Cap
Oct	16	10	29	00.8	+11	00	40	9.90	Leo	23	07	04.1	-06	32	20	19.3	Aqr	21	26	53.3	-15	20	01	29.6	Cap
Oct	17	10	29	23.7	+10	58	38	9.89	Leo	23	06	57.5	-06	32	60	19.3	Aqr	21	26	51.3	-15	20	10	29.6	Cap
Oct	18	10	29	46.3	+10	56	38	9.87	Leo	23	06	51.1	-06	33	38	19.3	Aqr	21	26	49.4	-15	20	19	29.6	Cap
Oct	19	10	30	08.7	+10	54	39	9.86	Leo	23	06	44.8	-06	34	16	19.3	Aqr	21	26	47.6	-15	20	28	29.6	Cap
Oct	20	10	30	30.9	+10	52	42	9.85	Leo	23	06	38.6	-06	34	52	19.3	Aqr	21	26	46.0	-15	20	36	29.6	Cap
Oct	21	10	30	52.8	+10	50	46	9.84	Leo	23	06	32.6	-06	35	28	19.3	Aqr	21	26	44.5	-15	20	43	29.7	Cap
Oct	22	10	31	14.4	+10	48	51	9.82	Leo	23	06	26.7	-06	36	03	19.4	Aqr	21	26	43.1	-15	20	50	29.7	Cap
Oct	23	10	31	35.8	+10	46	58	9.81	Leo	23	06	20.9	-06	36	37	19.4	Aqr	21	26	41.9	-15	20	56	29.7	Cap
Oct	24	10	31	57.0	+10	45	07	9.80	Leo	23	06	15.3	-06	37	10	19.4	Aqr	21	26	40.7	-15	21	01	29.7	Cap
Oct	25	10	32	17.8	+10	43	17	9.78	Leo	23	06	09.9	-06	37	43	19.4	Aqr	21	26	39.7	-15	21	06	29.7	Cap

GEOCENTRIC PLANET POSITIONS (continued)

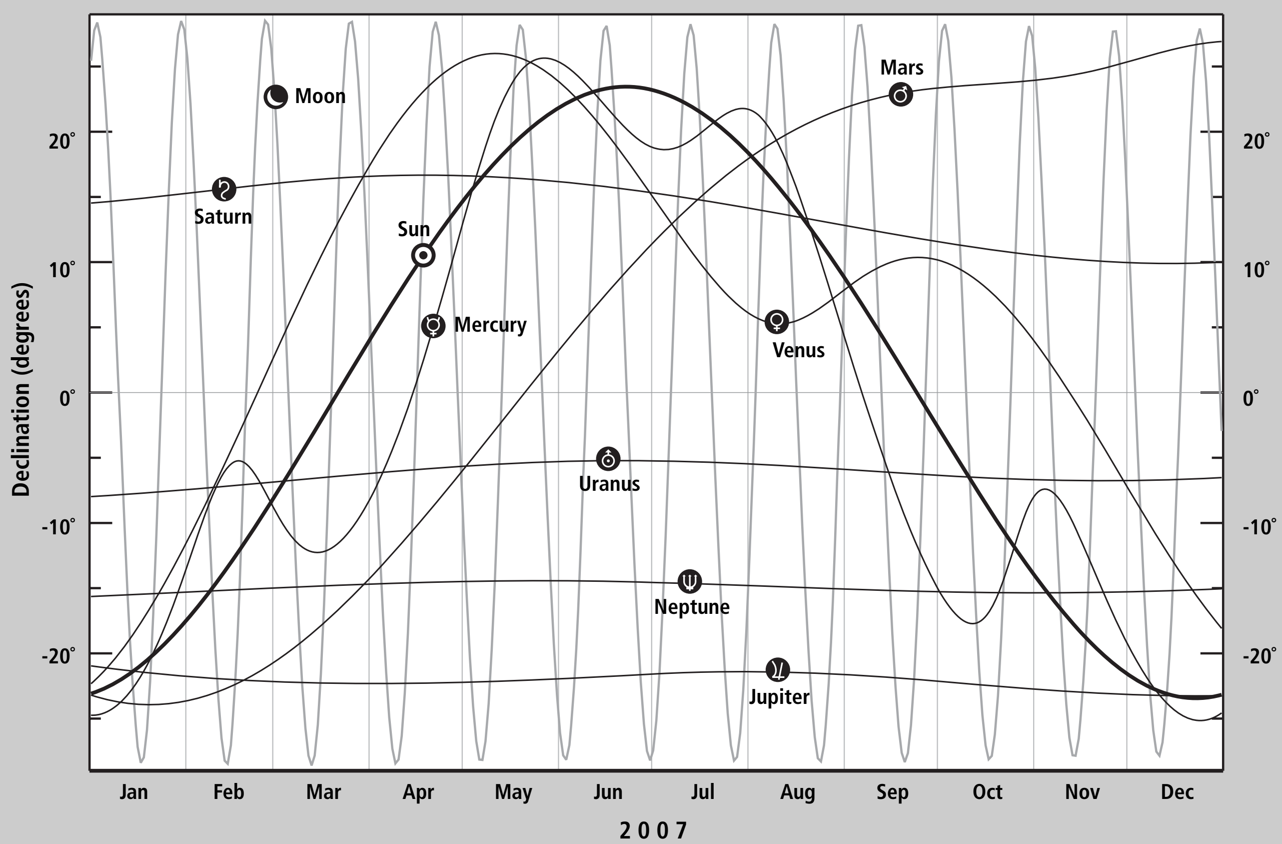
		SATURN				URANUS				NEPTUNE			
MTH	DAY	RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.	RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.	RA h m s	Declination ° ′ ″	Dist. (AU)	Cnst.
Oct	26	10 32 38.4	+10 41 29	9.77	Leo	23 06 04.5	-06 38 14	19.4	Aqr	21 26 38.9	-15 21 10	29.7	Cap
Oct	27	10 32 58.7	+10 39 42	9.76	Leo	23 05 59.4	-06 38 44	19.4	Aqr	21 26 38.1	-15 21 14	29.7	Cap
Oct	28	10 33 18.8	+10 37 57	9.74	Leo	23 05 54.3	-06 39 13	19.4	Aqr	21 26 37.5	-15 21 17	29.8	Cap
Oct	29	10 33 38.5	+10 36 14	9.73	Leo	23 05 49.5	-06 39 42	19.4	Aqr	21 26 37.0	-15 21 19	29.8	Cap
Oct	30	10 33 58.0	+10 34 32	9.71	Leo	23 05 44.7	-06 40 09	19.5	Aqr	21 26 36.7	-15 21 21	29.8	Cap
Oct	31	10 34 17.2	+10 32 52	9.70	Leo	23 05 40.2	-06 40 35	19.5	Aqr	21 26 36.5	-15 21 22	29.8	Cap
Nov	1	10 34 36.1	+10 31 14	9.68	Leo	23 05 35.8	-06 41 01	19.5	Aqr	21 26 36.4	-15 21 23	29.8	Cap
Nov	2	10 34 54.7	+10 29 38	9.67	Leo	23 05 31.5	-06 41 25	19.5	Aqr	21 26 36.5	-15 21 22	29.8	Cap
Nov	3	10 35 13.0	+10 28 03	9.66	Leo	23 05 27.5	-06 41 48	19.5	Aqr	21 26 36.6	-15 21 22	29.9	Cap
Nov	4	10 35 31.0	+10 26 31	9.64	Leo	23 05 23.5	-06 42 10	19.5	Aqr	21 26 37.0	-15 21 20	29.9	Cap
Nov	5	10 35 48.7	+10 24 60	9.63	Leo	23 05 19.8	-06 42 31	19.5	Aqr	21 26 37.4	-15 21 18	29.9	Cap
Nov	6	10 36 06.1	+10 23 31	9.61	Leo	23 05 16.2	-06 42 51	19.6	Aqr	21 26 38.0	-15 21 15	29.9	Cap
Nov	7	10 36 23.2	+10 22 04	9.59	Leo	23 05 12.8	-06 43 10	19.6	Aqr	21 26 38.7	-15 21 12	29.9	Cap
Nov	8	10 36 39.9	+10 20 38	9.58	Leo	23 05 09.6	-06 43 28	19.6	Aqr	21 26 39.6	-15 21 08	30.0	Cap
Nov	9	10 36 56.3	+10 19 15	9.56	Leo	23 05 06.5	-06 43 45	19.6	Aqr	21 26 40.6	-15 21 03	30.0	Cap
Nov	10	10 37 12.4	+10 17 54	9.55	Leo	23 05 03.6	-06 44 00	19.6	Aqr	21 26 41.7	-15 20 58	30.0	Cap
Nov	11	10 37 28.1	+10 16 35	9.53	Leo	23 05 00.9	-06 44 15	19.6	Aqr	21 26 43.0	-15 20 52	30.0	Cap
Nov	12	10 37 43.5	+10 15 18	9.52	Leo	23 04 58.4	-06 44 28	19.6	Aqr	21 26 44.4	-15 20 45	30.0	Cap
Nov	13	10 37 58.6	+10 14 03	9.50	Leo	23 04 56.1	-06 44 40	19.7	Aqr	21 26 45.9	-15 20 38	30.0	Cap
Nov	14	10 38 13.3	+10 12 50	9.49	Leo	23 04 53.9	-06 44 51	19.7	Aqr	21 26 47.6	-15 20 30	30.1	Cap
Nov	15	10 38 27.7	+10 11 39	9.47	Leo	23 04 51.9	-06 45 01	19.7	Aqr	21 26 49.4	-15 20 22	30.1	Cap
Nov	16	10 38 41.7	+10 10 31	9.45	Leo	23 04 50.2	-06 45 10	19.7	Aqr	21 26 51.4	-15 20 13	30.1	Cap
Nov	17	10 38 55.3	+10 09 24	9.44	Leo	23 04 48.5	-06 45 17	19.7	Aqr	21 26 53.4	-15 20 03	30.1	Cap
Nov	18	10 39 08.6	+10 08 20	9.42	Leo	23 04 47.1	-06 45 23	19.7	Aqr	21 26 55.6	-15 19 52	30.1	Cap
Nov	19	10 39 21.6	+10 07 18	9.41	Leo	23 04 45.9	-06 45 28	19.8	Aqr	21 26 58.0	-15 19 41	30.1	Cap
Nov	20	10 39 34.2	+10 06 18	9.39	Leo	23 04 44.8	-06 45 32	19.8	Aqr	21 27 00.5	-15 19 30	30.2	Cap
Nov	21	10 39 46.4	+10 05 21	9.37	Leo	23 04 44.0	-06 45 35	19.8	Aqr	21 27 03.1	-15 19 17	30.2	Cap
Nov	22	10 39 58.2	+10 04 25	9.36	Leo	23 04 43.3	-06 45 37	19.8	Aqr	21 27 05.8	-15 19 04	30.2	Cap
Nov	23	10 40 09.7	+10 03 32	9.34	Leo	23 04 42.8	-06 45 37	19.8	Aqr	21 27 08.7	-15 18 51	30.2	Cap
Nov	24	10 40 20.8	+10 02 41	9.32	Leo	23 04 42.5	-06 45 36	19.8	Aqr	21 27 11.7	-15 18 37	30.2	Cap
Nov	25	10 40 31.5	+10 01 53	9.31	Leo	23 04 42.4	-06 45 35	19.9	Aqr	21 27 14.8	-15 18 22	30.2	Cap
Nov	26	10 40 41.8	+10 01 07	9.29	Leo	23 04 42.5	-06 45 31	19.9	Aqr	21 27 18.0	-15 18 06	30.3	Cap
Nov	27	10 40 51.7	+10 00 23	9.27	Leo	23 04 42.8	-06 45 27	19.9	Aqr	21 27 21.4	-15 17 50	30.3	Cap
Nov	28	10 41 01.3	+09 59 41	9.26	Leo	23 04 43.2	-06 45 22	19.9	Aqr	21 27 24.9	-15 17 34	30.3	Cap
Nov	29	10 41 10.5	+09 59 02	9.24	Leo	23 04 43.9	-06 45 15	19.9	Aqr	21 27 28.6	-15 17 17	30.3	Cap
Nov	30	10 41 19.3	+09 58 25	9.22	Leo	23 04 44.7	-06 45 07	19.9	Aqr	21 27 32.3	-15 16 59	30.3	Cap
Dec	1	10 41 27.7	+09 57 51	9.21	Leo	23 04 45.7	-06 44 58	20.0	Aqr	21 27 36.2	-15 16 40	30.3	Cap
Dec	2	10 41 35.6	+09 57 19	9.19	Leo	23 04 47.0	-06 44 48	20.0	Aqr	21 27 40.2	-15 16 21	30.4	Cap
Dec	3	10 41 43.2	+09 56 49	9.18	Leo	23 04 48.4	-06 44 36	20.0	Aqr	21 27 44.4	-15 16 02	30.4	Cap
Dec	4	10 41 50.4	+09 56 22	9.16	Leo	23 04 50.0	-06 44 24	20.0	Aqr	21 27 48.6	-15 15 41	30.4	Cap
Dec	5	10 41 57.2	+09 55 58	9.14	Leo	23 04 51.8	-06 44 10	20.0	Aqr	21 27 53.0	-15 15 21	30.4	Cap
Dec	6	10 42 03.6	+09 55 35	9.13	Leo	23 04 53.8	-06 43 55	20.0	Aqr	21 27 57.5	-15 14 59	30.4	Cap
Dec	7	10 42 09.5	+09 55 16	9.11	Leo	23 04 56.0	-06 43 39	20.1	Aqr	21 28 02.1	-15 14 37	30.4	Cap
Dec	8	10 42 15.1	+09 54 59	9.09	Leo	23 04 58.3	-06 43 21	20.1	Aqr	21 28 06.9	-15 14 15	30.5	Cap
Dec	9	10 42 20.2	+09 54 44	9.08	Leo	23 05 00.9	-06 43 02	20.1	Aqr	21 28 11.7	-15 13 52	30.5	Cap
Dec	10	10 42 24.9	+09 54 32	9.06	Leo	23 05 03.6	-06 42 43	20.1	Aqr	21 28 16.7	-15 13 28	30.5	Cap
Dec	11	10 42 29.2	+09 54 22	9.04	Leo	23 05 06.6	-06 42 22	20.1	Aqr	21 28 21.8	-15 13 04	30.5	Cap
Dec	12	10 42 33.1	+09 54 15	9.03	Leo	23 05 09.7	-06 41 60	20.1	Aqr	21 28 27.0	-15 12 39	30.5	Cap
Dec	13	10 42 36.6	+09 54 10	9.01	Leo	23 05 13.0	-06 41 36	20.2	Aqr	21 28 32.3	-15 12 14	30.5	Cap
Dec	14	10 42 39.6	+09 54 08	8.99	Leo	23 05 16.5	-06 41 12	20.2	Aqr	21 28 37.7	-15 11 48	30.5	Cap
Dec	15	10 42 42.3	+09 54 09	8.98	Leo	23 05 20.2	-06 40 46	20.2	Aqr	21 28 43.2	-15 11 22	30.6	Cap
Dec	16	10 42 44.5	+09 54 12	8.96	Leo	23 05 24.1	-06 40 19	20.2	Aqr	21 28 48.9	-15 10 55	30.6	Cap
Dec	17	10 42 46.3	+09 54 17	8.95	Leo	23 05 28.1	-06 39 52	20.2	Aqr	21 28 54.6	-15 10 27	30.6	Cap
Dec	18	10 42 47.6	+09 54 25	8.93	Leo	23 05 32.4	-06 39 22	20.2	Aqr	21 29 00.5	-15 09 59	30.6	Cap
Dec	19	10 42 48.6	+09 54 36	8.91	Leo	23 05 36.8	-06 38 52	20.3	Aqr	21 29 06.5	-15 09 31	30.6	Cap
Dec	20	10 42 49.1	+09 54 49	8.90	Leo	23 05 41.4	-06 38 21	20.3	Aqr	21 29 12.5	-15 09 02	30.6	Cap
Dec	21	10 42 49.2	+09 55 04	8.88	Leo	23 05 46.2	-06 37 49	20.3	Aqr	21 29 18.7	-15 08 33	30.6	Cap
Dec	22	10 42 48.9	+09 55 22	8.87	Leo	23 05 51.2	-06 37 15	20.3	Aqr	21 29 24.9	-15 08 03	30.7	Cap
Dec	23	10 42 48.2	+09 55 43	8.85	Leo	23 05 56.3	-06 36 40	20.3	Aqr	21 29 31.3	-15 07 32	30.7	Cap
Dec	24	10 42 47.1	+09 56 06	8.84	Leo	23 06 01.6	-06 36 05	20.3	Aqr	21 29 37.8	-15 07 02	30.7	Cap
Dec	25	10 42 45.5	+09 56 31	8.82	Leo	23 06 07.1	-06 35 28	20.4	Aqr	21 29 44.3	-15 06 30	30.7	Cap
Dec	26	10 42 43.5	+09 56 59	8.81	Leo	23 06 12.8	-06 34 50	20.4	Aqr	21 29 51.0	-15 05 59	30.7	Cap
Dec	27	10 42 41.1	+09 57 29	8.79	Leo	23 06 18.6	-06 34 11	20.4	Aqr	21 29 57.7	-15 05 26	30.7	Cap
Dec	28	10 42 38.3	+09 58 02	8.78	Leo	23 06 24.6	-06 33 31	20.4	Aqr	21 30 04.5	-15 04 54	30.7	Cap
Dec	29	10 42 35.1	+09 58 37	8.76	Leo	23 06 30.8	-06 32 50	20.4	Aqr	21 30 11.4	-15 04 21	30.7	Cap
Dec	30	10 42 31.5	+09 59 15	8.75	Leo	23 06 37.2	-06 32 08	20.4	Aqr	21 30 18.4	-15 03 47	30.8	Cap
Dec	31	10 42 27.4	+09 59 55	8.73	Leo	23 06 43.7	-06 31 25	20.5	Aqr	21 30 25.5	-15 03 13	30.8	Cap

ANGULAR SIZES OF THE PLANETS 2007

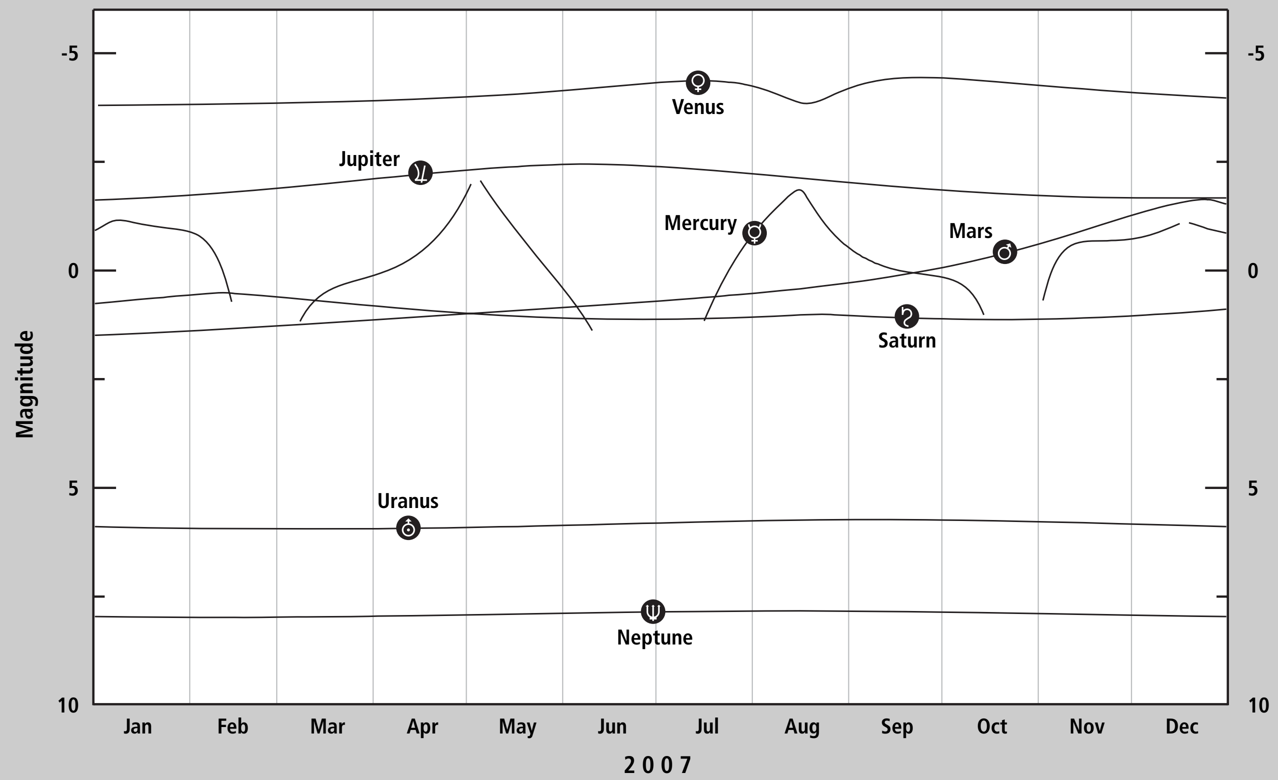


Note: Size of Sun and Moon in arc minutes.

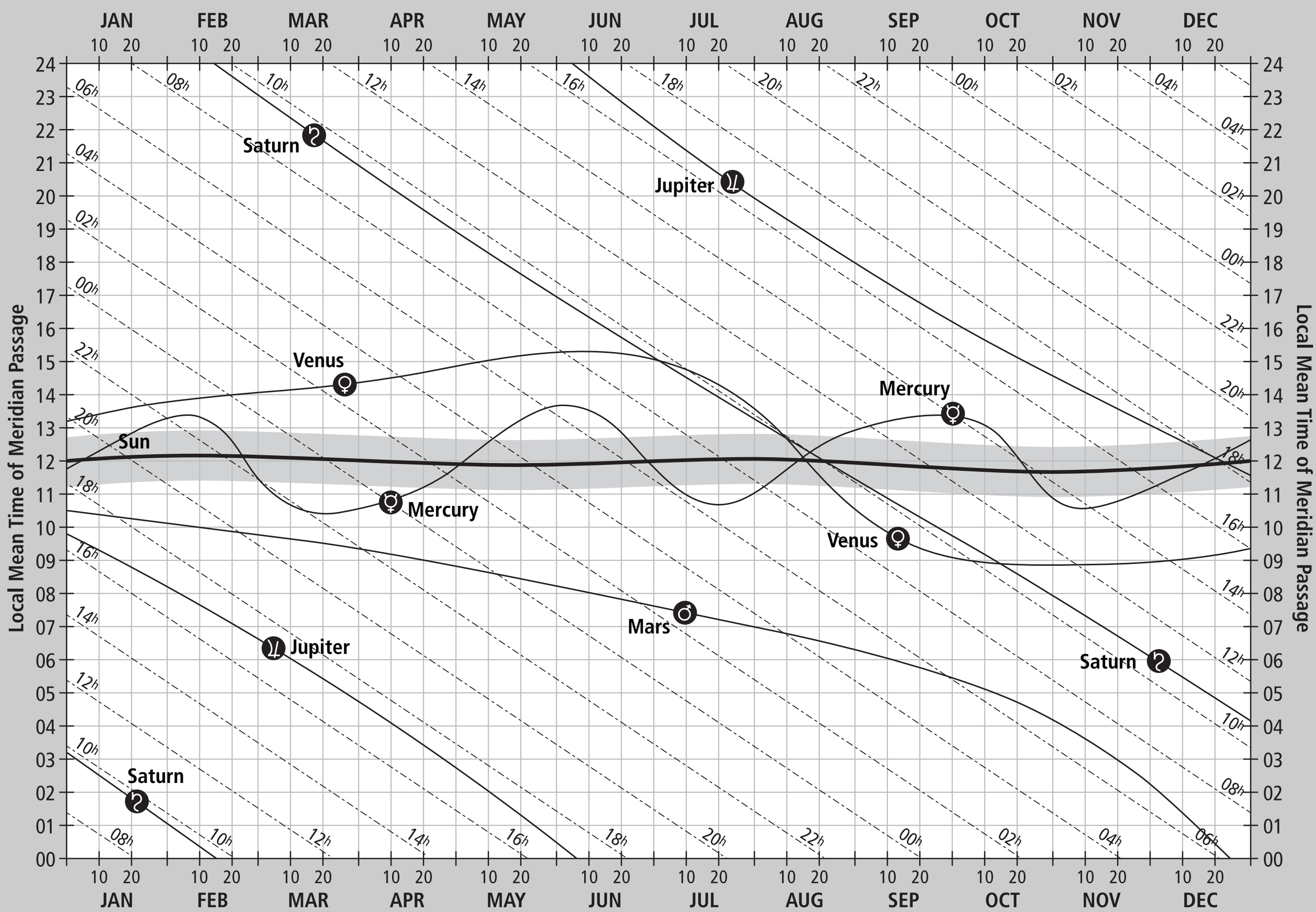
DECLINATIONS OF THE PLANETS 2007



MAGNITUDES OF THE PLANETS 2007



MERIDIAN TRANSIT OF PLANETS 2007



Geocentric positions of comets

Ephemerides are provided for known comets with V brighter than 10 and Declination less than +30º. Please note that comet brightness is notoriously unpredictable!

