DOCUMENT
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DOCUMENT TITLE

CPL NAVIGATION 2 (AUSTRALIA)

CHAPTER 1 – TIME

Version 2.1
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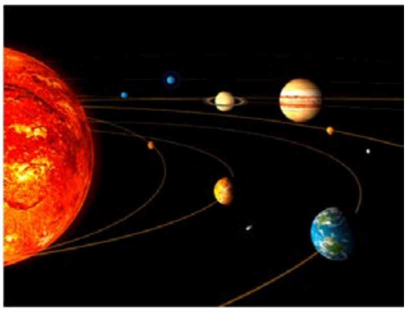
TIME

1.1 The Solar System



Over many centuries humans have come to regulate their affairs in relation to two phenomena. The first is the rotation of the Earth on its axis, and the corresponding appearance and disappearance of the Sun in a more or less regular cycle. This leads to our definition of the day. Secondly, the revolution of the Earth in its orbit around the Sun provides our concept of the year and the seasons.

Since the dynamics of the solar system are fundamental to both these processes, we will commence with a short description of the Earth's daily and annual movements.

1.2 Units of Time Measurement

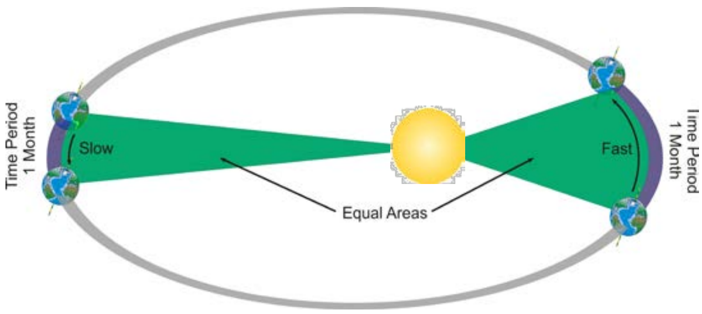
As aviators, we are not concerned with the most profound questions regarding time; what it is, when it started, how and when it might end. Rather, we are interested in the reference it provides in the organisation of our lives and activities, particularly aviation, and in the practical details of its measurement.

The basis of the measurement of time is the repetition of the obvious events, such as night and day, and the cycle of the seasons.

1.2.1 Laws of Planetary Motion

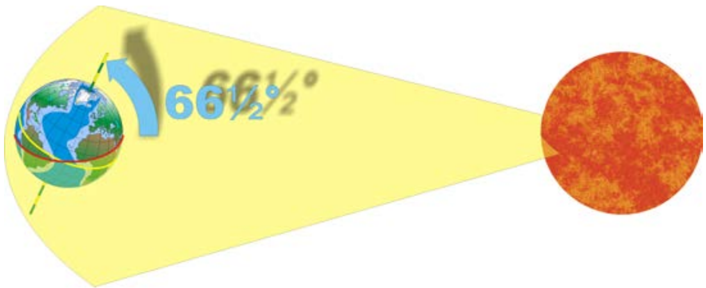
In 1619 Johannes Kepler published three laws governing the motion of planets around the sun, describing the shape and proportion of each planet's orbit. These laws are referred to as Keppler's Laws of Planetary Motion and can be summarised as follows:

- Each planet orbits the sun following an elliptical path around the sun.
- The speed at which a planet orbits the sun is not constant and will vary depending on its distance away from the sun.
- Planets closest to the sun orbit quicker than those further away from the sun.



1.2.2 The Earth's Orbital Plane and Spin Axis

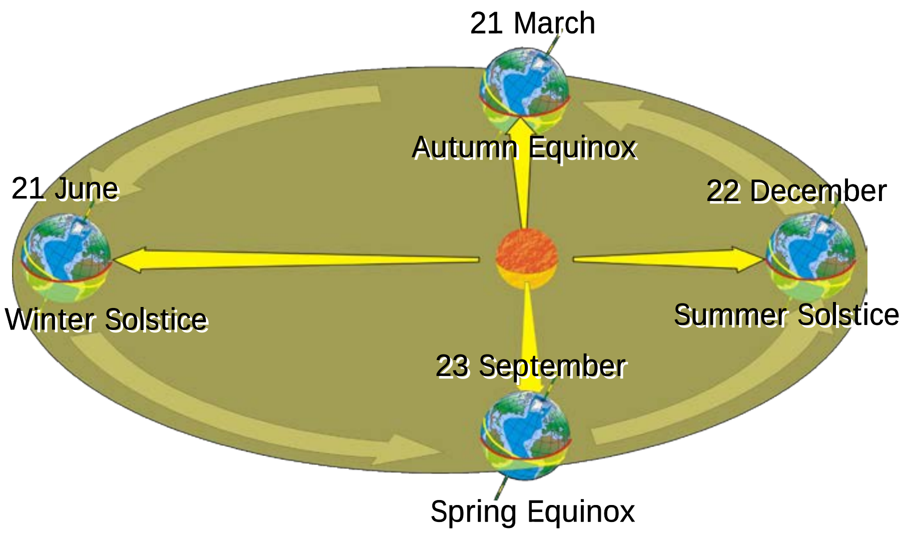
The Earth's spinning axis is not perpendicular to its orbital plane; it is inclined at an angle of 66½° to the orbital plane. As a result of this inclination the path of the sun over the earth is not aligned with the Equator. As the earth moves along its orbital path the latitude over which the sun is located will continually change. These changes are what we experience as seasons.



1.2.3 Seasons

Due to the inclination of the earth's spin axis relative to the orbital plane, the point on Earth which receives the most direct rays from the sun changes throughout the year and we experience this change as seasons.

The diagram below illustrates the seasons for the Southern Hemisphere. The seasons are opposite in the two hemispheres.



1.2.3.1 <u>Winter (Southern Hemisphere)</u>

On about June 21, at noon, the Sun will appear directly overhead the 23°27'N parallel of latitude and this is the point on Earth receiving the most direct rays from the sun on this date.

This parallel of latitude is called the Tropic of Cancer, and marks the most northerly latitude at which the Sun will reach 90° above the horizon at noon. This date is referred to as the Winter Solstice.

1.2.3.2 Summer (Southern Hemisphere)

By similar reasoning, on about December 22, the Sun will be directly overhead 23°27'S latitude at noon. This parallel is called the Tropic of Capricorn, marking the most southerly latitude at which the Sun will reach 90° above the horizon at noon. This date is referred to as the Summer Solstice.

1.2.3.3 Spring and Autumn (Southern Hemisphere)

On March 21 and September 23 the orientation of the radius vector