GEOCENTRIC POSITIONS OF COMETS 2006 Note: positions refer to 0000 WAST

DATE		RA		DECLINATION		V	r	Δ	CONST.
Mnth	Day	h	m	°	′		(AU)	(AU)	
Comet C/2006 P1 (McNaught)									
Jan	1	18	39.6	-07	51	7.4	0.47	1.34	Sct
Jan	2	18	43.8	-07	44	7.0	0.44	1.31	Sct
Jan	3	18	48.1	-07	38	6.7	0.41	1.27	Sct
Jan	4	18	52.8	-07	35	6.3	0.38	1.23	Sct
Jan	5	18	57.7	-07	35	5.9	0.35	1.19	Sct
Jan	6	19	03.0	-07	40	5.4	0.33	1.15	Sct
Jan	7	19	08.7	-07	51	4.9	0.30	1.11	Aql
Jan	8	19	14.9	-08	12	4.4	0.27	1.07	Aql
Jan	9	19	21.6	-08	47	3.8	0.24	1.02	Aql
Jan	10	19	28.8	-09	42	3.3	0.21	0.98	Aql
Jan	11	19	36.5	-11	04	2.7	0.19	0.94	Aql
Jan	12	19	44.7	-13	03	2.2	0.18	0.89	Aql
Jan	13	19	52.9	-15	42	2.0	0.17	0.86	Sgr
Jan	14	20	00.8	-18	55	2.0	0.17	0.83	Sgr
Jan	15	20	08.0	-22	28	2.3	0.19	0.82	Sgr
Jan	16	20	14.3	-26	01	2.7	0.21	0.82	Cap
Jan	17	20	19.9	-29	21	3.2	0.23	0.82	Cap
Jan	18	20	24.9	-32	23	3.7	0.26	0.83	Sgr
Jan	19	20	29.4	-35	06	4.2	0.29	0.85	Sgr
Jan	20	20	33.5	-37	29	4.7	0.32	0.87	Mic
Jan	21	20	37.3	-39	36	5.1	0.34	0.89	Mic
Jan	22	20	40.9	-41	27	5.5	0.37	0.91	Mic
Jan	23	20	44.3	-43	06	5.9	0.40	0.93	Mic
Jan	24	20	47.6	-44	35	6.3	0.43	0.95	Mic
Jan	25	20	50.7	-45	53	6.6	0.46	0.98	Mic
Jan	26	20	53.7	-47	04	6.9	0.49	1.00	Ind
Jan	27	20	56.7	-48	08	7.2	0.52	1.02	Ind
Jan	28	20	59.6	-49	06	7.5	0.54	1.04	Ind
Jan	29	21	02.4	-49	59	7.7	0.57	1.07	Ind
Jan	30	21	05.2	-50	48	8.0	0.60	1.09	Ind
Jan	31	21	08.0	-51	32	8.2	0.63	1.11	Ind
Jan	1	21	10.7	-52	14	8.4	0.65	1.13	Ind
Feb	2	21	13.3	-52	52	8.6	0.68	1.15	Ind
Feb	3	21	16.0	-53	27	8.8	0.70	1.17	Ind
Feb	4	21	18.6	-54	01	9.0	0.73	1.19	Ind
Feb	5	21	21.1	-54	32	9.2	0.75	1.21	Ind
Feb	6	21	23.7	-55	01	9.3	0.78	1.23	Ind
Feb	7	21	26.2	-55	29	9.5	0.80	1.25	Ind
Feb	8	21	28.8	-55	55	9.7	0.82	1.27	Ind
Feb	9	21	31.3	-56	20	9.8	0.85	1.28	Ind
Feb	10	21	33.7	-56	44	10.0	0.87	1.30	Ind
Feb	11	21	36.2	-57	06	10.1	0.90	1.32	Ind
Comet 2P/Encke									
Mar	23	01	33.8	+15	48	10.1	0.71	1.48	Psc
Mar	24	01	37.0	+16	02	9.9	0.69	1.46	Psc
Mar	25	01	40.3	+16	15	9.7	0.67	1.44	Psc
Mar	26	01	43.7	+16	29	9.5	0.65	1.42	Psc
Mar	27	01	47.1	+16	42	9.3	0.64	1.40	Psc
Mar	28	01	50.6	+16	55	9.1	0.62	1.38	Ari
Mar	29	01	54.2	+17	07	8.8	0.60	1.36	Ari
Mar	30	01	57.8	+17	19	8.6	0.58	1.34	Ari
Apr	31	02	01.5	+17	31	8.3	0.56	1.32	Ari
Apr	1	02	05.2	+17	42	8.1	0.54	1.29	Ari
Apr	2	02	08.9	+17	52	7.8	0.53	1.27	Ari
Apr	3	02	12.7	+18	02	7.6	0.51	1.25	Ari
Apr	4	02	16.6	+18	10	7.3	0.49	1.22	Ari
Apr	5	02	20.4	+18	17	7.0	0.47	1.19	Ari
Apr	6	02	24.3	+18	23	6.7	0.46	1.17	Ari
Apr	7	02	28.1	+18	28	6.4	0.44	1.14	Ari
Apr	8	02	31.9	+18	30	6.2	0.43	1.11	Ari
Apr	9	02	35.6	+18	31	5.9	0.41	1.08	Ari
Apr	10	02	39.2	+18	29	5.6	0.40	1.05	Ari
Apr	11	02	42.7	+18	25	5.3	0.38	1.02	Ari
Apr	12	02	46.0	+18	17	5.0	0.37	0.99	Ari
Apr	13	02	49.0	+18	06	4.8	0.36	0.96	Ari
Apr	14	02	51.6	+17	51	4.6	0.35	0.93	Ari
Apr	15	02	53.9	+17	32	4.4	0.35	0.90	Ari
Apr	16	02	55.8	+17	08	4.2	0.34	0.87	Ari
Apr	17	02	57.1	+16	39	4.1	0.34	0.84	Ari
Apr	18	02	57.9	+16	06	4.0	0.34	0.81	Ari
Apr	19	02	58.0	+15	28	3.9	0.34	0.78	Ari
Apr	20	02	57.5	+14	45	3.9	0.35	0.75	Ari
Apr	21	02	56.5	+13	57	4.0	0.35	0.72	Ari
Apr	22	02	54.8	+13	05	4.0	0.36	0.70	Ari
Apr	23	02	52.5	+12	08	4.1	0.37	0.67	Ari
Apr	24	02	49.7	+11	09	4.3	0.38	0.65	Ari
Apr	25	02	46.4	+10	06	4.4	0.39	0.63	Ari
Apr	26	02	42.8	+09	02	4.6	0.41	0.62	Cet
Apr	27	02	38.7	+07	55	4.7	0.42	0.60	Cet
Apr	28	02	34.4	+06	47	4.9	0.44	0.59	Cet
Apr	29	02	29.8	+05	39	5.1	0.45	0.57	Cet
May	30	02	25.1	+04	30	5.3	0.47	0.56	Cet
May	1	02	20.3	+03	21	5.5	0.49	0.55	Cet
May	2	02	15.3	+02	14	5.7	0.50	0.54	Cet
May	3	02	10.4	+01	07	5.9	0.52	0.54	Cet
May	4	02	05.4	+00	02	6.1	0.54	0.53	Cet
May	5	02	00.5	-01	02	6.3	0.56	0.53	Cet
May	6	01	55.5	-02	04	6.5	0.58	0.52	Cet
May	7	01	50.7	-03	04	6.7	0.59	0.52	Cet
May	8	01	45.9	-04	02	6.9	0.61	0.51	Cet
May	9	01	41.3	-04	59	7.0	0.63	0.51	Cet
May	10	01	36.7	-05	53	7.2	0.65	0.51	Cet
May	11	01	32.2	-06	45	7.4	0.67	0.51	Cet
May	12	01	27.8	-07	35	7.6	0.69	0.51	Cet
May	13	01	23.5	-08	24	7.7	0.70	0.51	Cet
May	14	01	19.4	-09	11	7.9	0.72	0.51	Cet
May	15	01	15.3	-09	56	8.1	0.74	0.51	Cet
May	16	01	11.3	-10	39	8.2	0.76	0.51	Cet
May	17	01	07.4	-11	21	8.4	0.78	0.51	Cet
May	18	01	03.5	-12	02	8.5	0.79	0.51	Cet
May	19	00	59.8	-12	41	8.7	0.81	0.51	Cet
May	20	00	56.1	-13	19	8.8	0.83	0.51	Cet
May	21	00	52.5	-13	57	9.0	0.85	0.51	Cet
May	22	00	48.9	-14	33	9.1	0.86	0.51	Cet
May	23	00	45.4	-15	08	9.2	0.88	0.51	Cet
May	24	00	41.9	-15	43	9.3	0.90	0.51	Cet
May	25	00	38.4	-16	17	9.5	0.92	0.51	Cet
May	26	00	35.0	-16	50	9.6	0.93	0.51	Cet
May	27	00	31.5	-17	22	9.7	0.95	0.51	Cet
May	28	00	28.1	-17	54	9.8	0.97	0.51	Cet
May	29	00	24.7	-18	26	9.9	0.98	0.51	Cet
May	30	00	21.3	-18	57	10.1	1.00	0.52	Cet

Legend:

RA and DECLINATION Astrometric right ascension and declination of target (J2000.0). Corrected for light-time. These positions refer to the geocentre.

V Comet's approximate apparent visual total magnitude

r Apparent heliocentric range (distance between comet and Sun)

Δ Apparent range (distance between comet and Earth)

FUTURE KNOWN CLOSEST ENCOUNTERS

DESIGNATION		DATE			DISTANCE		
Permanent	Provisional	Year	Month	Day (UT)	(AU)	(LD)	($R_\oplus$)
EXPECTED CLOSE ENCOUNTERS 2007 (time order)							
	2001 YE4	2007	Jan	02.96	0.0377	14.66	
	2006 QQ56	2007	Jan	10.36	0.0521	20.27	
(7341)	1991 VK	2007	Jan	21.50	0.0679	26.44	
	2006 CJ	2007	Jan	31.81	0.0264	10.27	
	2006 AM4	2007	Feb	01.30	0.0134	5.20	
	2004 RN251	2007	Feb	04.37	0.0617	24.00	
	1998 VO	2007	May	07.20	0.0631	24.56	
(1862) Apollo		2007	May	08.64	0.0714	27.79	
	2003 YN107	2007	May	22.70	0.0617	24.00	
	2005 NW44	2007	June	18.22	0.0593	23.07	
	2003 WE	2007	June	25.33	0.0672	26.15	
	2004 NF3	2007	July	03.99	0.0693	26.97	
	2006 BZ147	2007	July	10.03	0.0713	27.76	
	2002 CB19	2007	Aug	08.71	0.0438	17.06	
	2005 CN61	2007	Aug	16.61	0.0484	18.85	
(2340) Hathor		2007	Oct	22.24	0.0600	23.34	
	2005 GL	2007	Nov	08.30	0.0188	7.32	
(11500)	1989 UR	2007	Nov	24.94	0.0710	27.64	
	2005 WX	2007	Dec	15.52	0.0555	21.60	
	2005 YO3	2007	Dec	31.07	0.0585	22.78	
EXPECTED CLOSE ENCOUNTERS 2008 (time order)							
	2005 WJ56	2008	Jan	10.43	0.0279	10.87	
(4450) Pan		2008	Feb	19.93	0.0408	15.89	
	2002 TD66	2008	Feb	26.10	0.0421	16.38	
	2003 FY6	2008	Mar	21.84	0.0161	6.28	
	2005 NB7	2008	Apr	17.12	0.0422	16.43	
	2002 AZ1	2008	July	08.29	0.0231	9.01	
(90403)	2003 YE45	2008	July	13.39	0.0424	16.52	
	2005 RC34	2008	July	21.43	0.0373	14.52	
(35107)	1991 VH	2008	Aug	15.54	0.0458	17.81	
	2006 BJ55	2008	Aug	15.69	0.0437	16.99	
	1998 SD9	2008	Sept	01.67	0.0236	9.17	
	2003 WT153	2008	Sept	07.81	0.0145	5.62	
	2000 DP107	2008	Sept	10.99	0.0579	22.52	
	2001 SQ3	2008	Sept	17.61	0.0560	21.81	
	2003 SW130	2008	Sept	19.18	0.0236	9.18	
	2005 GN59	2008	Oct	06.79	0.0516	20.07	
	2005 TQ45	2008	Oct	07.09	0.0443	17.22	
	2005 VN	2008	Oct	31.06	0.0106	4.11	
(4179) Toutatis		2008	Nov	09.51	0.0503	19.56	
	2004 XK3	2008	Nov	21.22	0.0323	12.56	
TWENTY FUTURE KNOWN CLOSEST ENCOUNTERS (ranked by distance)							
(99942) Apophis		2029	Apr	13.91	0.0002	0.09	5.4
	2005 YU55	2011	Nov	08.98	0.0011	0.41	25.0
	2000 WO107	2140	Dec	01.82	0.0016	0.63	38.1
	2001 WN5	2028	June	26.23	0.0017	0.65	39.2
(85640)	1998 OX4	2148	Jan	22.14	0.0020	0.78	47.1
	1999 AN10	2027	Aug	07.29	0.0027	1.03	62.3
	1998 MZ	2116	Nov	26.98	0.0028	1.07	64.6
(35396)	1997 XF11	2136	Oct	28.49	0.0028	1.07	64.9
	2004 XP14	2006	July	03.18	0.0029	1.13	67.9
	2003 QC10	2066	Sept	24.86	0.0034	1.32	79.7
	2001 GQ2	2100	Apr	27.71	0.0034	1.32	79.9
	2005 WK4	2130	Aug	11.53	0.0039	1.52	91.4
	2002 CU11	2080	Aug	31.02	0.0043	1.66	100.0
	2004 HD2	2093	Apr	08.62	0.0049	1.90	114.6
	2006 GC1	2095	Apr	01.96	0.0050	1.95	117.4
	2004 VD17	2148	May	05.05	0.0050	1.95	117.5
	2002 AW	2103	Oct	06.90	0.0052	2.01	121.3
	2006 FX	2059	Mar	22.81	0.0053	2.08	125.3
	2005 GC120	2122	Nov	30.76	0.0054	2.09	126.3
	1999 MN	2137	June	04.26	0.0055	2.13	128.7

CLOSE APPROACHES BY ASTEROIDS (Known closest approaches to the Earth)

DISTANCE (AU)	(LD)	($R_\oplus$)	DATE (TT) Year	Mnth	Day	DESIGNATION (**Permanent**) Provisional
0.000086*	0.03	2.02	2004	Mar	31.65	2004 FU162
0.000226	0.09	5.31	2004	Dec	19.86	2004 YD5
0.000328	0.13	7.70	2004	Mar	18.92	2004 FH
0.00056	0.22	13.15	2005	Nov	26.02	2005 WN3
0.000564	0.22	13.24	2003	Sept	27.96	2003 SQ222
0.00072	0.28	16.91	1994	Dec	09.79	1994 XM1
0.000785	0.31	18.43	2006	Feb	23.29	2006 DD1
0.000788	0.31	18.50	2002	Dec	11.35	2002 XV90
0.000802	0.31	18.83	2002	June	14.09	2002 MN
0.00082	0.32	19.25	2005	Oct	10.18	2005 TK50
0.000963	0.37	22.61	2005	Mar	18.91	2005 FN
0.000991	0.39	23.27	2003	Dec	06.79	2003 XJ7
0.00099	0.39	23.25	1993	May	20.86	1993 KA2
0.00107	0.42	25.12	2006	Aug	31.90	2006 QM111
0.00108	0.42	25.36	2003	Sept	19.24	2003 SW130
0.00111	0.43	26.06	2004	July	16.21	2004 OD4
0.00113	0.44	26.53	1994	Mar	15.72	1994 ES1
0.00114	0.44	26.77	1991	Jan	18.72	1991 BA
0.00125	0.49	29.35	2005	Oct	30.01	2005 UW5
0.00137	0.53	32.17	2006	Jan	29.44	2006 BF56
0.00146	0.57	34.28	2005	Dec	05.47	2005 XA8
0.00155	0.60	36.40	2006	Feb	24.17	2006 DM63
0.0016	0.62	37.57	2004	Mar	27.85	2004 FY15
0.00177	0.69	41.56	2005	Jan	13.43	2005 BS1
0.00181	0.70	42.50	2006	Mar	08.64	2006 EC
0.00185	0.72	43.44	2004	Apr	18.01	2004 HE
0.00188	0.73	44.14	2003	Oct	12.07	2003 UM3
0.00188	0.73	44.14	2006	July	23.45	2006 OK3
0.00198	0.77	46.49	2004	Oct	24.73	2004 UH1
0.00205++	0.80	48.14	2001	Jan	15.85	2001 BA16
0.00217	0.84	50.95	2004	Dec	16.80	2004 XB45
0.00221	0.86	51.89	2003	Apr	29.27	2003 HW10
0.00225	0.88	52.83	2006	Jan	28.31	2006 BV39
0.00246	0.96	57.76	2004	Sept	21.98	2004 ST26
0.00246	0.96	57.76	2004	Sept	13.65	2004 RU109
0.00282	1.10	66.22	2002	Mar	31.15	2002 GQ
0.00289+	1.12	67.86	1995	Mar	27.15	1995 FF
0.00289	1.12	67.86	2006	July	03.18	2004 XP14
0.0029	1.13	68.10	2006	May	10.01	2006 JY26
0.00303	1.18	71.15	1996	May	19.69	1996 JA1
0.00303	1.18	71.15	2006	Jan	31.52	2006 BH99
0.00306	1.19	71.85	2003	Dec	06.95	2003 XV
0.00306**	1.19	71.85	1991	Dec	05.39	1991 VG
0.00311	1.21	73.03	2002	Mar	08.04	2002 EM7
0.00321	1.25	75.37	2002	Feb	08.80	2002 CB26
0.00326	1.27	76.55	2004	Feb	24.30	2004 DA53
0.00331	1.29	77.72	2003	June	01.22	2003 LW2
0.00332	1.29	77.96	2000	June	02.90	2000 LG6
0.0034	1.32	79.84	2006	Jan	22.14	2006 BA
0.00346	1.35	81.24	2005	Nov	12.15	2005 VN5
0.00353	1.37	82.89	2002	Aug	18.33	2002 NY40
0.00362	1.41	85.00	2003	Mar	03.26	2003 DW10
0.00367	1.43	86.18	2003	Mar	05.85	2003 DY15
0.00376	1.46	88.29	2005	Oct	14.85	2005 TC51
0.00378	1.47	88.76	2004	June	21.86	2004 MR1
0.0038	1.48	89.23	1999	May	06.14	2000 SG344
0.00411	1.60	96.51	2004	Aug	11.84	2004 PZ19
0.00423	1.65	99.32	2003	Dec	27.00	2003 YS70
0.00445	1.73	104.49	2004	Feb	01.99	2004 BK86
0.00448	1.74	105.20	2006	June	28.31	2006 MB14
0.00454	1.77	106.60	2003	Nov	30.80	2003 WT153
0.00457	1.78	107.31	1989	Mar	22.90	**(4581) Asclepius** 1989 FC
0.00464	1.81	108.95	2004	Mar	25.79	2004 FM32
0.00466	1.81	109.42	2004	May	31.88	2004 KF17
0.00474	1.84	111.30	1994	Nov	24.85	1994 WR12
0.00484	1.88	113.65	2001	Nov	29.33	2001 WM15
0.00486	1.89	114.12	2005	June	21.48	2005 MA
0.0049	1.91	115.06	2006	Apr	18.35	2006 HF6
0.00495	1.93	116.23	2000	Dec	22.29	2000 YA
0.00495	1.93	116.23	1937	Oct	30.71	**(69230) Hermes** 1937 UB
0.005	1.95	117.41	1995	Oct	17.20	1995 UB
0.00501	1.95	117.64	2006	Jan	25.62	2006 BO7
0.00503	1.96	118.11	2006	Mar	07.50	2006 EH1
0.00509	1.98	119.52	2005	Nov	27.92	2005 WY
0.00509	1.98	119.52	2005	Oct	03.73	2005 TA
0.0051	1.98	119.75	2002	Oct	02.08	2002 TY59
0.00511	1.99	119.99	2005	Oct	26.22	2005 UE1
0.00512	1.99	120.22	2005	July	10.06	2005 ND63
0.00519	2.02	121.87	2006	Sept	13.64	2006 SC

Notes:

- * This approach is to about 12,900 km from the centre of the earth!
- ** 1991 VG may be a returning piece of man-made space debris.
- \+ Closest approach to the moon was 0.0013 AU (0.51 LD) on 1995 Mar. 27.0.
- ++ Closest approach to the moon was 0.00053 AU (0.21 LD) on 2001 Jan. 15.80.
- **AU** Astronomical distance Unit: 1.0 AU is roughly the average distance between the Earth and the Sun (= 149,597,870 km).
- **LD** Lunar Distance unit: 1.0 LD is the average distance from the Earth to the Moon (about 0.00257 AU = 384,400 km).
- **$R_\oplus$** Radius of the Earth (see Sun & Planet Data table)

CLOSE APPROACHES BY HISTORIC COMETS

COMET NAME	Designation	DATE Year	Mnth	Day	DISTANCE (AU)	(LD)
Comet of 1491	C/1491 B1	1491	Feb	20.0	0.0094	3.7*
Lexell	D/1770 L1	1770	Jul	01.7	0.0151	5.9
Tempel-Tuttle	55P/1366 U1	1366	Oct	26.4	0.0229	8.9
IRAS-Araki-Alcock	C/1983 H1	1983	May	11.5	0.0313	12.2
Halley	1P/ 837 F1	837	Apr	10.5	0.0334	13.0
Biela	3D/1805 V1	1805	Dec	09.9	0.0366	14.2
Comet of 1743	C/1743 C1	1743	Feb	08.9	0.0390	15.2
Pons-Winnecke	7P/	1927	Jun	26.8	0.0394	15.3
Comet of 1014	C/1014 C1	1014	Feb	24.9	0.0407	15.8*
Comet of 1702	C/1702 H1	1702	Apr	20.2	0.0437	17.0
Comet of 1132	C/1132 T1	1132	Oct	07.2	0.0447	17.4*
Comet of 1351	C/1351 W1	1351	Nov	29.4	0.0479	18.6*
Comet of 1345	C/1345 O1	1345	Jul	31.9	0.0485	18.9*
Comet of 1499	C/1499 Q1	1499	Aug	17.1	0.0588	22.9*
Schwassmann-Wachmann 3	73P/1930 J1	1930	May	31.7	0.0617	24.0
Sugano-Saigusa-Fujikawa	C/1983 J1	1983	Jun	12.8	0.0628	24.4
Comet of 1080	C/1080 P1	1080	Aug	05.7	0.0641	24.9*
Great comet	C/1760 A1	1760	Jan	08.2	0.0681	26.5
Comet of 1472	C/1471 Y1	1472	Jan	22.9	0.0690	26.9*
Comet of 400	C/ 400 F1	400	Mar	31.1	0.0767	29.8*
LINEAR	P/2000 G1	1921	Mar	09.9	0.0775	30.1
Comet of 1556	C/1556 D1	1556	Mar	13.0	0.0835	32.5*
Schweizer	C/1853 G1	1853	Apr	29.1	0.0839	32.7
Bouvard-Herschel	C/1797 P1	1797	Aug	16.5	0.0879	34.2
Halley	1P/ 374 E1	374	Apr	01.9	0.0884	34.4
Halley	1P/ 607 H1	607	Apr	19.2	0.0898	34.9
Comet of 568	C/ 568 O1	568	Sep	25.7	0.0918	35.7*
Messier	C/1763 S1	1763	Sep	23.7	0.0934	36.3
Tempel	C/1864 N1	1864	Aug	08.4	0.0964	37.5
Machholz 2-A	141P-A	1905	Jan	05.2	0.0968	37.7
LINEAR	P/2000 G1	2000	Mar	04.7	0.0974	37.9
Schmidt	C/1862 N1	1862	Jul	04.6	0.0982	38.2
Comet of 390	C/ 390 Q1	390	Aug	18.9	0.1002	39.0*
Hyakutake	C/1996 B2	1996	Mar	25.3	0.1018	39.6
Seki	C/1961 T1	1961	Nov	15.2	0.1019	39.7

Notes:

* Distance is uncertain because comet's orbit is relatively poorly determined.

Near-Earth Objects

NEO GROUPS	
Group Description Definition:	
NECs	Near-Earth Comets. q<1.3 AU, P<200 yrs
NEAs	Near-Earth Asteroids. q<1.3 AU
Atens	Earth-crossing NEAs with semi-major axes smaller than Earth's (named after asteroid 2062 Aten). a<1.0 AU, Q>0.983 AU
Apollos	Earth-crossing NEAs with semi-major axes larger than Earth's (named after asteroid 1862 Apollo). a>1.0 AU, q<1.017 AU
Amors	Earth-approaching NEAs with orbits exterior to Earth's but interior to Mars' (named after asteroid 1221 Amor). a>1.0 AU, 1.017<q<1.3 AU
PHAs	Potentially Hazardous Asteroids: NEAs whose Minimum Orbit Intersection Distance (MOID) with the Earth is 0.05 AU or less and whose absolute magnitude (H) is 22.0 or brighter. MOID<=0.05 AU, H<=22.0

Near-Earth objects (NEOs) are comets and asteroids that have been nudged by the gravitational attraction of nearby planets into orbits that allow them to enter the Earth's neighbourhood. Composed mostly of water ice with embedded dust particles, comets originally formed in the cold outer planetary system while most of the rocky asteroids formed in the warmer inner solar system between the orbits of Mars and Jupiter. The scientific interest in comets and asteroids is due largely to their status as the relatively unchanged remnant debris from the solar system formation process some 4.6 billion years ago. The giant outer planets (Jupiter, Saturn, Uranus, and Neptune) formed from an agglomeration of billions of comets and the leftovers from this formation process are the comets we see today. Likewise, today's asteroids are the leftovers from the initial agglomeration of the inner planets that include Mercury, Venus, Earth, and Mars. As the primitive, leftover building blocks of the solar system formation process, comets and asteroids offer clues to the chemical mixture from which the planets formed some 4.6 billion years ago. If we wish to know the composition of the primordial mixture from which the planets formed, then we must determine the chemical constituents of the debris from this formation process – the comets and asteroids.

NEO Groups: In terms of orbital elements, NEOs are asteroids and comets with perihelion distance q less than 1.3 AU. Near-Earth Comets (NECs) are further restricted to include only short-period comets (i.e orbital period P less than 200 years). The vast majority of NEOs are asteroids, referred to as Near-Earth Asteroids (NEAs). NEAs are divided into groups (Aten, Apollo, Amor) according to their perihelion distance (q), aphelion distance (Q) and their semi-major axes (a).

Potentially hazardous asteroids (PHAs) are currently defined based on parameters that measure the asteroid's potential to make threatening close approaches to the Earth. Specifically, all asteroids with an Earth Minimum Orbit Intersection Distance (MOID) of 0.05 AU or less and an absolute magnitude (H) of 22.0 or less are considered PHAs. In other words, asteroids that can't get any closer to the Earth (i.e. MOID) than 0.05 AU (roughly 7,480,000 km or 4,650,000 mi) or are smaller than about 150 m in diameter are not considered PHAs. There are currently more than 800 known PHAs. This "potential" to make close Earth approaches does ***not*** mean a PHA ***will*** impact the Earth. It only means there is a possibility for such a threat. By monitoring these PHAs and updating their orbits as new observations become available, we can better predict the close-approach statistics and thus their Earth-impact threat.

(Adapted from http://neo.jpl.nasa.gov/neo/)

METEOR SHOWERS visible from the Southern Hemisphere

SHOWER NAME	DURATION	MAX. ACTIVITY DATE	MAX COUNT PER HOUR	RADIANT RA. (h m)	Dec. (°)	Size (°)
delta-Cancrids	Jan 01 - Jan 24	Jan 08	4	08 40	+20	5 - 10
alpha-Centaurids	Jan 28 - Feb 21	Feb 09	20	14 00	-59	4
delta-Leonids	Feb 15 - Mar 10	Feb 26	2	11 12	+16	5
gamma-Normids	Feb 25 - Mar 22	Mar 14	8	16 36	-51	5
Virginids	Jan 25 - Apr 15	Mar 24	5	13 00	-04	10 - 15
pi-Puppids	Apr 15 - Apr 28	Apr 23	periodic, <40	07 20	-45	5
eta-Aquarids	Apr 19 - May 28	May 05	60	22 32	-01	4
Sagittarids	Apr 15 - Jul 15	May 19	5	16 28	-22	10 - 15
Pegasids	Jul 07 - Jul 13	Jul 09	variable	22 40	+15	5
July Phoenicids	Jul 10 - Jul 16	Jul 13	variable, 3-10	02 08	-48	2
Pisces Austrinids	Jul 15 - Aug 10	Jul 27	5	22 44	-30	10 - 15
Southern delta-Aquarids	Jul 12 - Aug 19	Jul 27	20	22 36	-16	5
alpha-Capricornids	Jul 03 - Aug 15	Jul 29	4	20 28	-10	8
Southern iota-Aquarids	Jul 25 - Aug 15	Aug 04	2	22 16	-15	2
Northern delta-Aquarids	Jul 15 - Aug 25	Aug 08	4	22 20	-05	5
Northern iota-Aquarids	Aug 11 - Aug 31	Aug 19	3	21 48	-06	5
Piscids	Sep 01 - Sep 30	Sep 19	3	00 20	-01	5
epsilon-Geminids	Oct 14 - Oct 27	Oct 18	2	06 48	+27	5
Orionids	Oct 02 - Nov 07	Oct 21	23	06 20	+16	20
Southern Taurids	Oct 0 1 - Nov 25	Nov 05	5	03 28	+13	5 - 10
Northern Taurids	Oct 01 - Nov 25	Nov 12	5	03 52	+22	5 - 10
Leonids	Nov 14 - Nov 21	Nov 17	varies to 1000+	10 12	+22	5
alpha-Monocerotids	Nov 15 - Nov 25	Nov 22	variable	07 48	+01	5
chi-Orionids	Nov 26 - Dec 15	Dec 02	3	05 28	+23	8
Phoenicids	Nov 28 - Dec 09	Dec 06	variable	01 12	-53	5
Puppid-Velids	Dec 01 - Dec 15	Dec 06	10	08 12	-45	10
Monocerotids	Nov 27 - Dec 17	Dec 08	3	06 40	+08	5
sigma-Hydrids	Dec 03 - Dec 15	Dec 11	2	08 28	+02	5
Geminids	Dec 07 - Dec17	Dec 14	120	07 28	+33	5
Coma Berenicids	Dec 12 - Jan 23	Dec 19	5	11 40	+25	5

STARS & NON-STELLAR OBJECTS

BRIGHT STARS (EPOCH J2000.0)

DESIGNATION	NAME	CONSTELLATION	RA h m s	DECLINATION ° ′ ″	APP. MAG*	ABS. MAG**	SPECTRAL TYPE	PARALLAX ″	DIST. ly	DIST. pc
1	Sun				-26.7	+4.8	G2V			
2 α CMa	Sirius	Canis Major	06 45 08.9	-16 42 58	-1.47	1.4	A1V	0.379	8.6	2.6
3 α Car	Canopus	Carina	06 24 20.1	-52 41 44	-0.72	-5.7	F0II	0.010	330	100
4 α Cen	Rigil Kent	Centaurus	14 39 36.2	-60 50 08	-0.27	4.1	G2V+K1V	0.742	4.4	1.3
5 α Boo	Arcturus	Bootes	14 15 39.7	+19 10 57	-0.04	-0.3	K1.5III	0.089	36.0	11.0
6 α Lyr	Vega	Lyra	18 36 56.3	+38 47 01	0.03	0.6	A0V	0.129	25.3	7.8
7 α Aur	Capella	Auriga	05 16 41.4	+45 59 53	0.08	-0.5	G5IIIe+G0III	0.077	42.3	13.0
8 β Ori	Rigel	Orion	05 14 32.3	-08 12 06	0.15	-6.9	B8Ia	0.004	820	250
9 α CMi	Procyon	Canis Minor	07 39 18.1	+05 13 30	0.34	2.6	F5 IV-V	0.286	11.4	3.5
10 α Eri	Achernar	Eridanus	01 37 42.8	-57 14 12	0.50	-2.7	B3Vpe	0.023	143	44
11 α Ori	Betelgeuse	Orion	05 55 10.3	+07 24 25	0.58	-4.9	M2Ib	0.008	550	125
12 β Cen	Hadar	Centaurus	14 03 49.4	-60 22 23	0.60	-5.5	B1III	0.006	550	170
13 α Cru	Acrux	Crux	12 26 35.9	-63 05 56	0.75	-4.2	B0.5IV+B1V	0.010	330	100
14 α Aql	Altair	Aquila	19 50 47.0	+08 52 06	0.77	2.2	A7V	0.194	16.8	5.2
15 α Tau	Aldebaran	Taurus	04 35 55.2	+16 30 33	0.85	-0.7	K5III	0.050	65.0	20.0
16 α Vir	Spica	Virgo	13 25 11.6	-11 09 41	1.04	-3.6	B1III-IV+B2V	0.012	270	83
17 α Sco	Antares	Scorpius	16 29 24.5	-26 25 55	1.09	-5.4	M1.5Ib+B4V	0.005	490	150
18 β Gem	Pollux	Gemini	07 45 19.0	+28 01 34	1.15	1.1	K0IIIb	0.097	33.6	10.3
19 α PsA	Formalhaut	Piscis Austrinus	22 57 39.0	-29 37 20	1.16	1.7	A3V	0.130	25.1	7.7
20 α Cyg	Deneb	Cygnus	20 41 25.9	+45 16 49	1.25	-8.8	A2Iae	0.001	3300	1000
21 β Cru	Mimosa	Crux	12 47 43.3	-59 41 20	1.30	-3.9	B0.5IV	0.009	360	110
22 α Leo	Regulus	Leo	10 08 22.3	+11 58 02	1.35	-0.5	B7V	0.042	78.0	24.0
23 ε CMa	Adhara	Canis Major	06 58 37.5	-28 58 20	1.51	-4.0	B2Iab	0.008	410	125
24 α Gem	Castor	Gemini	07 34 35.9	+31 53 18	1.59	0.6	A2Vm	0.063	52.0	15.9
25 λ Sco	Shaula	Scorpius	17 33 36.5	-37 06 14	1.62	-4.9	B2IV	0.005	650	200
26 γ Cru	Gacrux	Crux	12 31 10.0	-57 06 48	1.63	-0.5	M3.5III	0.037	88.0	27.0
27 γ Ori	Bellatrix	Orion	05 25 07.9	+06 20 59	1.64	-2.8	B2III	0.013	250	77
28 β Tau	Alnath	Taurus	05 26 17.5	+28 36 27	1.68	-1.3	B7III	0.025	130	40
29 β Car	Miaplacidus	Carina	09 13 12.0	-69 43 02	1.70	-1.0	A2IV	0.029	110	34
30 ε Ori	Alnilam	Orion	05 36 12.8	-01 12 07	1.70	-6.8	B0Iab	0.002	1600	500

* Apparent Magnitude
** Absolute Magnitude

The brightness of stars

How bright a star appears is called **apparent magnitude** by astronomers. This depends on three factors:

1. *distance from Earth,*
2. *size and*
3. *how much light it emits per square metre from its outer layers.*

The brightest star in the sky is our Sun. It is not a particularly big or bright star, but it is by far the nearest star to us.

Astronomers measure the brightness of the stars on a scale called the **magnitude** scale. This scale has descended to us from ancient times when Hipparchus, a Greek astronomer, classified the stars by their brightness and used the word magnitude to describe their relative brightness. In Hipparchus' system a very bright star would have a magnitude of 1 and a very faint star a magnitude of 6. **The smaller the number, the brighter the star**.

Accurate measurements of the brightness of stars have showed that a magnitude 1 star emits 100 times more energy than a magnitude 6 star. Apparently, the human eye responds in a logarithmic way to differing light levels. So a difference in magnitude of 1 corresponds to about a factor of 2.5 in energy. A magnitude system roughly consistent with that of Hipparchus has been established by modern astronomers, but now each star can have its magnitude accurately measured.

The very brightest planets have a magnitude of -1 to -4. Under very clear, dark skies, stars with a magnitude of about 6 are detectable by the unaided eye. A very powerful telescope can detect very faint stars beyond magnitude 20. Nearly 3,000 stars are visible to the unaided eye in good conditions. Unfortunately, light pollution from household lighting and street lamps reduces the number of stars visible in urban areas compared to a dark site.

CLOSE STARS (EPOCH J2000.0)

DESIGNATION	NAME	CONSTELLATION	RA h	m	s	DEC. °	′	″	APP. MAG*	ABS. MAG**	SPECTRAL TYPE	PARA-LLAX ″	PROPER MOTION ″/year	DIST. ly	DIST. pc
1	Sun								-27	4.8	G2 V				
2 α Cen C	Proxima Cen	Centaurus	14	29	42.9	-62	40	46	11.05	15.49	M5.5Ve	0.772	3.85	4.22	1.30
α Cen A	Rigil Kentaurus	Centaurus	14	39	36.5	-60	50	02	-0.01	4.34	G2V	0.742	3.71	4.39	1.35
α Cen B	Rigil Kentaurus	Centaurus	14	39	35.1	-60	50	14	1.33	5.68	K1V	0.742	3.73	4.39	1.35
3	Barnard's Star	Ophiuchus	17	57	48.5	+04	41	36	9.54	13.24	M4Ve	0.549	10.37	5.94	1.82
4 G045-020	Wolf 359	Leo	10	56	29.0	+07	00	52	13.54	16.68	M5.5	0.425	4.71	7.67	2.35
5	Lalande 21185	Ursa Major	11	03	20.2	+35	58	12	7.49	10.46	M2V	0.392	4.81	8.32	2.55
6 α CMa A	Sirius A	Canis Major	06	45	08.9	-16	42	58	-1.47	1.42	A1V	0.379	1.34	8.60	2.64
α CMa B	Sirius B	Canis Major	06	45	08.9	-16	43	06	8.44	11.33	DA	0.379	1.33	8.60	2.64
7 L 726-8 A	BL Cet	Cetus	01	39	01.5	-17	57	02	12.57	15.43	M5.5V:e	0.374	3.37	8.72	2.67
L 726-8 B	UV Cet	Cetus	01	39	01.5	-17	57	04	12.52	15.42	M5.5e	0.381	3.37	8.56	2.62
8	Ross 154	Sagittarius	18	49	49.4	-23	50	10	10.95	13.58	M3.5	0.336	0.67	9.70	2.98
9	Ross 248	Andromeda	23	41	55.2	+44	10	38	12.28	14.77	M5	0.315	1.62	10.3	3.17
10 ε Eri	Epsilon Eridani	Eridanus	03	32	55.8	-09	27	30	3.73	6.19	K2 V	0.311	0.98	10.5	3.22
11 Gl 887	Lacaille 9352	Piscis Austrinus	23	05	52.0	-35	51	11	7.34	9.75	M0.5	0.304	6.90	10.7	3.29
12 G010-050	Ross 128	Virgo	11	47	44.4	+00	48	16	11.08	13.47	M4	0.300	1.36	10.9	3.33
13 G156-031 A	L 789-6 A	Aquarius	22	38	33.8	-15	18	03	13.3	15.69	M5.5	0.300	3.24	10.9	3.33
G156-031 B	L 789-6 B	Aquarius	22	38	33.8	-15	18	03	13.3	15.69	M5	0.300	3.24	10.9	3.33
G156-031 C	L 789-6 C	Aquarius	22	38	37.3	-15	17	07	14.0	16.34	M7	0.294	3.25	11.1	3.40
14 α CMi A	Procyon A	Canis Minor	07	39	18.1	+05	13	30	0.34	2.62	F5IV-V	0.286	1.26	11.4	3.50
α CMi B	Procyon B	Canis Minor	07	39	19.7	+05	15	25	10.7	12.98	-	0.286	1.25	11.4	3.50
15 Gl 820 A	61 Cygni A	Cygnus	21	06	53.9	+38	44	58	5.21	7.50	K5V	0.287	5.28	11.4	3.48
Gl 820 B	61 Cygni B	Cygnus	21	06	55.3	+38	44	31	6.03	8.30	K7V	0.285	5.17	11.4	3.51
16 Gl 725 A	Struve 2398 A	Draco	18	42	46.7	+59	37	49	8.91	11.15	M3V	0.280	2.24	11.6	3.57
Gl 725 B	Struve 2398 B	Draco	18	42	46.9	+59	37	37	9.69	11.96	M3.5	0.284	2.31	11.5	3.52
17 BD +43°44	Groombridge 34 A	Andromeda	00	18	22.9	+44	01	23	8.09	10.33	M1.5V	0.280	2.92	11.6	3.57
	Groombridge 34 B	Andromeda	00	18	25.8	+44	01	38	11.04	13.28	M3.5	0.280	2.93	11.6	3.57
18 ε Ind A	Gl 845 A	Indus	22	03	21.6	-56	47	10	4.69	6.89	K4V	0.276	4.70	11.8	3.62
ε Ind B	Gl 845 B	Indus	22	03	21.6	-56	47	10	-	-	T2.5	0.276	4.70	11.8	3.62
19 G51-15	GJ 1111	Cancer	08	29	49.5	+26	46	32	14.81	17.01	M6	0.276	1.27	11.8	3.62
20 τ Cet	Gl 71	Cetus	01	44	04.1	-15	56	15	3.50	5.69	G8V	0.274	1.92	11.9	3.65
21 L 725-32	YZ Ceti	Cetus	01	12	30.6	-16	59	56	11.6	13.75	M4.5	0.269	1.37	12.1	3.72
22 BD +5°1668	Luyten's Star	Canis Minor	07	27	24.5	+05	13	33	9.89	11.99	M3.5	0.263	3.74	12.4	3.80
23 Gl 191	Kapteyn's Star	Pictor	05	11	40.6	-45	01	06	8.89	10.92	M1	0.255	8.66	12.8	3.92
24 Gl 825	Lacaille 8760	Microscopium	21	17	15.3	-38	52	02	6.68	8.70	K7	0.253	3.45	12.9	3.95
25 L 372-58	GJ 1061	Horologium	03	35	59.6	-44	30	46	13.03	14.87	M5.5	0.233	0.83	14.0	4.29

* Apparent Magnitude
** Absolute Magnitude

Star names

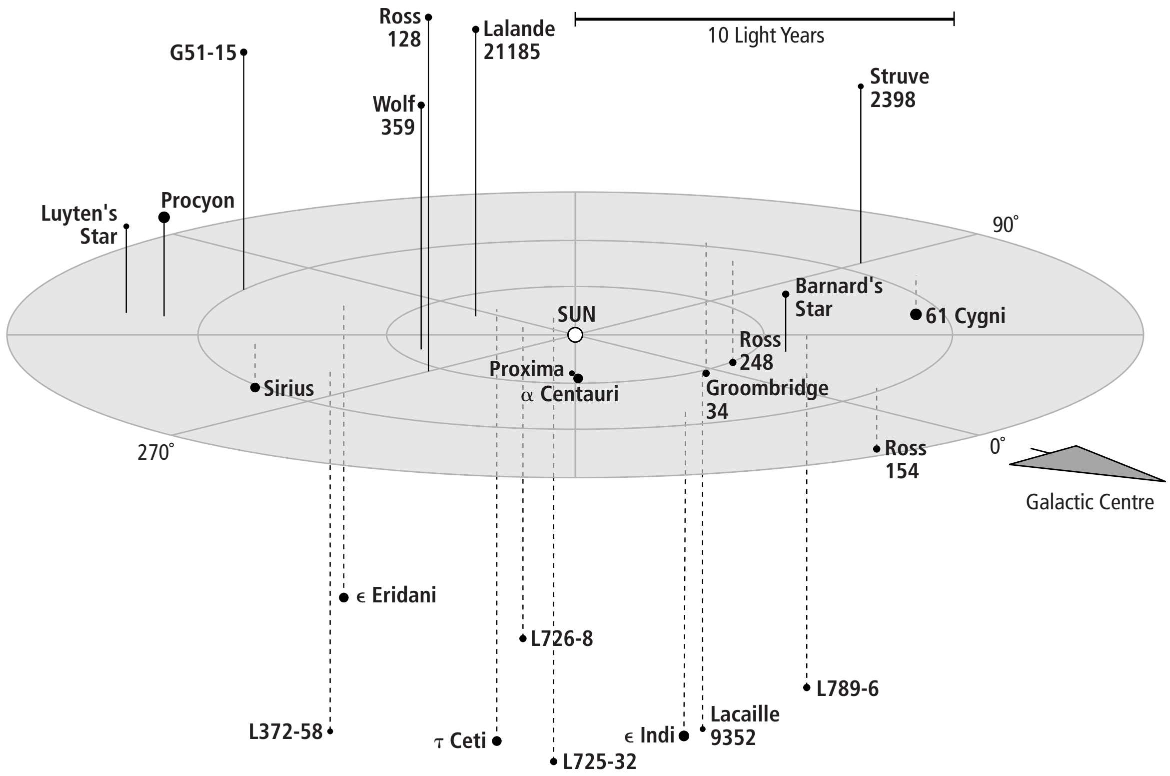
Many of the brighter stars were named in ancient times. Usually, the name referred to its place or association in its constellation. About 1,000 years ago Arab scholars kept the science of astronomy progressing and many star names are derived from their work.

In 1603, Johannes Bayer published an accurate atlas of the stars and constellations. He utilised a new system to name the stars within a constellation. The brightest star in a constellation was generallly designated α (alpha), and the next brightest was β (beta), and so on through the Greek alphabet (see section: ***Background & General Information***). Unfortunately, Bayer was not rigorous in the application of this system and so there are anomalies such as α Orionis (Betelgeuse) being fainter than β Orionis (Rigel).

Some of the fainter stars (but still visible to the unaided eye) are often referred to by their Flamsteed number. John Flamsteed (1646-1719) compiled a star catalogue which was published in 1725, six years after his death. In this catalogue, called the *Historia Coelestis Britannica*, Flamsteed assigned numbers to the stars within each constellation according to the stars' right ascensions. For example, the brightest star in the constellation Taurus is Aldebaran (*the follower* – in 'corrupted' Arabic), also designated α Tauri in Bayer's system and 87 Tauri according to Flamsteed's work.

Many stars have been catalogued and named in a variety of astronomical research programmes. Most names are now based on the position (right ascension and declination) of the star in the sky. Other naming systems are derived from the details of the observing equipment and how it has mapped the sky. Other names are based solely on the star's sequence in a published catalogue. For example, Aldebaran is also BD +16 629 in the Bonner Durchmusterung (Bonn Survey), BS 1457 in the Yale Bright Star Catalog, HD 29139 in the Henry Draper Catalog of stellar spectra, SAO 94027 in the Smithsonian Astrophysical Observatory Catalog, and HIP 21421 in the Hipparcos Catalogue of accurate star positions.

Diagram showing stars closest to the Solar System.



Spectral classes of main sequence stars

Stars are classified according to the temperature of their photosphere (the observable "surface" of the star). Most stars are powered by thermonuclear reactions in their interiors. Middle aged stars produce energy (light) by converting hydrogen to helium. Such stars are said to be on the Main Sequence.

Class	Colour	Representative Temperature	Representative Mass	Representative Radius	Representative density	Some Stars of this Colour
O	Blue	50,000K	20	10	0.01	Mintaka
B	Blue	30,000K	7	4	0.2	Achernar, Rigel, Acrux
A	White	10,000K	2	2	0.6	Sirius, Fomalhaut
F	White-Yellow	7,000K	1.5	1.2	1.1	Procyon, Canopus
G	Yellow	6,000K	1	1	1.6	Sun, Capella, α Centauri
K	Orange	5,000K	0.7	0.7	2.4	Arcturus, Aldebaran, Pollux
M	Red	3,500K	0.2	0.3	10.0	Betelgeuse, Antares

***Note**: At these temperatures, degrees Kelvin (K) is approximately equal to the same number of degrees Celsius. Typical star masses and typical star radii are given for each spectral class. These two figures are expressed relative to the Sun's mass (1.99 x 10^{30} kg) and the Sun's radius (6.96 x 10^5 km), respectively. Average density is given in grams/cm^3; for comparison, water has a density of 1 gram/cm^3.*

NON-STELLAR OBJECTS (EPOCH J2000.0)

NAME	RA h m	DEC. ° ′	SIZE ′	CONST.	TYPE	MAG.	DESCRIPTION
NGC 55	00 15.1	-39 13	30 x 63	Scl	Spiral galaxy	8.2	A bright galaxy in the Sculptor Group
NGC 104	00 24.1	-72 05	31	Tuc	Globular cluster	4.0	47 Tucanae, one of the finest globular clusters
NGC 224	**00 42.8**	**+41 16**	**186 x70**	**And**	**Spiral galaxy**	**4.5**	**M31, The 'Andromeda Galaxy'**
NGC 253	00 47.5	-25 17	26 x 6	Scl	Spiral galaxy	7.1	'Silver Coin' galaxy. Large, bright edge-on spiral
SMC	00 52.7	-72 49	300	Tuc	Galaxy	2.2	Small Magellanic Cloud. Visible to unaided eye from dark sky
Pleiades	03 47.0	+24 07	110	Tau	Open cluster	1.5	M45 or 'Seven Sisters'. Naked eye cluster, the brighter stars mag. 2
Hyades	04 26.9	+15 52	330	Tau	Open cluster	0.8	A naked eye, 'V' shaped cluster. 28 stars, the brighter mag. 3 and 4

NON-STELLAR OBJECTS (continued)

NAME	RA hh mm	DEC. ° ′	SIZE	CONST.	TYPE	MAG.	DESCRIPTION
LMC	05 23.6	-69 45	600	Dor	Galaxy	0.1	Large Magellanic Cloud. Visible to unaided eye from dark sky
NGC 1976	05 35.3	-05 23	90 x 60	Ori	Gaseous nebula	5.0	M42, 'Orion Nebula', emission and reflection nebula
NGC 2070	05 38.7	-69 06	30 x 20	Dor	Emission nebula	7.2	30 Doradus, 'Tarantula Nebula', bright complex looped structure
NGC 2169	06 08.5	+13 58	7	Ori	Open cluster	5.9	Rich loose cluster, 30 stars magnitude 7 and fainter
NGC 2168	06 08.9	+24 20	28	Gem	Open cluster	5.1	M35, 200 stars, magnitude range 9 to 16, no central concentration
NGC 2244	06 32.3	+04 52	24	Men	Open cluster	4.8	Rich cluster of 100 stars, with nebulosity (Rosette Nebula)
NGC 2264	06 41.1	+09 53	20	Men	Open cluster	3.9	40 stars, large brightness range, involved in nebulosity (Cone Nebula)
NGC 2287	06 46.9	-20 44	38	CMa	Open cluster	4.5	M41, 80 stars 7th magnitude and fainter with 6.9 mag. red star near centre
NGC 2301	06 51.8	+00 28	12	Mon	Open cluster	6.0	Rich cluster, 80 stars, large magnitude range, central concentration
NGC 2362	07 18.8	-24 57	8	CMa	Open cluster	4.1	60 stars, large brightness range (4th mag. down), concentrated centre
NGC 2422	07 36.6	-14 30	30	Pup	Open cluster	4.4	M47, large coarse cluster with 30 bright and faint stars
NGC 2437	07 41.8	-14 49	27	Pup	Open cluster	6.1	M46, rich open cluster, 100 stars, planetary nebula NGC2438 in same field
NGC 2447	07 44.6	-23 52	22	Pup	Open cluster	6.2	M93, 80 stars magnitude 8 to 13 with strong central concentration
NGC 2451	07 45.4	-37 58	45	Pup	Open cluster	3.5	Rich in stars with slight central concentration
NGC 2477	07 52.3	-38 33	27	Pup	Open cluster	5.8	~160 stars around 10 - 12th magnitude, strong central concentration
NGC 2516	07 58.3	-60 52	29	Car	Open cluster	3.8	80 stars 6th magnitude and fainter, strong central concentration
NGC 2547	08 10.4	-49 10	74	Vel	Open cluster	4.7	Rich in stars with strong central concentration. Brightest stars mag. 6
NGC 2548	08 13.8	-05 48	54	Hya	Open cluster	5.8	M48, Large cluster of 80 stars 8 to 13th magnitude, central concentration
NGC 2632	08 40.4	+19 40	95	Cnc	Open cluster	3.1	M44, 'Praesepe' or 'Beehive Cluster', very large cluster, 50 stars
IC 2391	08 40.2	-53 04	50	Vel	Open cluster	2.5	Moderately rich in bright (about mag. 3) and faint stars
IC 2395	08 42.6	-48 07	7	Vel	Open cluster	4.6	40 stars 6th magnitude and fainter
NGC 2808	09 12.0	-64 52	15	Car	Globular cluster	6.2	Large and rich, compressed centre, stars 13 to 15th magnitude
NGC 3114	10 02.7	-60 07	35	Car	Open cluster	4.2	Rich cluster, stars 9 to 14th magnitude, slight central concentration
NGC 3132	10 07.0	-40 26	0.5	Vel	Planetary nebula	9.9	The 'Eight Burst Nebula', ring and disk, 10th magnitude central star
IC 2602	10 43.3	-64 20	50	Car	Open cluster	1.6	Rich in stars, strong central concentration, brightest stars mag. 3
NGC 3372	10 44.3	-59 53		Car	Emission nebula	varies	The 'Eta Carinae Nebula', very bright, prominent dark lanes
NGC 3532	11 06.6	-58 44	55	Car	Open cluster	3.0	Rich and large, slight central concentration, 150 stars 7 to 12th magnitude
NGC 3766	11 36.2	-61 38	12	Cen	Open cluster	5.3	Rich cluster, 100 stars magnitude range 7 to 12th
NGC 4755	12 53.8	-60 22	10	Cru	Open cluster	5.2	The 'Jewel Box', rich in stars, large brightness range
NGC 4945	13 05.4	-49 28	23 x 6	Cen	Spiral galaxy	8.2	Large edge on spiral, good field, another small galaxy in same field
NGC 5128	13 25.5	-43 01	31 x 23	Cen	Galaxy	7.0	'Centaurus A', bright sphere crossed by dark lane, radio source
NGC 5139	13 26.8	-47 29	36	Cen	Globular cluster	3.7	Omega Centauri, one of the finest globular clusters
NGC 5272	13 42.2	+28 23	16	CVn	Globular cluster	6.2	M3, large bright globular cluster, brightens rapidly towards the middle
NGC 5281	13 46.5	-62 55	4	Cen	Open cluster	5.9	40 stars, moderately rich in bright and faint stars, magnitudes 6 to 12
NGC 5617	14 29.8	-60 43	10	Cen	Open cluster	6.3	80 stars, large brightness range, strong central concentration
NGC 5904	15 18.6	+02 05	20	Ser	Globular cluster	5.6	M5, bright, large very compressed in middle, slightly oval in shape
NGC 6025	16 03.7	-60 30	12	TrA	Open cluster	5.1	60 stars, large brightness range, slight central concentration
NGC 6067	16 13.2	-54 13	12	Nor	Open cluster	5.6	100 stars, large brightness range, strong central concentration
NGC 6087	16 18.9	-57 54	12	Nor	Open cluster	5.4	40 stars, moderate brightness range, slight central concentration
NGC 6121	16 23.6	-26 32	26	Sco	Globular cluster	5.6	M4, conspicuous globular near Antares, one of the nearest
NGC 6124	16 25.6	-40 40	29	Sco	Open cluster	5.8	100 stars, large brightness range, strong central concentration
NGC 6193	16 41.3	-48 46	14	Ara	Open cluster	5.2	Few stars, large brightness range, slight central concentration
NGC 6205	**16 41.7**	**+36 28**	**17**	**Her**	**Globular cluster**	**5.8**	**M13, the 'Great Hercules Cluster', showpiece of northern skies**
NGC 6231	16 54.2	-41 50	14	Sco	Open cluster	2.6	A few stars with strong central concentration. Brightest stars mag. 5
NGC 6405	17 40.1	-32 13	20	Sco	Open cluster	4.2	M6, the 'Butterfly Cluster', 80 stars, large brightness range
NGC 6397	17 40.7	-53 40	26	Ara	Globular cluster	5.7	Loose, scattered structure, one of the nearest of the globulars
NGC 6475	17 53.9	-34 49	80	Sco	Open cluster	4.5	M7, 80 stars brighter than 1 10th magnitude, large brightness range
NGC 6494	17 56.8	-19 01	27	Sgr	Open cluster	5.5	M23, 150 stars, moderate brightness range, lies in good star field
NGC 6514	18 02.4	-23 02	28	Sgr	Gaseous nebula	6.3	M20, 'Trifid Nebula', emission and reflection nebulosity cut by dark lanes
NGC 6523	18 03.6	-24 23	45 x 30	Sgr	Emission nebula	5.8	M8, 'Lagoon', densest section known as the 'Hourglass', dark lane
NGC 6611	18 18.8	-13 47	7	Ser	Open cluster	6.0	M16, 100 bright and faint stars in the 'Eagle Nebula'
IC 4725	18 31.9	-19 15	29	Sgr	Open cluster	6.2	M25, 30 stars loosely scattered
NGC 6656	18 36.4	-23 54	24	Sgr	Globular cluster	5.1	M22. Fine globular, only Omega Centauri and 47 Tucanae are brighter
NGC 6705	18 51.1	-06 16	14	Set	Open cluster	5.8	M11, the 'Wild Duck Cluster', rich and compact open cluster
NGC 7009	21 04.2	-11 22	0.5	Aqr	Planetary nebula	12.8	The 'Saturn Nebula', ring structure in a larger and fainter halo
NGC 7078	21 30.0	+12 10	12	Peg	Globular cluster	6.2	M15, bright, irregularly shaped, well resolved into faint stars
NGC 7293	22 29.6	-20 50	13	Aqr	Planetary nebula	13.5	The 'Helix Nebula', ring structure in a larger and fainter disk

The data in **bold** denotes objects that are difficult to view from southern parts of WA.

Astronomy on the Internet

There are many Internet sites available for those interested in astronomy, most of which are very user friendly, and full of information. The following list of sites has been found by Observatory staff to be quite useful. Please note that the Internet is a dynamic medium so access to sites can change without notice, while new sites are becoming available all the time. This is a small list – each of the sites mentioned will have links to more related sites.

Perth Observatory

http://www.perthobservatory.wa.gov.au

- ***Astronomy News***: Updated regularly, this section contains a weekly night sky column, plus notification of current phenomena and topical events.
- ***Information***: This gives information (small images) of planets, comets, stars etc. All of this information is taken from the Perth Observatory Project Kit. Also Sun and Moon rise/set times for Perth.

Rise and set times for Perth and Moon phases for WA:
http://www.perthobservatory.wa.gov.au/information/rise_set_times_phases.html

- ***Education and Outreach***: Details of services for the public. For availability, contact Perth Observatory. Daytime guided tours and evening star viewing available.
- ***Astronomy Links***: This section links the user to many areas of astronomical interest.

NASA Homepage

http://www.nasa.gov/

This is a good starting place for many NASA projects – especially current missions. When a shuttle mission is in orbit, this will give a link to the current shuttle home page, with associated projects and experiments.

Hubble Space Telescope

http://oposite.stsci.edu/pubinfo/

The Hubble Space Telescope is managed through the Space Telescope Science Institute in Baltimore. Many HST images are available, even those several years old.

Sky and Telescope Magazine

http://www.skypub.com/

This magazine is the premier astronomy magazine for amateur astronomers. Sky Publishing put out a weekly update of all astronomical events in non-technical language along with summaries of press releases. The site can also provide some basic astronomical information.

Sun

http://sohowww.nascom.nasa.gov/

Current real time Sun images, including animated GIFs of solar flares. Also information about auroras.

Sunrise/set times

http://www.auslig.gov.au/geodesy/astro

Type in your latitude, longitude and Time Zone for astronomical phenomena at any place – interactive.

Moon Phases

http://sunearth.gsfc.nasa.gov/eclipse/phase/phase2001.html

Dates and times for moon phases (in UT: WAST = UT + 8hrs).

Eclipses

http://sunearth.gsfc.nasa.gov/eclipse/eclipse.html

Provides a wealth of information concerning both solar and lunar eclipses.

Current Almanac

http://skyandtelescope.com/observing/almanac

Can be set for your location. Sun and Moon, rise and set times, planet visibility, plus Space Station viewing times are available at this site.

Planets

http://www.nineplanets.org

Latest Information on all the planets – an excellent site.

Solar System Conditions

http://www.spaceweather.com

Current state of the solar winds, plus aurora predictions and asteroid approaches.

ISS, Iridium Satellites, Satellites

http://www.heavens-above.com

Input your specific site, and bookmark for your location. This gives passages of all satellites, or ISS (International Space Station), or the Iridium satellite flashes visible from your site, with specific times.

Weather

http://www.bom.gov.au/weather/wa

Weather maps and predictions, wind forecasts, charts and current conditions.

Constellations

Constellations are a relatively arbitrary grouping of stars in the sky. They are arbitrary in the sense that the stars are not necessarily related in any way, or even close to one another, they just lie in the same area on the celestial sphere. Also, in ancient times some stars were grouped together in a constellation because they were reminiscent of the outline, or rough shape, of an animal, object, or a mythological being. Different cultures most times defined different constellations for the same grouping of stars, but sometimes they were quite similar. Identifying a constellation by eye is sometimes just a matter of 'joining the dots' defined by the stars and using some imagination. Some constellations are not easily identified in this way as the relationship of stars to object is abstract or obscure.

Some of the constellations are descended from catalogues created by the ancient Greeks around 2,000 years ago. The most influential of these catalogues is the *Almagest* by Ptolemy of Alexandria (AD 73 - AD 151) in which he mentions 48 constellations that were visible from the Northern Hemisphere. Naturally, these constellations descended from earlier Egyptian and Mesopotamian cultures. This catalogue had an influence lasting nearly 1,200 years and was the foundation of the astronomy accomplished by Arabic and Medieval scholars. In fact, the title *Almagest* is a corruption of the Arabic, Al-mijisti, which roughly translates to *the Magnificent* – such was this culture's appreciation of its scholarly importance.

A little more than half of the constellations in use today originated from ancient times. The others were defined by European astronomers and cartographers as the Southern Hemisphere began to be explored in the 16th Century.

The most notable of these astronomers was Nicolas Louis de Lacaille (1713-1762). After an observing expedition to South Africa, he named 14 new constellations in the uncharted parts of southern sky. The constellations he defined represented equipment (mostly scientific) in use at that time.

In 1930 the International Astronomical Union (the organisation of professional astronomers) fixed the names and boundaries of the constellations. They defined 88 constellations in all, covering the entire sky (see table below). They generally follow the patterns of the most common constellations defined in earlier times. Strict definitions were required because prior to that date mapmakers and astronomers could define constellations as they pleased. Sometimes this was undertaken in order to obtain favour from a patron.

The table also provides the Latin 'genitive' case of the constellation names. This case is often referred to as the possessive case, as that is the most similar English language case comparison. It expresses possession, origin, source, etc. and in Latin grammar is shown by inflection of nouns, pronouns, and adjectives. With respect to the constellations, this case is used to show that the location of a star, or other object, lies within the boundaries of a constellation. For example, the brightest star in Taurus, Aldebaran, becomes α Tauri.

Culmination occurs when the mid point of a constellation is highest in the sky around midnight.

CONSTELLATIONS

DESIGNATION	GENITIVE	ABBREV.	CULMINATION	MEANING
Andromeda	Andromedae	And	Nov 23	The Chained Maiden
Antlia	Antliae	Ant	Apr 10	The Air Pump
Apus	Apodis	Aps	Jul 05	The Bird of Paradise
Aquarius	Aquarii	Aqr	Oct 09	The Water Bearer
Aquila	Aquilae	Aql	Aug 30	The Eagle
Ara	Arae	Ara	Jul 25	The Altar
Aries	Arietis	Ari	Dec 14	The Ram
Auriga	Aurigae	Aur	Feb 04	The Charioteer
Bootes	Bootis	Boo	Jun 16	The Bear Driver
Caelum	Caeli	Cae	Jan 15	The Sculptor's Chisel
Camelopardus	Camelopardi	Cam	Feb 06	The Giraffe
Cancer	Cancri	Cnc	Mar 16	The Crab
Canes Venatici	Canum Venaticorum	CVn	May 22	The Hunting Dogs
Canis Major	Canis Majoris	CMa	Feb 16	The Greater Dog
Canis Minor	Canis Minoris	CMi	Feb 28	The Lesser Dog
Capricornus	Capricorni	Cap	Sep 22	The Sea Goat
Carina	Carinae	Car	Mar 17	The Keel (of Argo Navis)
Cassiopeia	Cassiopeiae	Cas	Nov 23	The Queen of Ethiopia
Centaurus	Centauri	Cen	May 14	The Centaur
Cepheus	Cephei	Cep	Nov 13	The King of Ethiopia
Cetus	Ceti	Cet	Nov 29	The Sea Monster (Whale)
Chamaeleon	Chamaeleontis	Cha	Apr15	The Chameleon
Circinus	Circini	Cir	Jun 14	The Compasses
Columba	Columbae	Col	Feb 01	Noah's Dove
Coma Berenices	Cornae Berenices	Corn	May 17	The Hair of Berenice
Corona Australis	Coronae Australis	CrA	Aug 14	The Southern Crown

CONSTELLATIONS (continued)

DESIGNATION	GENITIVE	ABBREV.	CULMINATION	MEANING
Corona Borealis	Coronae Borealis	CrB	Jul 03	The Northern Crown
Corvus	Corvi	Crv	May 12	The Crow
Crater	Crateris	Crt	Apr 26	The Cup
Crux	Crucis	Cru	May 12	The (Southern) Cross
Cygnus	Cygni	Cyg	Sep 13	The Swan
Delphinus	Delphini	Del	Sep 14	The Dolphin (Porpoise)
Dorado	Doradus	Dor	Jan 31	The Swordfish
Draco	Draconis	Dra	Jul 08	The Dragon
Equuleus	Equulei	Equ	Sep 22	The Foal
Eridanus	Eridani	Eri	Dec 25	The River
Fornax	Fornacis	For	Dec 17	The Laboratory Furnace
Gemini	Geminorum	Gem	Feb 19	The Twins
Grus	Gruis	Gru	Oct 12	The Crane
Hercules	Herculis	Her	Jul 28	Hercules (the hero)
Horologium	Horologii	Hor	Dec 25	The Pendulum Clock
Hydra	Hydrae	Hya	Apr 29	The Water Snake
Hydrus	Hydri	Hyi	Dec 10	The Southern Water Snake
Indus	Indi	Ind	Sep 26	The American Indian
Lacerta	Lacertae	Lac	Oct 12	The Lizard
Leo	Leonis	Leo	Apr 15	The Lion
Leo Minor	Leonis Minoris	LMi	Apr 09	The Lion Cub
Lepus	Leporis	Lep	Jan 28	The Hare
Libra	Librae	Lib	Jun 23	The Scales
Lupus	Lupi	Lup	Jun 23	The Wolf
Lynx	Lyncis	Lyn	Mar 05	The Lynx
Lyra	Lyrae	Lyr	Aug18	The Harp
Mensa	Mensae	Men	Jan 28	The Table Mountain
Microscopium	Microscopii	Mic	Sep, 18	The Microscope
Monoceros	Monocerotis	Mon	Feb 19	The Unicorn
Musca	Muscae	Mus	May 14	The Fly
Norma	Normae	Nor	Jul 03	The Carpenter's Square
Octans	Octantis	Oct	Circum	The Octant
Ophiuchus	Ophiuchi	Oph	Jul 26	The Serpent Bearer
Orion	Orionis	Ori	Jan 27	The Hunter
Pavo	Pavonis	Pav	Aug 29	The Peacock
Pegasus	Pegasi	Peg	Oct 16	The Winged Horse
Perseus	Persei	Per	Dec 22	Perseus (the hero)
Phoenix	Phoenicis	Phe	Nov 18	The Phoenix
Pictor	Pictoris	Pic	Jan 30	The Painter's Easel
Pisces	Piscium	Psc	Nov 11	The Fishes
Piscis Austrinus	Piscis Austrini	PsA	Oct 09	The Southern Fish
Puppis	Puppis	Pup	Feb 22	The Stern (of Argo Navis)
Pyxis	Pyxidis	Pyx	Mar 21	The Mariner's Compass
Reticulum	Reticuli	Ret	Jan 03	The Eyepiece Reticle
Sagitta	Sagittae	Sge	Aug 30	The Arrow
Sagittarius	Sagittarii	Sgr	Aug 21	The Archer
Scorpius	Scorpii	Sco	Jul 18	The Scorpion
Sculptor	Sculptoris	Scl	Nov 10	The Sculptor's Workshop
Scutum	Scuti	Sct	Aug 15	The Shield
Serpens	Serpentis	Ser	Jul 21	The Serpent
Sextans	Sextantis	Sex	Apr 08	The Sextant
Taurus	Tauri	Tau	Jan 14	The Bull
Telescopium	Telescopii	Tel	Aug 24	The Telescope
Triangulum	Trianguli	Tri	Dec 07	The Triangle
Triangulum Australe	Trianguli Australis	TrA	Jul 07	The The Southern Triangle
Tucana	Tucanae	Tuc	Nov 01	The Toucan
Ursa Major	Ursae Majoris	UMa	Apr 25	The Great Bear
Ursa Minor	Ursae Minoris	Umi	Jun 27	The Bear Cub
Vela	Velorum	Vel	Mar 30	The Sail (of Argo Navis)
Virgo	Virginis	Vir	May 26	The Virgin
Volans	Volantis	Vol	Mar 04	The Flying Fish
Vulpecula	Vulpeculae	Vul	Sep 08	The Fox

GREEK ALPHABET

Α	α	Alpha
Β	β	Beta
Γ	γ	Gamma
Δ	δ	Delta
Ε	ϵ	Epsilon
Ζ	ζ	Zeta
Η	η	Eta
Θ	θ	Theta
Ι	ι	Iota
Κ	κ	Kappa
Λ	λ	Lambda
Μ	μ	Mu
Ν	ν	Nu
Ξ	ξ	Xi
Ο	ο	Omicron
Π	π	Pi
Ρ	ρ	Rho
Σ	σ	Sigma
Τ	τ	Tau
Υ	υ	Upsilon
Φ	φ	Phi
Χ	χ	Chi
Ψ	ψ	Psi
Ω	ω	Omega

CALENDAR WITH JULIAN DATE AND DAY NUMBERS

DAY OF MONTH	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	Day of: Week	Year	Julian Date -2,454,000	Day of: Week	Year	Julian Date -2,454,000	Day of: Week	Year	Julian Date -2,454,000	Day of: Week	Year	Julian Date -2,454,000	Day of: Week	Year	Julian Date -2,454,000	Day of: Week	Year	Julian Date -2,454,000
1	Mon	1	101.5	Thu	32	132.5	Thu	60	160.5	Sun	91	191.5	Tue	121	221.5	Fri	152	252.5
2	Tue	2	102.5	Fri	33	133.5	Fri	61	161.5	Mon	92	192.5	Wed	122	222.5	Sat	153	253.5
3	Wed	3	103.5	Sat	34	134.5	Sat	62	162.5	Tue	93	193.5	Thu	123	223.5	Sun	154	254.5
4	Thu	4	104.5	Sun	35	135.5	Sun	63	163.5	Wed	94	194.5	Fri	124	224.5	Mon	155	255.5
5	Fri	5	105.5	Mon	36	136.5	Mon	64	164.5	Thu	95	195.5	Sat	125	225.5	Tue	156	256.5
6	Sat	6	106.5	Tue	37	137.5	Tue	65	165.5	Fri	96	196.5	Sun	126	226.5	Wed	157	257.5
7	Sun	7	107.5	Wed	38	138.5	Wed	66	166.5	Sat	97	197.5	Mon	127	227.5	Thu	158	258.5
8	Mon	8	108.5	Thu	39	139.5	Thu	67	167.5	Sun	98	198.5	Tue	128	228.5	Fri	159	259.5
9	Tue	9	109.5	Fri	40	140.5	Fri	68	168.5	Mon	99	199.5	Wed	129	229.5	Sat	160	260.5
10	Wed	10	110.5	Sat	41	141.5	Sat	69	169.5	Tue	100	200.5	Thu	130	230.5	Sun	161	261.5
11	Thu	11	111.5	Sun	42	142.5	Sun	70	170.5	Wed	101	201.5	Fri	131	231.5	Mon	162	262.5
12	Fri	12	112.5	Mon	43	143.5	Mon	71	171.5	Thu	102	202.5	Sat	132	232.5	Tue	163	263.5
13	Sat	13	113.5	Tue	44	144.5	Tue	72	172.5	Fri	103	203.5	Sun	133	233.5	Wed	164	264.5
14	Sun	14	114.5	Wed	45	145.5	Wed	73	173.5	Sat	104	204.5	Mon	134	234.5	Thu	165	265.5
15	Mon	15	115.5	Thu	46	146.5	Thu	74	174.5	Sun	105	205.5	Tue	135	235.5	Fri	166	266.5
16	Tue	16	116.5	Fri	47	147.5	Fri	75	175.5	Mon	106	206.5	Wed	136	236.5	Sat	167	267.5
17	Wed	17	117.5	Sat	48	148.5	Sat	76	176.5	Tue	107	207.5	Thu	137	237.5	Sun	168	268.5
18	Thu	18	118.5	Sun	49	149.5	Sun	77	177.5	Wed	108	208.5	Fri	138	238.5	Mon	169	269.5
19	Fri	19	119.5	Mon	50	150.5	Mon	78	178.5	Thu	109	209.5	Sat	139	239.5	Tue	170	270.5
20	Sat	20	120.5	Tue	51	151.5	Tue	79	179.5	Fri	110	210.5	Sun	140	240.5	Wed	171	271.5
21	Sun	21	121.5	Wed	52	152.5	Wed	80	180.5	Sat	111	211.5	Mon	141	241.5	Thu	172	272.5
22	Mon	22	122.5	Thu	53	153.5	Thu	81	181.5	Sun	112	212.5	Tue	142	242.5	Fri	173	273.5
23	Tue	23	123.5	Fri	54	154.5	Fri	82	182.5	Mon	113	213.5	Wed	143	243.5	Sat	174	274.5
24	Wed	24	124.5	Sat	55	155.5	Sat	83	183.5	Tue	114	214.5	Thu	144	244.5	Sun	175	275.5
25	Thu	25	125.5	Sun	56	156.5	Sun	84	184.5	Wed	115	215.5	Fri	145	245.5	Mon	176	276.5
26	Fri	26	126.5	Mon	57	157.5	Mon	85	185.5	Thu	116	216.5	Sat	146	246.5	Tue	177	277.5
27	Sat	27	127.5	Tue	58	158.5	Tue	86	186.5	Fri	117	217.5	Sun	147	247.5	Wed	178	278.5
28	Sun	28	128.5	Wed	59	159.5	Wed	87	187.5	Sat	118	218.5	Mon	148	248.5	Thu	179	279.5
29	Mon	29	129.5				Thu	88	188.5	Sun	119	219.5	Tue	149	249.5	Fri	180	280.5
30	Tue	30	130.5				Fri	89	189.5	Mon	120	220.5	Wed	150	250.5	Sat	181	281.5
31	Wed	31	131.5				Sat	90	190.5				Thu	151	251.5			

DAY OF MONTH	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	Day of: Week	Year	Julian Date -2,454,000	Day of: Week	Year	Julian Date -2,454,000	Day of: Week	Year	Julian Date -2,454,000	Day of: Week	Year	Julian Date -2,454,000	Day of: Week	Year	Julian Date -2,454,000	Day of: Week	Year	Julian Date -2,454,000
1	Sun	182	282.5	Wed	213	313.5	Sat	244	344.5	Mon	274	374.5	Thu	305	405.5	Sat	335	435.5
2	Mon	183	283.5	Thu	214	314.5	Sun	245	345.5	Tue	275	375.5	Fri	306	406.5	Sun	336	436.5
3	Tue	184	284.5	Fri	215	315.5	Mon	246	346.5	Wed	276	376.5	Sat	307	407.5	Mon	337	437.5
4	Wed	185	285.5	Sat	216	316.5	Tue	247	347.5	Thu	277	377.5	Sun	308	408.5	Tue	338	438.5
5	Thu	186	286.5	Sun	217	317.5	Wed	248	348.5	Fri	278	378.5	Mon	309	409.5	Wed	339	439.5
6	Fri	187	287.5	Mon	218	318.5	Thu	249	349.5	Sat	279	379.5	Tue	310	410.5	Thu	340	440.5
7	Sat	188	288.5	Tue	219	319.5	Fri	250	350.5	Sun	280	380.5	Wed	311	411.5	Fri	341	441.5
8	Sun	189	289.5	Wed	220	320.5	Sat	251	351.5	Mon	281	381.5	Thu	312	412.5	Sat	342	442.5
9	Mon	190	290.5	Thu	221	321.5	Sun	252	352.5	Tue	282	382.5	Fri	313	413.5	Sun	343	443.5
10	Tue	191	291.5	Fri	222	322.5	Mon	253	353.5	Wed	283	383.5	Sat	314	414.5	Mon	344	444.5
11	Wed	192	292.5	Sat	223	323.5	Tue	254	354.5	Thu	284	384.5	Sun	315	415.5	Tue	345	445.5
12	Thu	193	293.5	Sun	224	324.5	Wed	255	355.5	Fri	285	385.5	Mon	316	416.5	Wed	346	446.5
13	Fri	194	294.5	Mon	225	325.5	Thu	256	356.5	Sat	286	386.5	Tue	317	417.5	Thu	347	447.5
14	Sat	195	295.5	Tue	226	326.5	Fri	257	357.5	Sun	287	387.5	Wed	318	418.5	Fri	348	448.5
15	Sun	196	296.5	Wed	227	327.5	Sat	258	358.5	Mon	288	388.5	Thu	319	419.5	Sat	349	449.5
16	Mon	197	297.5	Thu	228	328.5	Sun	259	359.5	Tue	289	389.5	Fri	320	420.5	Sun	350	450.5
17	Tue	198	298.5	Fri	229	329.5	Mon	260	360.5	Wed	290	390.5	Sat	321	421.5	Mon	351	451.5
18	Wed	199	299.5	Sat	230	330.5	Tue	261	361.5	Thu	291	391.5	Sun	322	422.5	Tue	352	452.5
19	Thu	200	300.5	Sun	231	331.5	Wed	262	362.5	Fri	292	392.5	Mon	323	423.5	Wed	353	453.5
20	Fri	201	301.5	Mon	232	332.5	Thu	263	363.5	Sat	293	393.5	Tue	324	424.5	Thu	354	454.5
21	Sat	202	302.5	Tue	233	333.5	Fri	264	364.5	Sun	294	394.5	Wed	325	425.5	Fri	355	455.5
22	Sun	203	303.5	Wed	234	334.5	Sat	265	365.5	Mon	295	395.5	Thu	326	426.5	Sat	356	456.5
23	Mon	204	304.5	Thu	235	335.5	Sun	266	366.5	Tue	296	396.5	Fri	327	427.5	Sun	357	457.5
24	Tue	205	305.5	Fri	236	336.5	Mon	267	367.5	Wed	297	397.5	Sat	328	428.5	Mon	358	458.5
25	Wed	206	306.5	Sat	237	337.5	Tue	268	368.5	Thu	298	398.5	Sun	329	429.5	Tue	359	459.5
26	Thu	207	307.5	Sun	238	338.5	Wed	269	369.5	Fri	299	399.5	Mon	330	430.5	Wed	360	460.5
27	Fri	208	308.5	Mon	239	339.5	Thu	270	370.5	Sat	300	400.5	Tue	331	431.5	Thu	361	461.5
28	Sat	209	309.5	Tue	240	340.5	Fri	271	371.5	Sun	301	401.5	Wed	332	432.5	Fri	362	462.5
29	Sun	210	310.5	Wed	241	341.5	Sat	272	372.5	Mon	302	402.5	Thu	333	433.5	Sat	363	463.5
30	Mon	211	311.5	Thu	242	342.5	Sun	273	373.5	Tue	303	403.5	Fri	334	434.5	Sun	364	464.5
31	Tue	212	312.5	Fri	243	343.5				Wed	304	404.5				Mon	365	465.5

What's an Era?

An era is a start point for chronological calculations and those in the accompanying table relater to different calendar systems. A calendar is a system of time reckoning over long durations and different cultures start their calendars at an era that has significance to them. Currently, there are about 40 calendars in use around the world.

The calendar in common use in Australia (and all developed countries) is associated with the Christian Church and its starting epoch is the estimated first year of the life of Christ. However, its correct name is the Gregorian calendar because in 1582 Pope Gregory XIII reformed the rule of Leap Years in order to better keep the months in synchronism with the seasons. Therefore this calendar is a solar calendar – it is based on the orbital motion of the Earth about the Sun. The Gregorian calendar is an improvement of the earlier Julian calendar (initiated by Julius Caesar around BC46). Most countries use the Gregorian calendar for the conduct of trade.

In Byzantium, their era started from the Biblical Creation and not from Christ's birth. The number of elapsed years between the events was deemed to be 5508 years.

The Chinese calendar is a combined lunar and solar (lunisolar) calendar and is mainly used to determine the dates of traditional Chinese holidays. Its start epoch is that for the birth of Emporor Huang Di.

The Coptic calendar, also called the Diocletian calendar, is used by the Coptic Orthodox Church. This calendar is based on the ancient Egyptian (solar) calendar. Coptic years are counted from AD 284, the year the notorious persecutor of christians Diocletian became Roman Emperor.

The Buddhist calendar used in Cambodia, Thailand, and Myanmar is a lunisolar calendar. Thailand uses the Buddhasakarat era, Cambodia uses the Mahasakarat era (that happens to be the same as the Saka Era in the Indian Saka calendar) and Myanmar uses the Chulasakarat era.

The Islamic (Hegira) calendar in a lunar calendar (based on the orbit of the Moon about the Earth) and its starting year is that for the birth of the Prophet Muhammad.

The Japanese calendar is based on the mythical founding of Japan by Emperor Jimmu in 660BCE.

The Jewish calendar is a lunisolar calendar and starts at the date of Creation as outlined in the Old Testament.

The Greek astronomer Claudius Ptolemaeus defined an era that started from the first year of the reign of Nabonassar the founder of a kingdom in Babylon. This system was used by Ptolemy and later astronomers, but not by the Babylonians themselves.

In the later Roman Republic, historians and scholars began to count years from the founding of the city of Rome. Different scholars used different dates for this event. The date most widely used today is that calculated by Varro, 753 BC, but other systems varied by up to several decades. Dates given by this method are numbered ab urbe condita (meaning after the founding of the city, and abbreviated AUC).

ERAS (2007)

ERA NAME	YEAR	BEGINS
Byzantine	7516	Sep 14
Chinese (Ding-Hai)	(4644)	Feb 18
Diocletian	1724	Sep 12
Grecian (Seleucidae)	2319	Sep 14 (or Oct 14)
GREGORIAN	**2007**	**Jan 1**
Indian (Saka)	1929	Mar 22
Islamic (Hegira)*	1428	Jan 19
Japanese	2667	Jan 1
Jewish (A.M)*	5768	Sep 12
Nabonassar	2756	Apr 22
Roman (A.U.C.)	2760	Jan 14

* Year begins at sunset.

All dates are given in terms of the Gregorian calendar in which 2007 January 14 corresponds to 2007 January 1 of the Julian Calendar.

RELIGIOUS CALENDAR (2007)

EVENT	DATE
Epiphany	Jan 6
Islamic New Year (tabular)	Jan 20
Ash Wednesday	Feb 21
Palm Sunday	Apr 1
First Day of Passover (Pesach)	Apr 3
Good Friday	Apr 6
Easter Day	Apr 8
Ascension Day	May 17
Feast of Weeks (Shavuot)	May 23
Whit Sunday - Pentecost	May 27
Trinity Sunday	Jun 3
First Day of Ramadan (tabular)	Sep 13
Jewish New Year (tabular) (Rosh Hashanah)	Sep 13
Day of Atonement (Yom Kippur)	Sep 22
First Day of Tabernacles (Succoth)	Sep 27
First Sunday in Advent	Dec 2
Christmas Day (Sunday)	Dec 25

The Jewish and Islamic dates above are tabular dates, which begin at sunset on the previous evening and end at sunset on the date tabulated. In practice, the dates of Islamic fasts and festivals are determined by an actual sighting of the appropriate New Moon.

CHRONOLOGICAL CYCLES (2007)

Dominical Letter	G	A "letter" that corresponds to the day upon which the first Sunday (and every subsequent Sunday) of the year falls. For example, A=Sunday Jan 1st, B=Sunday Jan 2nd, C= Sunday Jan 3rd etc. This system was developed in Roman times and is used in constructing the ecclesiastical calendar (and determining Easter) for any year.
Epact	11	The 'age' of the Moon: the number of days since new moon, diminished by one day, on January 1 in the Gregorian ecclesiastical lunar cycles. It is used in constructing the ecclesiastical calendar for any year.
Golden Number (Lunar Cycle)	XIII	Year within a 19-year cycle after which moon phases repeat (approximately) on the same calendar day in the Julian Calendar. It used to be used in constructing the ecclesiastical calendar for any year.
Julian Period (year of)	6720	Number of Julian years from Julian Day 0.
Roman Indiction	15	Year within a 15-year cycle based on a Roman taxation cycle. (This, in turn, was based on the maximum length of military service, at the end of which taxation had to be finalised.)
Solar Cycle	28	Year within a 28-year cycle after which weekdays and calendar dates repeat in the Julian Calendar. It used to be used in constructing the ecclesiastical calendar for any year..

Calculation of Easter

The calculation of the Easter date has the ecclesiastical name of the comput. It is somewhat complicated because it is linked to the Hebrew calendar.

Jesus was crucified immediately before the Jewish Passover, which is a celebration of the Exodus from Egypt under Moses. Celebration of Passover started on the 15th day of the (spring) month of Nisan. Jewish months start when the Moon is new, therefore the 15th day of the month must be immediately after a Full Moon.

It was therefore decided to make Easter Sunday the first Sunday after the first Full Moon after March equinox. Or more precisely: Easter Sunday is determined using the *ecclesiastical Moon*, the fictitious average Moon, as the first Sunday after the ecclesiastical Full Moon on or after the ecclesiastical March equinox.

The ecclesiastical March equinox is always 21 March. The ecclesiastical Full Moon may differ from the astronomical Full Moon by one or two days.

The Full Moon that precedes Easter is called the Paschal Full Moon. Two constructs play an important role when calculating the Paschal Full Moon: The Golden Number and the Epact.

The following table shows the date for the Paschal Full Moon for a given Epact: Easter Sunday is the Sunday following the above Full Moon date. If the Full Moon falls on a Sunday, Easter Sunday is the following Sunday. An Epact of 25 requires special treatment, as it has two dates in the above table. There are two equivalent methods for choosing the correct Paschal Full Moon date, either:

Epact	Paschal Full Moon	Epact	Paschal Full Moon
1	12 April	16	28 March
2	11 April	17	27 March
3	10 April	18	26 March
4	9 April	19	25 March
5	8 April	20	24 March
6	7 April	21	23 March
7	6 April	22	22 March
8	5 April	23	21 March
9	4 April	24	18 April
10	3 April	25	18 or 17 April
11	2 April	26	17 April
12	1 April	27	16 April
13	31 March	28	15 April
14	30 March	29	14 April
15	29 March	30	13 April

a) Choose 18 April, unless the current century contains years with an Epact of 24, in which case 17 April should be used.

b) If the Golden Number is > 11 choose 17 April, otherwise choose 18 April.

(Adapted from 'Frequently Asked Questions About Calendars' by Claus Tondering, 2005.)

HOURS	01	02	03	04	05	06	07	08	09	10	11	12
FRACTION OF A DAY:	0.042	0.083	0.125	0.167	0.208	0.250	0.292	0.333	0.375	0.417	0.458	0.500

HOURS	13	14	15	16	17	18	19	20	21	22	23	24
FRACTION OF A DAY:	0.542	0.583	0.625	0.667	0.708	0.750	0.792	0.833	0.875	0.917	0.958	1.000

Rise Set Corrections

Most of the rise and set times quoted in this Almanac are correct for WA's population centre and state capital, Perth. The maps provided here will assist in the process of making corrections for observations at other locations around the state.

Meteorological and local topography affect the actual time of an object's rise or set. These affects vary from place to place and in general add an uncertainty of about two minutes to these times.

How to make a correction

1. Find the relevant rise or set time at Perth for the date you require,

2. Find the declination of the object on that date,

3. Find the rise or set map for the object's declination, or the two maps that bracket the declination, and

4. Estimate your location on the maps,

5. Estimate the correction from the map, or maps.

6. If you use two maps you will need to estimate the correction for both maps, then interpolate (estimate an intermediate value given the objects declination as a proportion between the map declinations) between these two values to obtain the overall correction.

An example:

Sunrise time at Leonora on 2007 Dec 22nd (the December Solstice of 2007).

1 The sunrise time at Perth on that date is 0507 WAST (from December Sun and Moon rise and set table, see section: *December*).

2. The declination of the Sun on that date is -23° 26' 10" = -(23+26/60+10/3600)° = -23.°44 (from Sun position table, section: *Solar System Information*).

3. Leonora is approximately NW of the line joining Kalgoorlie and Laverton, or, latitude = -28.9 degrees and longitude = 121.33 degrees E.

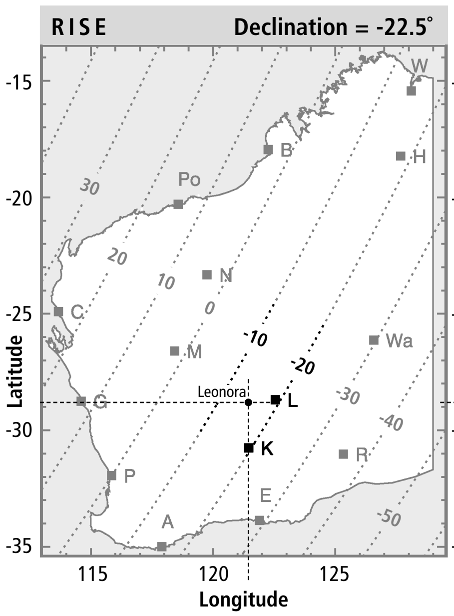
4. Use the rise maps, with declinations –22.°5 and –30.°0. From the rise correction maps the corrections are –16 minutes and –13 minutes, respectively.

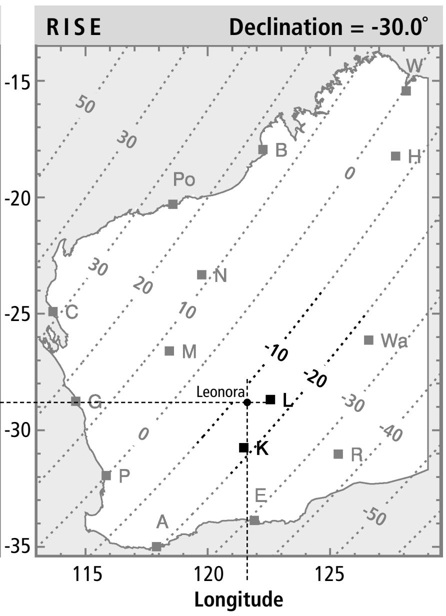
5. Interpolate between maps: -23.°44 is 0.°94 from –22.°5 toward –30.°0. So we must add 0.94/7.5 of the difference between the estimates, from the estimate at –22.°5.

The interpolation 'correction' = 0.94/7.5 * (-13+16) minutes, is approximately 0 minutes (any fraction of 2 minutes is negligible for these purposes).

Total correction is –16 minutes (at declination = –22.°5) + interpolation (=0 minutes) = -16 minutes.

Sunrise time at Leonora
= Sunrise time at Perth + correction = 0507 WAST –16 minutes = 0451 WAST.





Notes for maps

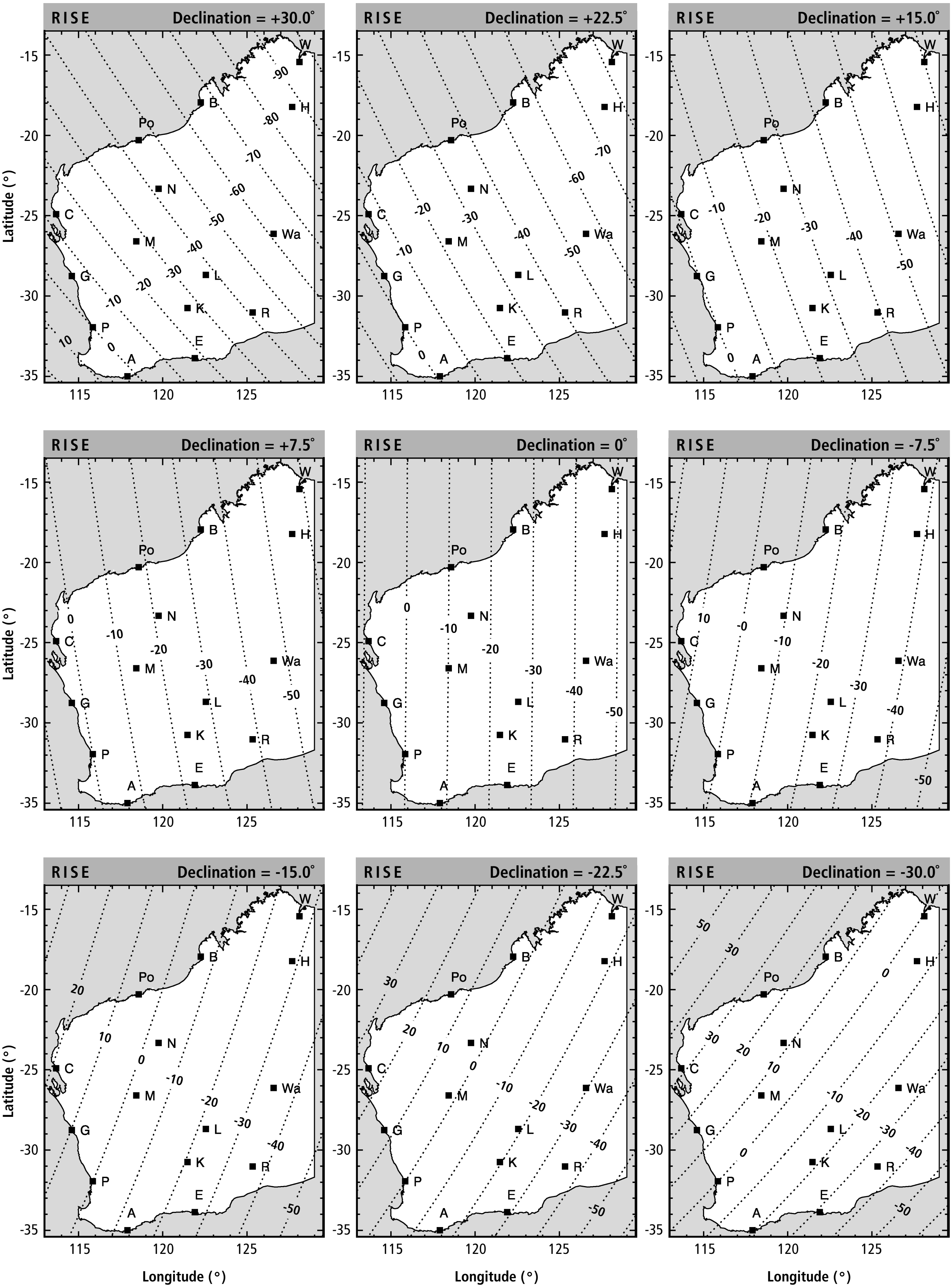
All corrections are the number of minutes to be added to the rise or set time at Perth. The cities and towns indicated are:

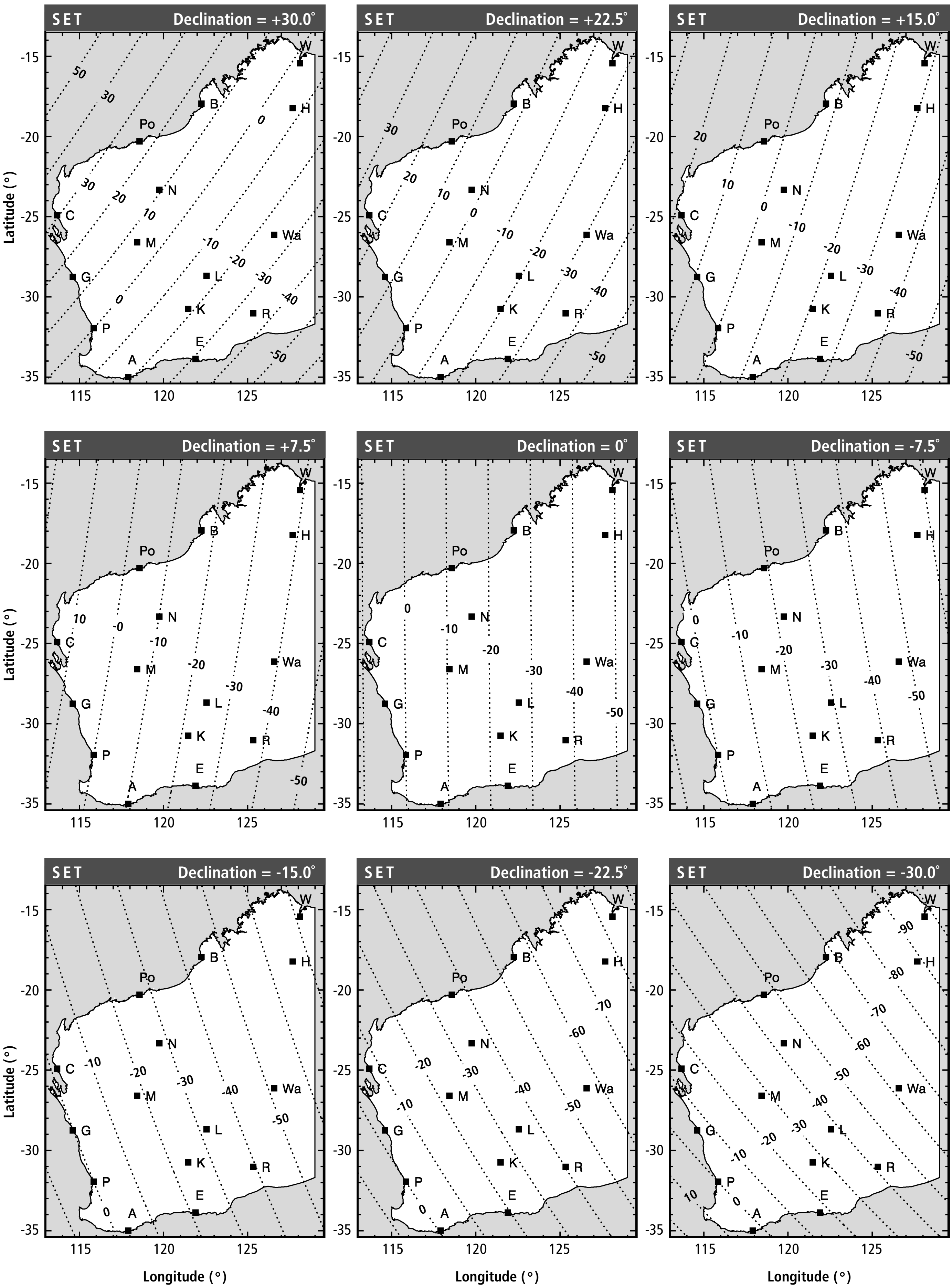
A	**Albany**	**B**	**Broome**	**C**	**Carnarvon**	**E**	**Esperance**
G	**Geraldton**	**H**	**Halls Creek**	**K**	**Kalgoorlie**	**L**	**Laverton**
M	**Meekatharra**	**N**	**Newman**	**P**	**Perth**	**Po**	**Port Hedland**
R	**Rawlinna**	**Wa**	**Warburton Community**			**W**	**Wyndham**

COORDINATES AROUND WA

LOCATION	Latitude (° South)	Longitude (° East)
Albany	35.018	117.884
Augusta	34.312	115.159
Bickley (Perth Observatory)	32.017	116.133
Bridgetown	33.958	116.141
Broome	17.962	122.236
Bunbury	33.340	115.642
Carnarvon	24.890	113.660
Christmas Island	10.483	105.623
Cocos (Keeling) Islands	12.166	96.823
Denmark	34.972	117.357
Derby	17.303	123.629
Esperance	33.866	121.888
Eucla	31.675	128.883
Fitzroy Crossing	18.178	125.591
Fremantle	32.056	115.746
Geraldton	28.779	114.614
Giles Meteorological Station	18.227	127.668
Joondalup	31.745	115.766
Kalgoorlie	30.749	121.466
Karratha	20.731	116.857
Kellerberrin	31.632	117.708
Kojonup	33.838	117.152
Lake Grace	33.089	118.405
Laverton	28.623	122.401
Mandurah	32.529	115.723
Marble Bar	21.172	119.746
Meekatharra	26.591	118.497
Moora	30.638	116.010
Mount Magnet	28.062	117.848
Narrogin	32.936	117.178
Newman	23.358	119.730
Norseman	32.196	121.778
Northam	31.647	116.669
Onslow	21.688	115.135
Pemberton	34.446	116.036
Perth	31.952	115.859
Port Hedland	20.310	118.601
Rawlinna	30.776	125.440
Rockingham	32.281	115.727
Southern Cross	31.227	119.327
Tom Price	22.694	117.793
Warburton Community	26.132	126.571
Wiluna	26.595	120.225
Wyndham	15.486	128.120
Yampi Sound	16.129	123.656

RISE/SET CORRECTION DIAGRAMS FOR WESTERN AUSTRALIA





A Albany	C Carnarvon	G Geraldton	K Kalgoorlie	M Meekatharra	P Perth	R Rawlinna	Wa Warburton Community
B Broome	E Esperance	H Halls Creek	L Laverton	N Newman	Po Port Hedland	W Wyndham	

Astrophotography

Astrophotography can be a rewarding and challenging hobby. You will need a camera that is firmly mounted on a tripod or the like. You can also eliminate vibration with a remote switch, which is also handy to control the long time exposures sometimes required.

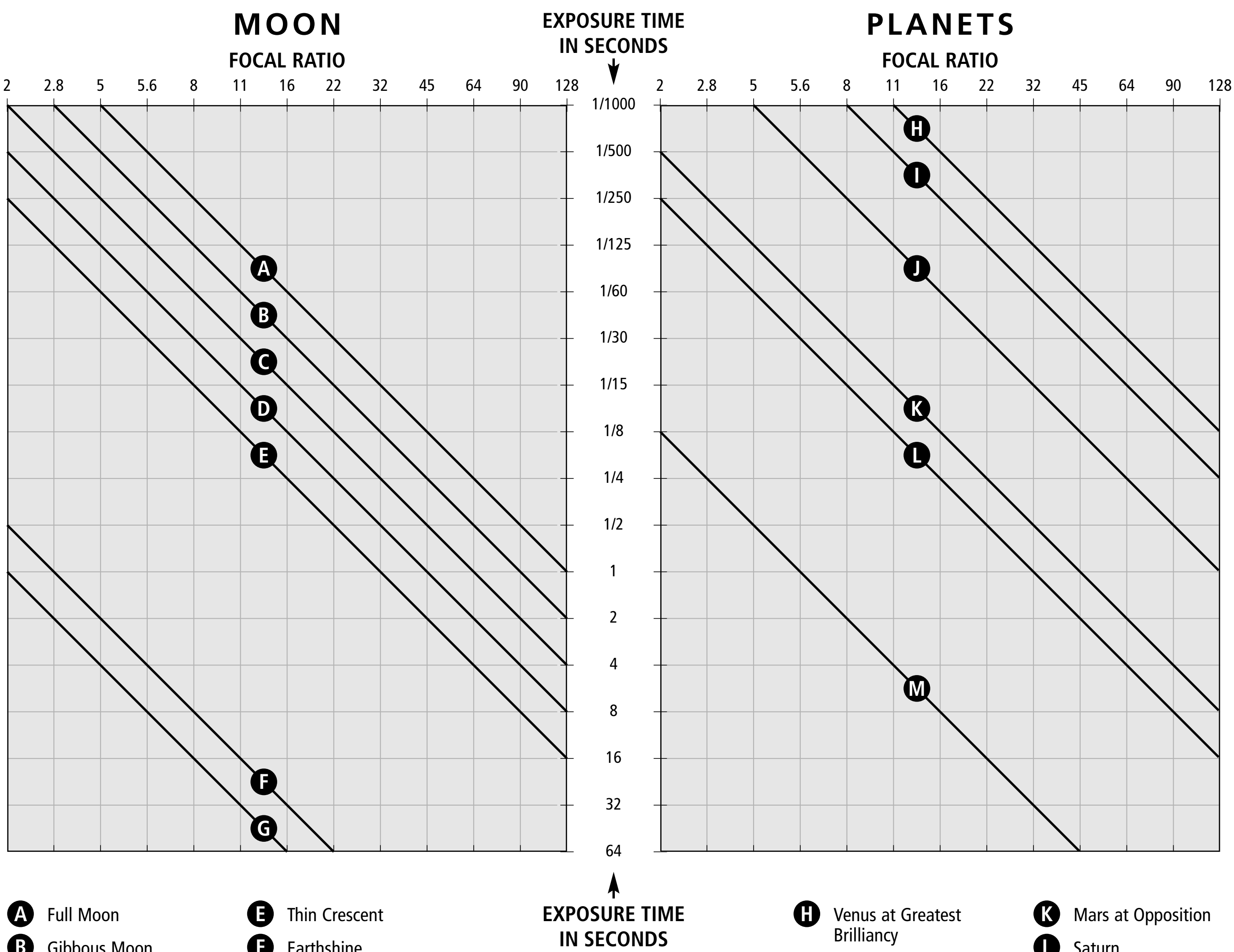
The graphs show the recommended exposure times for the Moon and planets using 100 ISO film. They should only be used as a guide because many factors influence the exposure time.

To select the correct exposure time:

1. **Select your system's focal ratio along the horizontal axis,**
2. **Find the intersection with the exposure line of the Moon or planet required,**
3. **Follow a horizontal line across to find the intersection with the vertical axis for the exposure time, and**
4. **Correct the exposure time for the speed of your film.**

FILM SPEED	MULTIPLY BY	FILM SPEED	DIVIDE BY	FILM SPEED	DIVIDE BY
32 ISO	4	200 ISO	2	800 ISO	8
64 ISO	2	400 ISO	4	1600 ISO	16

For best results you should take at least three exposures, one at the recommended exposure time, the next at one half the exposure, and the last at twice the exposure time.



- **A** Full Moon
- **B** Gibbous Moon
- **C** First and Last Quarter
- **D** Crescent Moon
- **E** Thin Crescent
- **F** Earthshine (2 day old Moon)
- **G** Total Lunar Eclipse
- **H** Venus at Greatest Brilliancy
- **I** Venus at Eastern or Western Elongation
- **J** Jupiter
- **K** Mars at Opposition
- **L** Saturn
- **M** Jupiter's Satellites

ASTRONOMY AND ASTROPHYSICS DEFINITIONS

A

aberration: the apparent angular displacement of the observed position of a celestial object from its geometric position, caused by the finite velocity of light in combination with the motions of the observer and of the observed object.

aberration, annual: the component of stellar aberration resulting from the motion of the Earth about the Sun.

aberration, diurnal: the component of stellar aberration resulting from the observer's diurnal motion about the centre of the Earth.

aberration, planetary: the apparent angular displacement of the observed position of a celestial body produced by motion of the observer and the actual motion of the observed object.

aberration, secular: the component of stellar aberration resulting from the essentially uniform and rectilinear motion of the entire Solar System in space. Secular aberration is usually disregarded.

aberration, stellar: the apparent angular displacement of the observed position of a celestial body resulting from the motion of the observer. Stellar aberration is divided into diurnal, annual, and secular components.

accretion, accretion disk: Astronomical objects as diverse as protostars and active galaxies may derive their energy from the gravitational power released by the infall, or accretion, of material onto a central object. The combined effects of gravity, friction and rotation often force the accreting material into an orbiting accretion disk.

active galaxy: Certain galaxies emit far more energy than can be accounted for by their stars alone. The central regions of these galaxies harbour a compact, solar-system-sized object capable of outshining the rest of the galaxy by a factor of 100. The ultimate energy source for active galaxies may be the accretion of matter onto a supermassive black hole. Active galaxies can emit strongly across the entire electromagnetic spectrum, from radio waves to gamma rays. See quasar.

active optics: A technique to reduce the effects of slowly varying forces, such as gravitational deflections and temperature drifts, that can distort a mirror on time scales of minutes to hours, resulting in imperfect images.

adaptive optics: A set of techniques to adjust the mirrors of telescopes on time scales of hundredths of a second to correct for distortions in astronomical images due to turbulence in Earth's atmosphere.

arcminute: A unit of angle corresponding to 1/60th of a degree. The full moon is 30 arcminutes in diameter.

arcsecond: A unit of angle corresponding to 1/3600th of a degree; 1/60th of an arcminute. An arcsecond is approximately the size of a five cent coin viewed from a distance of 1 kilometre.

altitude: the angular distance of a celestial body above or below the horizon, measured along the great circle passing through the body and the zenith. Altitude is 90° minus zenith distance.

anomaly: angular measurement of a body in its orbit from its perihelion.

aphelion: the point in a planetary orbit that is at the greatest distance from the Sun.

apogee: the point at which a body in orbit around the Earth reaches its farthest distance from the Earth. Apogee is sometimes used with reference to the apparent orbit of the Sun around the Earth.

apparent place: the position on a celestial sphere, centred at the Earth, determined by removing from the directly observed position of a celestial body the effects that depend on the topocentric location of the observer; i.e., refraction, diurnal aberration and geocentric (diurnal) parallax. Thus, the position at which the object would actually be seen from the centre of the Earth, displaced by planetary aberration (except the diurnal part and referred to the true equator and equinox.

apparent solar time: the measure of time based on the diurnal motion of the true Sun. The rate of diurnal motion undergoes seasonal variation because of the obliquity of the ecliptic and because of the eccentricity of the Earth's orbit. Additional small variations result from irregularities in the rotation of the Earth on its axis.

array: There are two examples of arrays in common use in astronomy:
(1) A group, or array, of telescopes can be combined to simulate a single large telescope, kilometres or even thousands of kilometres across.
(2) Astronomical instruments have recently been fabricated using new electronic components called detector arrays or charge-coupled devices (CCDs) that consist of thousands of individual detectors constructed on centimetre-sized wafers of silicon, or other materials.

aspect: the apparent position of any of the planets or the Moon relative to the Sun, as seen from Earth.

astrometric ephemeris: an ephemeris of a solar system body in which the tabulated positions are essentially comparable to catalogue mean places of stars at a standard epoch.

astrometry: The branch of astronomy concerned with measuring the positions of celestial objects. Advances in technology may soon permit a 1,000-fold improvement in the measurement of positions, and thus in astronomers' ability to determine distances to stars and galaxies. See parallax.

astronomical co-ordinates: the longitude and latitude of a point on Earth relative to the geoid. These co-ordinates are influenced by local gravity anomalies.

astronomical unit (a.u.): the radius of a circular orbit in which a body of negligible mass, and free of perturbations, would revolve around the Sun in $2\pi/k$ days, where k is the Gaussian gravitational constant. This is slightly less than the semimajor axis of the Earth's orbit. Its value is approximately 1.496×10^8 km.

azimuth: the angular distance measured clockwise along the horizon from a specified reference point (usually north) to the intersection with the great circle drawn from the zenith through a body on the celestial sphere. Similar to compass bearing.

B

baseline: The separation between telescopes in an interferometer. The largest baseline determines the finest detail that can be discerned with an interferometer.

Big Bang: Most astronomers believe that the universe began in a giant explosion called the Big Bang about 14 billion years ago. Starting from an initial state of extremely high density, the universe has been expanding and cooling ever since. Some of the most fundamental observed properties of the universe, including the abundance of light elements such as helium and lithium and the recession of galaxies, can be accounted for by modern theories of the Big Bang.

black hole: A region in space where the density of matter is so extreme, and the resultant pull of gravity so strong, that not even light can escape. Black holes are probably the end point in the evolution of some types of stars and are probably located at the centres of some active galaxies and quasars.

blackbody radiation: A glowing object emits radiation in a quantity and at wavelengths that depend on the temperature of the object. For example, a poker placed in a hot fire first glows red-hot, then yellow-hot, then finally white-hot. This radiation is called thermal or blackbody radiation.

brown dwarf: A star-like object that contains less than about 0.08 the mass of the Sun and is thus too small to ignite nuclear fuels and become a normal star. Brown dwarfs emit small amounts of infrared radiation due to the slow release of gravitational energy and may be a component of dark matter.

C

calendar: a system of reckoning time in which days are enumerated according to their position in cyclic patterns.

Catalogue Equinox: the intersection of the hour circle of zero right ascension of a star catalogue with the celestial equator.

Celestial Equator: the projection onto the celestial sphere of the Earth's equator.

Celestial Pole: either of the two points projected onto the celestial sphere by the extension of the Earth's axis of rotation to infinity.

celestial sphere: an imaginary sphere of arbitrary radius upon which celestial bodies may be considered to be located. As circumstances require, the celestial sphere may be centred at the observer, at the Earth's centre, or at any other location.

charge-coupled device, or CCD: An electronic detector used for lowlight-level imaging and astronomical observations. CCDs were developed by NASA for use in the Hubble Space Telescope and the Galileo probe to Jupiter and are now widely used on ground-based telescopes. See also array.

conjunction: the phenomenon in which two bodies have the same apparent celestial longitude or right ascension as viewed from a third body. Conjunctions are usually tabulated as geocentric phenomena. For Mercury and Venus, geocentric inferior conjunction occurs when the planet is between the Earth and Sun, and superior conjunction occurs when the Sun is between the planet and Earth.

constellation: a grouping of stars, usually with pictorial or mythical associations, that serves to identify an area of the celestial sphere. Also, one of the precisely defined areas of the celestial sphere, associated with a grouping of stars, that the International Astronomical Union has designated as a constellation,

co-ordinated Universal Time (UTC): the time scale available from broadcast time signals. UTC differs from TAI (see International Atomic Time) by an integral number of seconds; it is maintained within ±0.90 second of UTI (see Universal Time) by the introduction of one second steps (leap seconds).

cosmic microwave background (CMB) radiation: The radiation left over from the Big Bang explosion at the beginning of the universe. As the universe expanded, the temperature of the fireball cooled to its present level of 2.7 degrees above absolute zero (2.7 K). Blackbody radiation from the cosmic background is observed at radio, millimetre, and submillimetre wavelengths.

cosmic rays: Protons and nuclei of heavy atoms that are accelerated to high energies in the magnetic field of our galaxy and that can be studied directly from Earth or from satellites.

culmination: passage of a celestial object across the observer's meridian; also called meridian passage. More precisely, culmination is the passage through the point of greatest altitude in the diurnal path. Upper culmination (also called "culmination above pole" for circumpolar stars and the Moon) or transit is the crossing closer to the observer's zenith. Lower culmination (also called "culmination below pole" for circumpolar stars and the Moon) is the crossing farther from the zenith.

D

dark energy: An as yet unknown form of energy that pervades the universe. Its presence was inferred from the discovery that the expansion of the universe is accelerating, and these observations suggest that about 70 percent of the total density of matter plus energy is in this form. Such an acceleration is predicted if the cosmological constant that Einstein included in his General Theory of Relativity were non-zero.

dark matter: Approximately 80 percent of the matter in the universe may so far have escaped direct detection. The presence of this unseen matter has been inferred from motions of stars and gas in galaxies, and of galaxies in clusters of galaxies. Candidates for the missing mass include brown dwarf stars and exotic subatomic particles. Dark matter was called "missing mass" for many years. However, because it is the light, not the mass, that is missing, astronomers have given up this terminology.

day: an interval of 86,400 SI seconds (see second, Systeme International), unless otherwise indicated.

declination: angular distance on the celestial sphere north or south of the celestial equator. It is measured along the hour circle passing through the celestial object. Declination is usually given in combination with right ascension or hour angle. It can be considered the celestial analogue of latitude on Earth.

diffraction limit: The finest detail that can be discerned with a telescope. The physical principle of diffraction limits this level of detail to a value proportional to the wavelength of the light observed divided by the diameter of the telescope.

direct motion: for orbital motion in the solar system, motion that is counter clockwise in the orbit as seen from the north pole of the ecliptic; for an object observed on the celestial sphere, motion that is from west to east, resulting from the relative motion of the object and the Earth.

diurnal motion: the apparent daily motion caused by the Earth's rotation, of celestial bodies across the sky from east to west.

Dynamical Time: the family of time scales introduced in 1984 to replace ephemeris time as the independent argument of dynamical theories and ephemerides.

E

eccentricity: a parameter (usually for orbits) that specifies the extent to which an ellipse departs from circularity. For a circle, eccentricity = 0. Most of the planets and their satellites have low eccentricity. Many comets, and some asteroids and planetary satellites have very eccentric orbits, with eccentricity approaching 1.

eclipse: the obscuration of a celestial body caused by its passage through the shadow cast by another body.

eclipse, annular: a solar eclipse (see eclipse, solar) in which the solar disk is never completely covered but is seen as an annulus or ring at maximum eclipse. An annular eclipse occurs when the apparent disk of the Moon is smaller than that of the Sun.

eclipse, lunar: an eclipse in which the Moon passes through the shadow cast by the Earth. The eclipse may be total (the Moon passing completely through the Earth's umbra), partial (the Moon passing partially through the Earth's umbra at maximum eclipse), or intersectic penumbral (the Moon passing only through the Earth's penumbra).

eclipse, solar: an eclipse in which the Earth passes through the shadow cast by the Moon. It may be total (observer in the Moon's umbra), partial (observer in the Moon's penumbra), or annular.

ecliptic: the mean plane of the Earth's orbit around the Sun. It is also the path of the Sun against the background stars.

elements, orbital: parameters that specify the position and motion of a body in orbit.

electromagnetic spectrum: Radiation can be represented as electric and magnetic fields vibrating with a characteristic wavelength or frequency. Long wavelengths (low frequencies) correspond to radio radiation; intermediate wavelengths, to millimetre and infra-red radiation; short wavelengths (high frequencies), to visible and ultraviolet light; and extremely short wavelengths, to x-rays and gamma rays. Most astronomical observations measure some form of electromagnetic radiation.

elongation, greatest: the instants when the geocentric angular distances of Mercury and Venus from the Sun are at a maximum.

elongation (planetary): the geocentric angle between a planet and the Sun, measured in the plane of the planet, Earth and Sun. Planetary elongations are measured from 0° to 180° east or west of the Sun.

elongation (satellite): the geocentric angle between a satellite and its primary, measured in the plane of the satellite, planet and Earth. Satellite elongations are measured from 0° east or west of the planet.

ephemeris: a tabulation of the positions of a celestial object in an orderly sequence for a number of dates.

Ephemeris Time (ET): the time scale used prior to 1984 as the independent variable in gravitational theories of the solar system. In 1984, ET was replaced by dynamical time.

epoch: an arbitrary fixed instant of time or date used as a chronological reference point for calendars (see calendar), celestial reference systems, star catalogues, or orbital motions.

equation of time: the hour angle of the true Sun minus the hour angle of the fictitious mean sun; alternatively, apparent solar time minus mean solar time.

equator: the great circle on the surface of a body formed by the intersection of the surface with the plane passing through the centre of the body perpendicular to the axis of rotation. (See celestial equator.)

equinox: either of the two points on the celestial sphere at which the ecliptic intersects the celestial equator; also, the time at which the Sun passes through either of these intersection points; i.e., when the apparent longitude of the Sun is 0° or 180°.

era: a system of chronological notation reckoned from a given date.

expansion of the universe: The tendency of every part of the universe to move away from every other part due to the initial impetus of the Big Bang; also known as the Hubble expansion, after the American astronomer Edwin Hubble, whose observations of receding galaxies led to scientists' current understanding of the expanding universe. See redshift.

extragalactic: Objects outside our galaxy, more than about 50,000 light-years away, are referred to as extragalactic.

F

fictitious mean sun: an imaginary body introduced to define mean solar time; essentially the name of a mathematical formula that defined mean solar time. This concept is no longer used in high precision work.

G

galaxy: An isolated grouping of tens to hundreds of billions of stars ranging in size from 5,000 to 150,000 light-years across. Spiral galaxies like our own Milky Way are flattened disks of stars and often contain large amounts of gas out of which new stars can form. Elliptical galaxies are shaped more like footballs and are usually devoid of significant quantities of gas.

gamma-ray astronomy: The study of astronomical objects using the most energetic form of electromagnetic radiation.

gegenschein: faint nebulous light about 20º across near the ecliptic and opposite the Sun, best seen in September and October. Also called counterglow.

General Relativity: Einstein's theory of gravity in which the gravity is the curved geometry of space and time.

geocentric: with reference to, or pertaining to, the centre of the Earth.

geocentric co-ordinates: the latitude and longitude of a point on the Earth's surface relative to the centre of the Earth; also, celestial co-ordinates given with respect to the centre of the Earth.

geoid: an equipotential surface that coincides with mean sea level in the open ocean. On land it is the level surface that would be assumed by water in an imaginary network of frictionless channels connected to the ocean.

geometric position: the geocentric position of an object on the celestial sphere referred to the true equator and equinox, but without the displacement due to planetary aberration.

gravitational lens: A consequence of Einstein's General Relativity Theory is that the path of light rays can be bent by the presence of matter. Astronomers have observed that the light from a distant galaxy or quasar can be 'lensed' by the matter in an intervening galaxy to form multiple and often distorted images of the background object.

Gregorian calendar: the calendar introduced by Pope Gregory XIII in 1582 to replace the Julian calendar; the calendar now used as the civil calendar in most countries. Every year when the end year is exactly divisible by four is a leap year, except for centurial years, which must be exactly divisible by 400 to be leap years. Thus, 2000 is a leap year, but 1900 and 2100 are not leap years.

H

halo (of a galaxy): The roughly spherical distribution of dark matter and thinly scattered stars, star clusters, and gas that surround a spiral galaxy.

height: elevation above ground or distance upwards from a given level (especially sea level) to a fixed point. (See altitude.)

heliocentric: with reference to, or pertaining to, the centre of the Sun.

helioseismology: The study of the internal vibrations of the Sun. In a manner analogous to terrestrial seismology, helioseismology can reveal important information about the Sun's internal condition.

horizon: a plane perpendicular to the line from an observer to the zenith. The great circle formed by the intersection of the celestial sphere with a plane perpendicular to the line from an observer to the zenith is called the astronomical horizon.

horizontal parallax: the difference between the topocentric and geocentric positions of an object, when the object is on the astronomical horizon.

hour angle: angular distance on the celestial sphere measured westward along the celestial equator from the meridian to the hour circle that passes through a celestial object.

hour circle: a great circle on the celestial sphere that passes through the celestial poles and is therefore perpendicular to the celestial equator.

Hubble Space Telescope (HST): A 2.4-m-diameter space telescope designed to study visible, ultraviolet, and infrared radiation; the first of NASA's Great Observatories.

hydrogen: The most abundant element in the universe. It can be observed at a variety of wavelengths, including 21-cm radio, infrared, visible, and ultraviolet wavelengths, and in a variety of forms, including atoms (HI) and molecular (H_2) and ionised (HII) forms.

I

inclination: the angle between two planes or their poles; usually the angle between an orbital plane and a reference plane; one of the standard orbital elements that specifies the orientation of an orbit.

infra-red astronomy: The study of astronomical objects using intermediate-wavelength radiation to which the atmosphere is mostly opaque and the human eye insensitive. Humans sense infra-red energy as heat. The infra-red part of the electromagnetic spectrum generally corresponds to radiation with wavelengths from 1 mm to 1,000 mm. Objects with temperatures around room temperature emit most of their radiation in the infrared.

interferometer, interferometry: A spatial interferometer combines beams of light from different telescopes to synthesise the aperture of a single large telescope; see array. Spatial interferometry is the main technique used by astronomers to map sources at high resolution and to measure their positions with high precision. A different form of interferometer can be used on a single telescope to break up the light into its constituent colours; see spectroscopy.

International Atomic Time (TAI): the continuous scale resulting from analyses by the Bureau International des Poids et Mesures of atomic time standards in many countries. The fundamental unit of TAI is the SI second, and the epoch is 1958 January 1.

invariable plane: the plane through the centre of mass of the Solar System perpendicular to the angular momentum vector of the Solar System.

irradiation: an optical effect of contrast that makes bright objects viewed against a dark background appear to be larger than they really are.

J

Julian calendar: the calendar introduced by Julius Caesar in 46 B.C. to replace the Roman calendar. In the Julian calendar a common year is defined to comprise 365 days, and every fourth year is a leap year comprising 366 days. The Julian calendar was superseded by the Gregorian calendar.

Julian date (JD): the interval of time in days and fraction of a day since 4713 B.C. January 1, Greenwich noon, Julian proleptic calendar. In precise work the timescale, e.g., dynamical time or Universal Time, should be specified. This system facilitates easy calculation of the time interval between two events.

Julian date, modified (MJD): the Julian date minus 2400000.5.

Julian day number: the integral part of the Julian date.

L

latitude, celestial: angular distance on the celestial sphere measured north or south of the ecliptic along the great circle passing through the poles of the ecliptic and the celestial object.

latitude, terrestrial: angular distance on the Earth measured north or south of the equator along the meridian of a geographic location.

leap second: a second added between 60 seconds and 0 seconds at the announced times to keep UTC within 0s.90 of UT1 Generally, leap seconds are added at the end of June or December.

librations: variations in the orientation of the Moon's surface with respect to an observer on the Earth. Physical librations are due to variations in the orientation of the Moon's rotational axis in inertial space. The much larger optical librations are due to variations in the rate of the Moon's orbital motion, the obliquity of the Moon's equator to its orbital plane, and the diurnal changes of geometric perspective of an observer on the Earth's surface.

light-time: the interval of time required for light to travel from a celestial body to the Earth. During this interval the motion of the body in space causes an angular displacement of its apparent place from its geometric place.

light pollution: The emission of stray light or glare from lighting fixtures in manners that counter the purpose of the light (which is to light what is below); also known as the waste of money and energy in the form of electric light, usually meant in the form of outdoor night lighting. Such light trespass can cause severe safety problems for motorists, pedestrians, and cyclists at night from lighting that shines onto streets and highways and footpaths from poorly-designed or poorly-mounted lighting. Such glare also imposes on privacy, by shining brightly into private residences at night and into backyards where adults and children are trying to observe the night sky. It also restricts our view of the night sky – a part of our world's natural and cultural heritage. While most people have accepted bad lighting and glare without question and assumed that nothing could be done about it, dedicated groups of volunteers around the world are now showing that effective laws and guidelines can be instated at the local and regional levels of government (and in planning and engineering offices). This can mean that proper outdoor night lighting can be a norm so that everybody benefits - car drivers, sleeping residents, government budgets, and skygazers alike. Laws limiting light pollution are already in existence in the Czech Republic and certain regions of the USA.

light-year: A unit of astronomical distance equal to the distance light travels in a year: about 10,000,000,000,000 km. The nearest star is 4 light-years away. The center of our galaxy is about 25,000 light-years away. The closest galaxy is about 180,000 light-years away.

limb: the apparent edge of the Sun, Moon, or a planet or any other celestial body with a detectable disk.

local sidereal time: the local hour angle of a catalogue equinox.

longitude, celestial: angular distance on the celestial sphere measured eastward along the ecliptic from the dynamical equinox to the great circle passing through the poles of the ecliptic and the celestial object.

longitude, terrestrial: angular distance measured along the Earth's equator from the Greenwich meridian to the meridian of a geographic location.

luminosity class: distinctions among stars of the same spectral class. (See spectral types or classes).

lunar phases: cyclically recurring apparent forms of the Moon. New moon, first quarter, full moon and last quarter are defined as the times at which the excess of the apparent celestial longitude of the Moon over that of the Sun is 0°, 90°, 180° and 270° respectively.

lunation: the period of time between two consecutive new moons.

M

Magellanic Clouds, Large and Small: Two galaxies close to our own Milky Way, located about 180,000 light-years away and visible only from the Southern Hemisphere. A bright supernova, SN1987A, was observed in the Large Magellanic Cloud in 1987.

magnetohydrodynamics: The study of the motion of gases in the presence of magnetic fields.

magnitude, stellar: a measure on a logarithmic scale of the brightness of a celestial object considered as a point source. Fainter stars have numerically larger magnitudes. The brightest stars, excluding the Sun, are about magnitude 0; the faintest star visible to the unaided eye is about magnitude 6. A star of magnitude 15 is one-millionth as bright as the half dozen brightest stars of magnitude 0. Stars as faint as magnitude 28 can be seen with powerful terrestrial or spacebourne telescopes.

magnitude of a lunar eclipse: the fraction of the lunar diameter obscured by the shadow of the Earth at the greatest phase of a lunar eclipse, measured along the common diameter.

magnitude of a solar eclipse: the fraction of the solar diameter obscured by the Moon at the greatest phase of a solar eclipse, measured along the common diameter.

massive compact halo object (MACHO): An hypothetical object of roughly stellar mass in the halo of our galaxy that is too faint to be detected by its own emission. MACHOs are indirectly detected via gravitational microlensing of more distant stars.

mean anomaly: in undisturbed elliptic motion, the product of the mean motion of an orbiting body and the interval of time since the body passed pericentre. Thus, the mean anomaly is the angle from pericentre of a hypothetical body moving with a constant angular speed that is equal to the mean motion.

mean distance: the semimajor axis of an elliptic orbit.

mean equator and equinox: the celestial reference system determined by ignoring small variations of short period in the motions of the celestial equator. Thus, the mean equator and equinox are affected only by precession. Positions in star catalogues are normally referred to the mean catalogue equator and equinox of a standard epoch.

mean motion: in undisturbed elliptic motion, the constant angular speed required for a body to complete one revolution in an orbit of a specified semimajor axis.

mean place: the geocentric position, referred to the mean equator and equinox of a standard epoch, of an object on the celestial sphere centred at the Sun. A mean place is determined by removing from the directly observed position the effects of refraction, parallax geocentric and stellar parallax, and stellar aberration, and by referring the co-ordinates to the mean equator and equinox of a standard epoch.

mean solar time: a measure of time based conceptually on the diurnal motion of the fictitious mean sun, under the assumption that the Earth's rate of rotation is constant.

meridian: a great circle passing through the celestial poles and through the zenith of any location on Earth. For planetary observations a meridian is half the great circle passing through the planet's poles and through any location on the planet.

microlensing: Gravitational lensing due to a stellar mass object. This lensing phenomenon is called microlensing because the mass of the lens is so small compared with that of a galaxy. Microlensing of distant stars by intervening faint stars can reveal planets in orbit around the lensing star.

Milky Way: Our Sun is located in the Milky Way Galaxy, a spiral galaxy consisting of some 100,000,000,000 stars spread in a disk more than 80,000 light-years across and hundreds of light-years thick. The central disk of the Milky Way is the wide path of faint light that stretches across the night sky.

month: the period of one complete synodic or sidereal revolution of the Moon around the Earth; also, a calendrical unit that approximates the period of revolution.

moonrise, moonset: the times at which the apparent upper limb of the Moon is on the astronomical horizon; i.e., when the true zenith distance, referred to the centre of the Earth, of the central point of the disk is $90° 34' + s - \pi$, where s is the Moon's semi-diameter, π is the horizontal parallax, and 34' is the adopted value of horizontal refraction.

N

nadir: the point on the celestial sphere diametrically opposite to the zenith.

neutrino: One of a family of subatomic particles with little or no mass. These particles are generated in nuclear reactions on Earth, in the centers of stars, and during supernova explosions and can give unique information about these energetic processes. Because neutrinos interact only weakly with matter, they are difficult to detect.

node: either of the points on the celestial sphere at which the plane of an orbit intersects a reference plane. The position of a node is one of the standard orbital elements used to specify the orientation of an orbit.

nucleosynthesis: The process by which heavy elements such as helium, carbon, nitrogen, and iron are formed out of the fusion of lighter elements, such as hydrogen, during the normal evolution of stars, during supernova explosions, and in the Big Bang.

nutation: the short-period oscillations in the motion of the pole of rotation of a freely rotating body that is undergoing torque from external gravitational forces. Nutation of the Earth's pole is discussed in terms of components in obliquity and longitude.

O

obliquity: in general, the angle between the equatorial and orbital planes of a body or, equivalently, between the rotational and orbital poles. For the Earth the obliquity of the ecliptic is the angle between the planes of the equator and the ecliptic.

occultation: the obscuration of one celestial body by another of greater apparent diameter; especially the passage of the Moon in front of a star or planet, or the disappearance of a satellite behind the disk of its primary. If the primary source of illumination of a reflecting body is cut off by the occultation, the phenomenon is also called an eclipse. The occultation of the Sun by the Moon is a solar eclipse.

opposition: a configuration of the Sun, Earth and a planet in which the apparent geocentric longitude of the planet differs by 180° from the apparent geocentric longitude of the Sun.

optical astronomy: The study of astronomical objects using light waves with wavelengths from about 1 to 0.3 μm. The human eye is sensitive to most of these wavelengths. See electromagnetic spectrum.

orbit: the path in space followed by a celestial body.

P

parallax: the difference in apparent direction of an object as seen from two different locations; conversely, the angle at the object that is subtended by the line joining two designated points. Geocentric (diurnal) parallax is the difference in direction between a topocentric observation and a hypothetical geocentric observation. Heliocentric or annual parallax is the difference between hypothetical geocentric and heliocentric observations; it is the angle subtended at the observed object by the semimajor axis of the Earth's orbit.

parsec: the distance at which one astronomical unit subtends an angle of one second of arc; equivalently, the distance to an object having an annual parallax of one second of arc. Its value is 3.086 x 10^{13} km, or 3.27 light years.

penumbra: the portion of a shadow in which light from an extended source is partially but not completely cut off by an intervening body; the area of partial shadow surrounding the umbra.

pericentre: the point in an orbit that is nearest to the centre of force.

perigee: the point at which a body in orbit around the Earth most closely approaches the Earth. Perigee is sometimes used with reference to the apparent orbit of the Sun around the Earth.

perihelion: the point at which a body in orbit around the Sun most closely approaches the Sun.

period: the interval of time required to complete one revolution in an orbit or one cycle of a periodic phenomenon, such as a cycle of phases.

phase: the ratio of the illuminated area of the apparent disk of a celestial body to the area of the entire apparent disk taken as a circle. For the Moon, phase designations (see lunar phases) are defined by specific configurations of the Sun, Earth and Moon. For eclipses, phase designations (total, partial, penumbral, etc.) provide general descriptions of the phenomena. More generally, for use with oddly shaped bodies, phase might be defined as 0.5(1 + cos (phase angle)).

phase angle: the angle measured at the centre of an illuminated body between the light source and the observer.

photometry: a measurement of the intensity of light usually specified for a specific frequency range.

planetocentric co-ordinates: co-ordinates for general use, where the z-axis is the mean axis of rotation, the x-axis is the intersection of the planetary equator (normal to the z-axis through the centre of mass) and an arbitrary prime meridian, and the y-axis completes a right-hand co-ordinate system. Longitude of a point is measured positive to the prime meridian as defined by rotational elements. Latitude of a point is the angle between the planetary equator and a line to the centre of mass. The radius is measured from the centre of mass to the surface point.

planetographic co-ordinates: co-ordinates for cartographic purposes dependent on an equipotential surface as a reference surface. Longitude of a point is measured in the direction opposite to the rotation (positive to the west for direct rotation) from the cartographic position of the prime meridian defined by a clearly observable surface feature. Latitude of a point is the angle between the planetary equator (normal to the z-axis and through the centre of mass) and normal to the reference surface at the point. The height of a point is specified as the distance above a point with the same longitude and latitude on the reference surface.

polar motion: the irregularly varying motion of the Earth's pole of rotation with respect to the Earth's crust.

precession: the uniformly progressing motion of the pole of rotation of a freely rotating body undergoing torque from external gravitational forces. In the case of the Earth, the component of precession caused by the Sun and Moon acting on the Earth's equatorial bulge is called lunisolar precession; the component caused by the action of the planets is called planetary precession. The sum of lunisolar and planetary precession is called general precession.

proper motion: the projection onto the celestial sphere of the space motion of a star relative to the solar system; thus, the transverse component of the space motion of a star with respect to the solar system. Proper motion is usually tabulated in star catalogues as changes in right ascension and declination per year or century.

protogalaxy: Galaxies are thought to have formed fairly early in the history of the universe, by the collapse of giant clouds of gas. During this process, a first generation of stars formed.

protoplanetary or protostellar disk: A disk of gas and dust surrounding a young star or protostar out of which planets may form.

protostar: The earliest phase in the evolution of a star, in which most of its energy comes from the infall of material, or accretion, onto the growing star. A protostellar disk probably forms around the star at this time.

Q

quadrature: a configuration in which two celestial bodies have apparent longitudes that differ by 90° as viewed from a third body. Quadratures are usually tabulated with respect to the Sun as viewed from the centre of the Earth.

quasar: An extremely compact, luminous source of energy found in the cores of certain galaxies. A quasar may outshine its parent galaxy by a factor of 1,000 yet be no larger than our own solar system. The accretion of gas onto a supermassive black hole probably powers the quasar. Active galaxies are probably less luminous and less distant versions of quasars.

R

radial velocity: the rate of change of the distance to an object.

radio astronomy: The study of astronomical objects using radio waves with wavelengths generally longer than 0.5 to 1 mm. See electromagnetic spectrum.

redshift: Radiation from an approaching object is shifted to higher frequencies (to the blue), while radiation from a receding object is shifted to lower frequencies (to the red). A similar effect raises the pitch of an ambulance siren as it approaches. The expansion of the universe makes objects recede so that the light from distant galaxies is redshifted. The redshift is parameterised by z, where the wavelength shift is given by the factor (1 + z) times the wavelength.

refraction, astronomical: the change in direction of travel (bending) of a light ray as it passes obliquely through the atmosphere. As a result of refraction the observed altitude of a celestial object is greater than its geometric altitude. The amount of refraction depends on the altitude of the object and on atmospheric conditions.

resolution: Spatial resolution describes the ability of an instrument to separate features at small details; see diffraction limit and interferometer.

retrograde motion: for orbital motion in the solar system, motion that is clockwise in the orbit as seen from the north pole of the ecliptic; for an object observed on the celestial sphere, motion that is from east to west, resulting from the relative motion of the object and the Earth.

right ascension: angular distance on the celestial sphere measured eastward along the celestial equator from the equinox to the hour circle passing through the celestial object. Right ascension is usually given in combination with declination. It can be considered the celestial analogue of longitude on Earth.

S

second, Systeme International (SI): the duration of 9,192,631,770 cycles of radiation corresponding to the transition between two hyperfine levels of the ground state of caesium 133.

selenocentric: with reference to, or pertaining to, the centre of the Moon.

semidiameter: the angle at the observer subtended by the equatorial radius of the Sun, Moon or a planet.

semi-major axis: half the length of the major axis of an ellipse; a standard element used to describe an elliptical orbit.

sidereal day: the time interval between two consecutive transits of the catalogue equinox (Right Ascension 0h for a specific catalogue). A slightly inaccurate definition is the time interval between two consecutive transits of a given star.

sidereal hour angle: angular distance on the celestial sphere measured westward along the celestial equator from the catalogue equinox to the hour circle passing through the celestial object. It is equal to 360° minus right ascension in degrees.

sidereal time: the measure of time defined by the apparent diurnal motion of the catalogue equinox; hence, a measure of the rotation of the Earth with respect to the stars rather than the Sun.

solstice: either of the two points on the ecliptic at which the apparent longitude of the Sun is 90° or 270°; also, the time at which the Sun is at either point.

spectral resolution: describes the ability of an instrument to discern small shifts in wavelength; see spectroscopy.

spectroscopy: A technique whereby the light from astronomical objects is broken up into its constituent colours. Radiation from the different chemical elements that make up an object can be distinguished, giving information about the abundances of these elements and their physical state.

spectral types or classes: catagorisation of stars according to their spectra, primarily due to differing temperatures of the stellar atmosphere. From hottest to coolest, the spectral types are 0, B, A, F, G, K and M.

standard epoch: a date and time that specifies the reference system to which celestial co-ordinates are referred. Prior to 1984 co-ordinates of star catalogues were commonly referred to the mean equator and equinox of the beginning of a Besselian year. Beginning with 1984 the Julian year has been used, as denoted by the prefix J, e.g., J2000.0.

starburst galaxy: Certain galaxies, particularly those perturbed by a close encounter or collision with another galaxy, often form stars at a rate hundreds of times greater than that evident in our galaxy. Such galaxies are bright sources of infrared radiation.

stationary point (of a planet): the position at which the rate of change of the apparent right ascension of a planet is momentarily zero.

submillimetre radiation: Electromagnetic radiation with wavelengths between about 0.1 and 1 mm intermediate between radio and infrared radiation.

sunrise, sunset: the times at which the apparent upper limb of the Sun is on the astronomical horizon; i.e., when the true zenith distance, referred to the centre of the Earth, of the central point of the disk is 90° 50′, based on adopted values of 34′ for horizontal refraction and 16′ for the Sun's semidiameter.

Sunyaev-Zeldovich effect: An astrophysical effect whereby the distribution of wavelengths of radiation seen through the gas in a distant cluster of galaxies is subtly modified. Measurement of this effect can be used to determine the distance to the cluster.

supermassive black hole: A black hole that is much more massive than the Sun. Supermassive black holes with masses exceeding a million solar masses are found in the nuclei of most galaxies.

supernova: A star that, due to accretion of matter from a companion star or exhaustion of its own fuel supply, can no longer support itself against its own weight and thus collapses, throwing off its outer layers in a burst of energy that outshines an entire galaxy. In 1987 a star in the Large Magellanic Cloud was observed as a dramatic supernova called Supernova 1987A.

surface brightness (of a planet): the visual magnitude of an average square arc-second area of the illuminated portion of the apparent disk.

synodic period: for planets, the mean interval of time between successive conjunctions of a pair of planets, as observed from the Sun; for satellites, the mean interval between successive conjunctions of a satellite with the Sun, as observed from the satellite's primary.

T

Terrestrial Time (TT): the independent argument for apparent geocentric ephemerides, known in this publication 1984 - 2000 as Terrestrial Dynamical Time (TDT). At 1977 January 1d00h00m00s TAI, the value of TT was exactly 1977 January 1d0003725. The unit of TT is 86 400 SI seconds at mean sea level. For practical purposes TT = TAI + 32s184.

terminator: the boundary between the illuminated and dark areas of the apparent disk of the Moon, a planet or a planetary satellite

topocentric: with reference to, or pertaining to, a point on the surface of the Earth.

transit: the passage of the apparent centre of the disk of a celestial object across a meridian; also, the passage of one celestial body in front of another of greater apparent diameter (e.g., the passage of Mercury or Venus across the Sun or Jupiter's satellites across its disk); however, the passage of the Moon in front of the larger apparent Sun is called an annular eclipse. The passage of a body's shadow across another body is called a shadow transit; however, the passage of the Moon's shadow across the Earth is called a solar eclipse.

true anomaly: the angle, measured at the focus nearest the pericentre of an elliptical orbit, between the pericentre and the radius vector from the focus to the orbiting body; one of the standard orbital elements.

true equator and equinox: the celestial co-ordinate system determined by the instantaneous positions of the celestial equator and ecliptic. The motion of this system is due to the progressive effect of precession and the short-term, periodic variations of nutation.

twilight: the interval of time preceding sunrise and following sunset (see sunrise, sunset) during which the sky is partially illuminated. Civil twilight comprises the interval when the zenith distance, referred to the centre of the Earth, of the central point of the Sun's disk is between 90° 50′ and 96°, nautical twilight comprises the interval from 96° to 102°, and astronomical twilight comprises the interval from 102° to 108°.

U

ultraviolet astronomy: The study of astronomical objects using short-wavelength radiation, from 0.3 mm to 0.01 mm (10 nm), to which the atmosphere is opaque and the human eye insensitive. See electromagnetic spectrum.

umbra: the portion of a shadow cone in which none of the light from an extended light source (ignoring refraction) can be observed.

Universal Time (UT): a measure of time that conforms, within a close approximation, to the mean diurnal motion of the Sun and serves as the basis of all civil timekeeping. UT is formally defined by a mathematical formula as a function of sidereal time. Thus, UT is determined from observations of the diurnal motions of the stars. The time scale is determined directly from such observations is designated UT0; it is slightly dependent on the place of observation. When UT0 is corrected for the shift in longitude of the observing station caused by polar motion, the time scale UT1 is obtained. Whenever the designation UT is used in this volume, UT1 is implied.

V

vernal equinox: the ascending node of the ecliptic on the celestial sphere; also, the time at which the apparent longitude of the Sun is 0°.

vertical: the apparent direction of gravity at the point of observation (normal to the plane of a free level surface).

W

week: an arbitrary period of days, usually seven days; approximately equal to the number of days counted between the four phases of the Moon.

X

x-ray astronomy: The study of astronomical objects using x-rays with wavelengths shorter than about 10 nm, to which the atmosphere is opaque. X-rays are emitted by extremely energetic objects that have temperatures of millions of degrees. See electromagnetic spectrum.

Y

year: a period of time based on the orbit of the Earth around the Sun. The calendar year (see Gregorian calendar) is an approximation to the tropical year. The anomalistic year is the mean interval between successive passages of the Earth through perihelion. The sidereal year is the mean period of revolution with respect to the background stars.

year, tropical: the period of one complete revolution of the mean longitude of the Sun with respect to the dynamical equinox.

Z

zenith: in general, the point directly overhead on the celestial sphere. The astronomical zenith is the extension to infinity of a plumb line. The geocentric zenith is defined by the line from the centre of the Earth through the observer. The geodetic zenith is the normal to the geodetic ellipsoid at the observer's location.

zenith distance: angular distance on the celestial sphere measured along the great circle from the zenith to the celestial object. Zenith distance is 90° minus altitude.

zodiacal light: a nebulous light seen in the cast before twilight and in the west after twilight. It is triangular in shape along the ecliptic with the base on the horizon and its apex at varying altitudes. It is best seen in middle latitudes on spring evenings and autumn mornings.

What was that?

Attention seekers in the night sky

One of the ways Perth Observatory serves the taxpayers of Western Australia is by answering enquiries from the public. A lot of these involve interpreting people's naked-eye observations of something in the sky. Hopefully, reading this section will stimulate an awareness of what is visible in the night sky as well facilitating an increase in observing skills so that anyone can make scientifically meaningful observations. More details concerning some of the objects discussed here, and their visibility, can be found elsewhere in this Almanac.

Most careful and detailed observations of apparently unusual objects are explicable by known phenomena. When given thorough (but time consuming) examination, less than 2% of allegedly unusual observations remain "unidentified". Just because they are unidentified does not mean they are evidence of extraterrestrials, or their technology! The late Professor Carl Sagan once said, "extraordinary claims require extraordinary evidence".

The following objects are the subject of most enquiries.

Venus

Venus is the brightest star-like object in the sky. It can appear as an 'evening star' as well as a 'morning star' – it just depends on its and Earth's positions in their respective orbits around the Sun. Venus orbits closer to the Sun than Earth, so it is only visible up to about three hours after sunset or before sunrise – it can never be visible around midnight from temporate latitudes. Consult the monthly sections for information on the visibility of this planet (and other planets).

Shooting stars or meteors

Shooting stars are the glow of energy released as small particles about the size of a grain of sand "crash" into Earth's upper atmosphere. Very bright meteors are called fireballs or bolides. Sometimes they are so bright they can even be observed in the daytime, and sometimes a sonic boom can be heard as they break the sound barrier when they plough through the atmosphere. At certain times of the year the Earth passes through a cloud of comet debris and the number of meteors substantially increases (see meteor showers in the *Solar System Information* Section). Some meteors are the debris from collisions between asteroids.

Artificial Satellites

Artificial satellites are generally visible for a few hours after sunset and a few hours before sunrise as they reflect sunlight off their highly reflective outer surfaces. Around midnight low-Earth orbiting satellites (the majority) are not visible because they are in Earth's shadow. Most satellites are launched in a roughly west to east orbit as this has the lowest fuel requirements. This is also the trajectory of most of the **space junk** that glows on re-entry into the atmosphere. Space junk re-entries have orbits essentially parallel with the ground so they last for a longer duration and can be viewed along a long path across the Earth. Weather and reconnaissance satellites can orbit north to south (or vice versa) in order to get a longer duration view of the Earth. **Iridium communication satellites** have one highly reflecting surface and when the geometry is favourable we can observe a slow flash of light that builds up to a maximum in about 5 seconds, and then fades over a similar time. About one of these flashes is visible from any location on the Earth every night, and about once per month a flash about ten times brighter than Venus provides a spectacular sight. Information about the visibility of satellites can be found in the *Astronomy on the Internet* sub-section.

Unusual Space Sightings #216.
SPACE HOON
Not all Extra Terrestrials are intelligent.

Clouds

Clouds can partially obscure the Moon, planets and aircraft thus giving the impression of changing lights or a halo effect. Beams of light moving through the sky, or circles of light on the under side of clouds result from **searchlights** operated on the ground (usually to promote some entertainment activity). High-altitude aircraft can also leave a trail of water vapour called a contrail.

Refraction (the bending of light) through **ice crystals** or **water droplets** high in the atmosphere can create halos and coronae (coloured clouds) near the Sun or Moon.

Pranks

Some people make artificial "UFOs". One of the Observatory staff has actually recovered one after tracking it. Such "UFOs" may have the appearance of either a solitary light, or a string of lights moving in unison across the night sky. This prank can be very dangerous because of the fire and aviation hazards involved.

Recording your observations

A **Sighting Report Form** is provided on the following page, and an explanation of its contents is given in order to assist the recording of scientifically useful observations.

The first thing of note about the Sighting Report Form is its rather non-specific nature. That is, with only minor modification it could be adapted for other uses such as bird watching, rock hunting etc. You are encouraged to modify it for your specific use.

An important point to remember is: ***record your own observations as soon as possible after the event***. Try not to be influenced by those who may have accompanied you. Instead, get them to complete their own Sighting Report Forms. We don't all observe things in the same way, so multiple individual reports of a sighting will provide a more accurate description of the event. Also, try to be objective about your observations. This can be difficult because a spectacular or sudden event can evoke a variety of emotions.

The section concerning the Observer Details is rather obvious, but we do need these should we require to contact you.

The Sighting Details section has many parts, but please try to be brief as well accurate with your report.

The **date** and **time** are important details. Don't forget to look at your watch or a clock as soon as possible after the sighting (this is probably inappropriate during the sighting). Local time (appropriate to your time zone) should be recorded to the nearest minute. Try to be fairly precise with your **location**. It is acceptable to record this in relative terms such as "100 metres west of Fremantle Railway Station", "in my backyard", etc. Observatory staff can always determine the location more accurately later if need be. Also, note the **sky conditions** as best you can. Conditions other than clear, dark skies can really limit the quality of the observation or distort an otherwise commonplace event such as the motion of an aeroplane. Next, record your **method of observation**.

Some sightings are over in an instant, but try to determine the **duration**. It's probably inopportune to look at your watch during a sighting, but you could try to count the seconds using some mental (or voiced) counting method like – "One (thousand and), two (thousand and), three (thousand and) ..." Beware, most people are notoriously unreliable at guessing time intervals after a particularly startling event. Some phenomena have **sound** associated with them so report anything that you hear.

The **trajectory**, or path across the sky, or the location of a stationary event, is important data. The altitude above the horizon and the compass bearing where you first detected the object are the first things to note. The horizon has an altitude of 0 degrees (assuming any surrounding hills and valleys are of insignificant size), while straight overhead (the zenith) is at altitude 90 degrees. One way to estimate altitude is by spreading out your hand and holding it out at arm's length. The span between the tips of your thumb and little finger is approximately 20 degrees. Compass bearings start at 0 degrees for due north, and progress to 90 degrees for due east, 180 degrees for due south, 270 degrees for due east, and 360 degrees (reset back to 0 degrees) for the full circle around to due north. A compass will give you an accurate bearing and the difference between true north and magnetic north is generally negligible in this context. If you can't determine the altitude and bearing at the time, then work them out at a later time providing you remember these quantities with respect to the scene around you, eg "above the south-side neighbour's highest tree when I was standing on my front door step". Apply the same principles for the altitude and bearing when the object was last seen. Record if it disappeared below the horizon. Note the requirement for direction to be expressed in angular format. Actual distance measurements are extremely unreliable for objects in the sky because there are few, if any, distance markers on which to base your estimate. **Sketch** the trajectory if you can, and try to indicate altitude and compass bearing..

Try to estimate the **angular size** of the object. For comparison the Moon is 1/2 degree in diameter and a finger width at arm's length from your eye is about 1 to 2 degrees wide. Also note any **colour** (and whether you are colour blind!). Record the structure of the object: was it a star-like point, did it fragment, etc?

Your observation will gain greater credibility if it is **confirmed** by another independent observer (who should complete a separate Sighting Report Form) or by use of another observing method such as photography.

Finally, record anything you think is relevant concerning the sighting or your particular observation.

Please feel free to copy the Sighting Report Form as many times as you need. Take them with you on your holidays, give them to your friends who live on (say) a remote cattle station or to your police officer sister-in-law etc. It is unlikely you will discover a new phenomenon unknown to science, but not impossible! One type of object you may sight quite often is a bright meteor. Your observation may assist in recovering any piece that reaches the ground. This extraterrestrial material is scientifically valuable as it gives clues on such matters as the formation of Solar System.

If you complete a Sighting Report Form please read the first part of this article. You will probably be able to identify what you observed. Then, if appropriate, please mail (or fax) your report to the address on the Sighting Report Form. If you think your sighting is of immediate interest please ring the number on the Sighting Report Form and relay the information you have just recorded. (Observatory staff will attempt to answer the telephone at night but sometimes they are too busy with observing duties).

In summary, the use of the Sighting Report Form should not only assist you as an observer but should also aid Observatory staff in interpreting your sighting. Finally, it's important to just enjoy viewing the night sky – its beauty has entranced humankind for untold millennia.

You can obtain a PDF of the Sighting Report from Perth Observatory's website at **www.perthobservatory.wa.gov.au**

Perth Observatory Sighting Report Form

PERTH OBSERVATORY

OBSERVER DETAILS

Name: ______________________________

Address: ______________________________

Telephone: ____________ Fax: ____________ Email: ____________

SIGHTING DETAILS

Date: ____________ Time: ____________

Location: ______________________________

Sky Conditions (eg. clear, 1/2 moon, 1/3 cloud, raining etc): ______________________________

Method of Observation (eg. naked eye, binoculars etc): ______________________________

Duration: ______________________________

Sound: ______________________________

	Altitude angle	Compass Bearing
Direction when first seen:		
Direction when last seen:		

Trajectory sketch:

Apparent Angular Size (eg. Full Moon is 1/2 degree):

____

Colour:

____

Structure (eg. point-like, streak, fragments):

____

Confirmation (other observer, video, etc):

____

Other Comments:

____

____

____

____

____

____

Send to: **Sighting Report, Perth Observatory, 337 Walnut Rd, Bickley 6076, WA**
Telephone: (08) 9293 8255 Fax: (08) 9293 8138

The Deep Foundations of Astronomy in Everyday Life – Units of Time

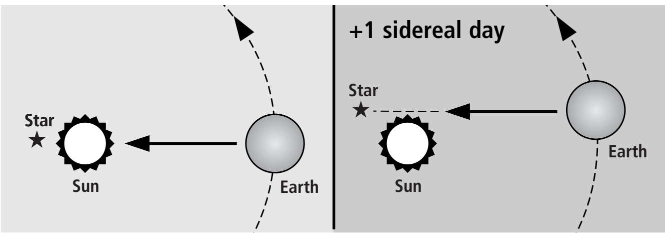
Knowledge accumulated over the ages shapes and influences our culture. Astronomy, being one of the oldest sciences, is particularly pervasive in our everyday lives. However this is often overlooked or not well appreciated by us all. In particular, our many units of time and ultimately our system of long-term time reckoning, calendars, have profound roots in astronomy.

Day

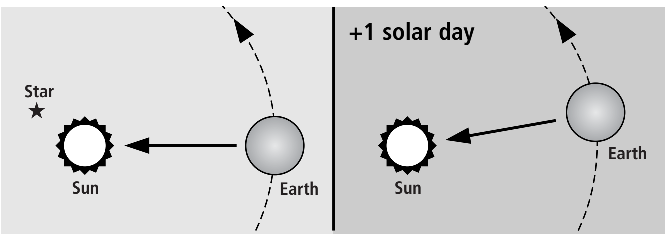
One of the most pervasive units of time is the day. This light and dark cycle is inherently astronomical in basis as it corresponds to one rotation of the Earth about its axis.

However, the day does not readily provide a straightforward standard of time keeping. First, the day is a local phenomenon because the precise position of the Sun varies across the Earth. Second, the exact definition of the day depends on the reference system used to count one complete rotation. Finally, the flow of time is only as constant as the rotation of the Earth.

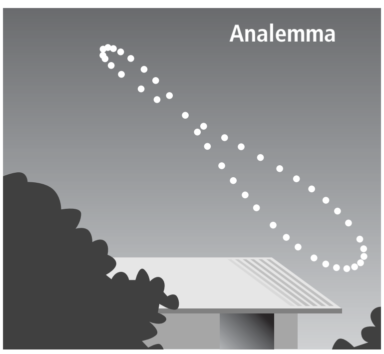
A **sidereal day** is defined as the time between successive passages of a given stellar background across the observer's meridian (the imaginary line in the sky joining the north and south poles). In this definition the distant stars are used as the external reference.



The **apparent solar day** is another definition of the day and is measured by the Sun's diurnal (day) movement across sky. That is, it is defined as the time it takes for successive passages of the Sun across the observer's meridian (or some other locally fixed reference).



Unfortunately, this definition produces a day whose length varies throughout the year, and is thus not a very accurate time standard (especially when compared to the sidereal day). This variability is apparent when one considers the **Analemma** – a plot of the Sun's position at a given local time across the days of one year. It is clear that the Sun's position at a given time moves about through the year, and so the time between meridian passages must vary throughout the year. The azimuth (parallel to the horizon) movement results for the elliptical orbit of the Earth about the Sun, and the altitude (perpendicular to the horizon) movement results from the tilt of the Earth's rotation axis with respect to its orbital axis.



In order to overcome the variability in the apparent solar day the **mean solar day** was defined by astronomers. This definition uses a fictitious body, the **mean sun**, which moves along the Celestial Equator with constant angular speed. This angular speed is equal to the mean angular speed of the real Sun along the ecliptic, that is, approximately 1˚/day. The mean solar day is defined as the average time between successive passages of the Mean Sun over observer's meridian. It is 3 minutes 56 seconds longer than the Sidereal Day because of the Earth's orbital motion about the Sun. Another manifestation of this is that a given star rises 3 minutes 56 seconds earlier each day.

Hour

The division of the day into twenty-four hours is derived from ancient Egypt. At that time the Egyptians thought that the day was the manifestation of the motion across the sky of Ra the sun god in his boat. Early in Egyptian history the day (including night) was divided into 36 decans. However, they noticed that in the summer months in Lower Egypt (the region closest to the Nile delta) there was only twelve decans during the night. So in order to maintain a balance it was decreed that there were only twelve decans in the daylight time. Eventually the Egyptians divided the entire day into twenty-four intervals and these have descended to us as the way we divide the day by hours.

Minutes and Seconds

Division of the hour into sixty minutes and the minute, in turn, divided into sixty seconds results from the work of the famous astronomer Hipparchus of Rhodes (194 - 120 BCE). His work on the positions of the stars and, in particular, the motion of the planets was based on observations acquired earlier by the Babylonians. The Babylonians had a very well developed mathematics based on the sexagesimal (base 60) system, that is, they had a distinct symbol for each number from one to 59. Their system also incorporated the concept of placeholders which made mathematical operations such as addition and subtraction more straightforward. The placeholder concept is implicit in our decimal (base 10) system, for example, the ordering of the 3, 4 and 5 in the number 345 means 3 hundreds + 4 tens + 5 units. In the Babylonian system the number 345 would represent 3 60?60's + 4 60's + 5 units.

Today, the second is defined in a manner independent of the motion of the Solar System (and irregularities in the rotation and orbit of the Earth). It is based on the frequency of oscillation associated with ^{133}Cs isotope. In fact, the second is now the fundamental unit of time in the international standards system (System Internationale, SI). It is formally defined in terms of the quantum mechanical manifestation of an atom, namely, as 9,192,631,770 periods of the hyperfine transition of ^{133}Cs ground state.

Week

There is no direct astronomical basis for the definition of the week. However, it is still related to astronomy. The Babylonians assigned planet names to the days of week. This was important to them because each of the objects they defined as planets was graced with the name of a god. At that time they knew of seven celestial objects that 'wandered' (the word planet is derived from the Greek for wander) through the skies.

'Planet'	Ancient planet gods			Modern		
	Babylonian	Roman	Anglo-Saxon	English	French	Spanish
Sun	Shamash	Sol	Sun	Sunday	Dimanche	Domingo
Moon	Sin	Luna	Moon	Monday	Lundi	Lunes
Mars	Nergal	Mars	Tiw	Tuesday	Mardi	Martes
Mercury	Nabu	Mercurius	Woden	Wednesday	Mercredi	Miercoles
Jupiter	Marduk	Jupiter	Thor	Thursday	Jeudi	Jueves
Venus	Ishtar	Venus	Freya	Friday	Vendredi	Viernes
Saturn	Ninurta	Saturnus	Saturn	Saturday	Samedi	Sabato

These seven 'planets' were (from closest to most distant as determined by the Babylonians) the Moon, Mercury, Venus, Sun, Mars, Jupiter and Saturn. The table shows that the days of the week essentially retain the names of these gods even though they have been affected by changes in culture and language. The romance languages of French and Spanish retain a great similarity to their root language of Latin (the language of the Romans), whilst the English names are expressions of the equivalent Anglo-Saxons gods.

The days are not ordered with the Babylonian system of closest to most distant planet. This arose in response to the further association of the hours in each day with a planet. This association was organised in a cyclic order with the further constraint that a day had to have the same planet name for both the day and the first hour of the day.

Month

The very conspicuous change in the appearance of the Moon in its orbit about Earth is the astronomical basis of the month. In coastal regions this interval is also associated with the periodic behaviour of the tides. The length of the lunar month, the time between repetitions of a given phase, is 29.5306 days. Thus 12 repetitions of a given phase, i.e. months, corresponds to 354 days, nearly as long as one year.

Our current system of twelve months in a year is descended from the Romans. Early on the Roman year only contained 10 months. This led to a year that was too short and this was corrected around 700 BCE when further months were added. In order to make the year keep track with the seasons the number of days in February was changed and the inter-calendar month was either included or omitted from a given year in order to keep the months in track with the seasons.

In 46 BCE Julius Caesar made changes to the Roman calendar, as the old system was open to abuse by the religious and political authorities that controlled it. His introduction of the leap year (an additional day in February for any year divisible by four) also assisted the calendar at better keeping the seasons in synchronism with the year. He was rewarded for this innovation by the naming of the month of July for him.

Augustus, during his reign, reminded the authorities that Julius had decreed that the interval between leap years was four years, and not three, as some thought. For this accomplishment he was rewarded around 8 BCE by the naming of the month of August after him. Also, in order that he not be slighted the number of days in August was increased to 31 as for July, and February lost one day in this process.

Year

The astronomical basis of the year is Earth's orbit about the Sun. The following sections discuss the many definitions of the year that have arisen from scientific and civil needs.

A **calendar year** contains 365 or 366 mean solar days. This is the simplest form of the year we encounter in everyday life. Another type of calendar year we often encounter is the **leap year** that contains 366 mean solar days with the addition of an extra day in February. The **mean civil year** gives an estimate of the long-term average length of the calendar year. However, the mean civil year's length depends upon which calendar is in use. In the Julian calendar there are on average 365.25 mean solar days. Today, most countries use the Gregorian calendar and the mean civil year's length is 365.2425 mean solar days. The difference between these two figures arises from the different ways in which leap years are defined and this is discussed in more detail in the calendars section below.

A more astronomically related time interval is the **sidereal year** that is defined as the time it takes for Sun to complete one hypothetical "orbit about the Earth" with respect to the fixed background stars. This time interval is 365.2565 mean solar days.

Arguably the most important definition of the year is the **tropical year**. This is the time interval between successive passages of Sun across the celestial equator from the southern sky to the northern sky (this point in the sky is called the First Point of Aries). This passage occurs at the March Equinox and assists track the seasons that are the climatic response to the position of the Sun in the sky and the attendant amount of daily sunshine. The time interval of the tropical year is 365.2422 mean solar days. The Gregorian calendar with its mean civil year of 365.2425 mean solar days is specifically constructed for the purpose of assisting ongoing civil activities by keeping the months in synchronism with the seasons.

The difference between the duration of the sidereal and tropical years arises from the effect called precession. The rotation axis of the Earth slowly moves and this makes the position of the first point of Aries also move, thus shortening the tropical year compared to the sidereal year.

Calendars

A calendar is a system of organising units of time for the purpose of reckoning time over extended periods. Some calendars replicate astronomical cycles according to fixed rules, while others are based on abstract, perpetually repeating cycles of no astronomical significance. Our calendar, the Gregorian calendar, has an astronomical basis in the day, month and year. Complexity automatically arises for calendars based on astronomical cycles because the basic units of time are; not perfectly commensurable with each other, and, not constant.

Pope Gregory XIII instituted the Gregorian calendar in CE1582. It involved having calendar years of 365 days in length and 366 days in a leap year, and a redefinition of the leap year being any year divisible by 4, except those divisible by 100 – unless they were divisible by 400. (For example, 1900 and 1901 are not leap years, 2000 and 2004 are leap years). This leap year rule was created in order to make a better long term average approximation for the number of days per year and thus keep the seasons fixed appropriately to the months. However, the fine leap year adjustments in the Gregorian calendar are not perfect and after about 3,300 years it will be one day out of synchronism with the tropical year.

WESTERN AUSTRALIAN
PLACES OF ASTRONOMICAL INTEREST

OBSERVATORIES

Perth Observatory

founded 1896

Perth Observatory is the oldest continuously operating astronomical observatory in Australia. For over 100 years it has served the state of Western Australia by its provision of information and educational services, as well as conducting international-standard astronomical research. It is situated in the locality of Bickley in the Darling Range. This site is adequate for astronomical research, yet it is only 25 km east of the city and conveniently close for the public to attend its educational activities.

As part of the Observatory's education and public outreach programme, several telescopes with apertures ranging from 20 to 40cm (10" to 16") are used by the Observatory's professional astronomers to show night visitors the splendors of the southern skies. These nights are very popular so booking is essential. Alternatively, we can bring portable telescopes to your site for an Astronomy Field Night in order to show you the stars. Observatory staff regularly conduct many astronomy talks and lectures.
A museum has been established to inform visitors about the history of the Observatory and to educate them in the science of astronomy.

Generous assistance from the Perth Observatory Volunteer Group and LotteryWest has facilitated acquisition of equipment to assist the disabled to participate in starviewing activities.

The Observatory also has a well-equipped shop that sells a variety of astronomy-based educational material and gifts.

Star viewing nights
Times vary during the year. No sessions May-September inclusive – Bookings essential. Session lasts approximately 1.5 hours.

Daytime Guided Tours
10am, 12.30pm, or by appointment – Bookings essential.

Astronomy Field Nights
Observatory staff take portable telescopes to your site in order to show you the stars. Booking is essential.

Costs
All services attract charges, contact the Observatory for details.

Phone: (08) 9293 8255
Fax: (08) 9293 8138
Information Line: (08) 9293 8109
Website: www.perthobservatory.wa.gov.au
Email: Perth.Observatory@dec.wa.gov.au

Pingelly Heights Observatory

(Astro Ventures)

The Pingelly Heights Observatory is just one and a half hours drive from the Perth Metropolitan area. Follow the Brookton Highway from Kelmscott to Brookton then turn south for Pingelly.
The property is named 'SUNARISE' Lot 25 Pingelly Heights (off Aldersyde Road), Pingelly.

Astro Ventures caters especially for: primary and secondary schools, youth groups, community organisations, private parties and others on request. They are open from October 1 to April 30, the following year; on Friday and Saturday nights only.

For prices, further information and ticket reservations:

Phone: (08) 9887 0088 or 0407 380 922
Fax: (08) 9887 0207
Address: Astro Ventures, PO Box 512, Pingelly, WA 6308
Website: http://www.westnet.com.au/astroventures
Email: astroventures@westnet.com.au

Southern Cross Cosmos Centre

The Southern Cross Cosmos Centre is a commercial observatory situated about an hours drive north of Perth, and is co-sited with the Australian International Gravitational Observatory, a research establishment run by the University of Western Australia. The SCCC has seven telescopes including one of West Australia's biggest, the 25 inch Obsession. The other instruments include two 8 inch Schmidt Cassegrains, two 12 inch LX200 computer controlled SC's, a 14 inch Celestron SC and a 16 inch Meade Newtonian. Binoculars will be available for patrons to use plus live video of the Moon and planets when appropriate.

The observatory is open each Friday and Saturday from October to April, (inclusive) with the evenings running from 7.30pm to 10.00pm. Other evenings are available on request but minimum charges apply. Bookings are essential and can be made by contacting ***Astro Nights***.

Phone: (08) 9307 1353
Website: www.sccc.asn.au
Email: sccc@arach.net.au

AMATEUR ASTRONOMICAL SOCIETIES & ASSOCIATED GROUPS

Astronomical Society of WA Inc. (ASWA)

Established in 1950, the Astronomical Society of WA strives to promote and popularise astronomy – as both a modern-day science and an exciting and rewarding hobby, providing many activities for members and the public -particularly encouraging beginners. Classes and the Radio Astronomy group meeting at 7pm precede the monthly General Meeting with guest speaker at 8pm. Special interest groups – Deep Sky observing at 2 sites, Lunar observing, Workshops, a night at a central observatory with viewing and speakers and Club nights with speakers also meet monthly. Astrocamps are held at least twice yearly at locations with dark skies and accommodation. The Society offers members the use of its library and equipment. The ASWA has free members' email newsgroup and a bi-monthly journal, *The Sidereal Times*.

The society meets at 8pm on the second Monday of every month (except January) at the South Perth Bridge Club, cnr Brittain St. and Barker Ave, Como. ASWA promotes public awareness by holding regular observing nights and offering viewing nights/speakers to schools and community groups.

Fees: *Ordinary Member $20 nomination, $50 subscription, discounts for Associate, Junior, Student and Country Membership*

Phone: (08) 9299 6347 (Val Semmler)
Address: PO Box 421, Subiaco WA 6008
Website: http://aswa.info
Email: aswa@aswa.info

Astronomical Group of Western Australia (AGWA)

AGWA was formed to provide activity and networking for amateur astronomers and people interested in the wonders of the night sky, with or without their own telescopes. Activities throughout the year include: Field trips, seminars by noted astronomers, workshops and special events and an Annual Astro-Fest. The group meets at 7pm on the first Tuesday of every month at 159A Scarborough Beach Rd, Mt Hawthorn. Everybody is welcome to attend the meetings. AGWA is proudly sponsored by Binocular, Telescope and Optical World.

Phone: (08) 9201 0895
Address: 159A Scarborough Beach Rd, Mt Hawthorn WA 6016

Astronomical Society of the South West Inc.

Membership is open to anyone interested in basic astronomy. Observing nights at their observatory south of Bunbury on the two Fridays before the new moon. There is an active junior group that meets twice monthly. Astronomy camps in good cottage accommodation are held during the year at dark sky sites. Other observing at nearby dark sky sites occurs on an informal basis.
A six evening's astronomy course for beginners is conducted each year in March/April. Nights for the general public are held during school holidays on three occasions through the year. Community groups are welcome to book for special nights.

Phone: (08) 9721 1586
Address: PO Box 1100, Bunbury, WA 6231
Website: www.assw.org.au
Email: mail@assw.org.au

Perth Observatory Volunteer Group Inc.

Perth Observatory is keen to get the public more involved in its activities. One way to directly participate and assist is to join our Volunteer Group that has been running since 1996. Currently about 30 people assist the Observatory in its activities and contribute the equivalent of one extra full-time staff member. Recently, the Observatory's Volunteer Group has become incorporated with the aim to obtain funding from external sources in order to further their work.

Furthermore, the fine activities and achievements of the Volunteer Group were formally recognised in 2001 with the award of $1,000 by the National Australia Bank CommunityLink Programme. Only 109 of the 2,703 nominations (Australia-wide) won awards, and the Perth Observatory Volunteers Group was the only **highly recommended** winner in the Recreation category. They were also awarded a $3,600 International Year of the Volunteer grant from the Commonwealth Department of Family and Community. Apparently 17,000 organisations applied; 2,835 were successful and only 263 of those successful were based in WA. Most notably, they were also awarded a $15,000 grant from the Lotteries Commission Gordon Reid fund in order obtain equipment that would assist integrate disabled people into The Observatory's Star Viewing Night programme.

Current projects involve:

- assisting permanent staff with the public star viewing sessions,
- archiving and preserving historical documents,
- rearranging the library, inputting the library database onto computer,
- assisting at open days.

Those interested should send a written application to the Perth Observatory Director and Volunteer Coordinator, Dr James Biggs. The applicant should outline:

- why they wish to become part of the program,
- what skills, qualifications or experience they possess,
- what realistic amount of time they can contribute, and
- anything else that they think is relevant.

Please note that the qualification requirement is not really very stringent - what is really important is simply the desire to assist the Perth Observatory. Interviews are conducted with applicants shortlisted from their written applications around September most years. Vast astronomical knowledge is not required as successful applicants are trained for the project (or projects) in which they wish to participate. Furthermore, ongoing training is provided at the monthly Volunteer Group meeting and as required.

W E S T E R N   A U S T R A L I A N

ASTRONOMY ALMANAC

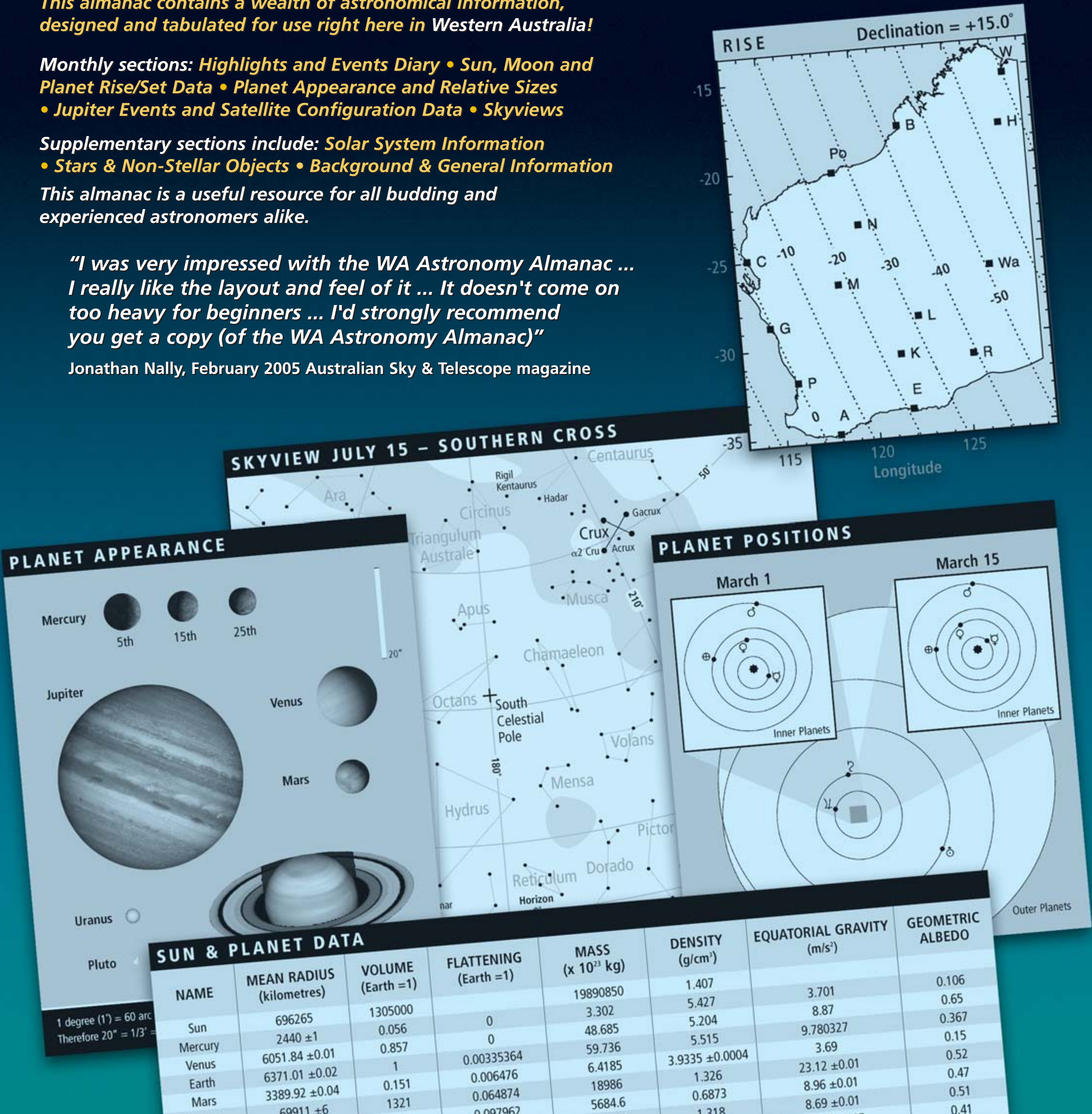
This almanac contains a wealth of astronomical information, designed and tabulated for use right here in Western Australia!

Monthly sections: Highlights and Events Diary • Sun, Moon and Planet Rise/Set Data • Planet Appearance and Relative Sizes • Jupiter Events and Satellite Configuration Data • Skyviews

Supplementary sections include: Solar System Information • Stars & Non-Stellar Objects • Background & General Information

This almanac is a useful resource for all budding and experienced astronomers alike.

> *"I was very impressed with the WA Astronomy Almanac ... I really like the layout and feel of it ... It doesn't come on too heavy for beginners ... I'd strongly recommend you get a copy (of the WA Astronomy Almanac)"*
>
> Jonathan Nally, February 2005 Australian Sky & Telescope magazine



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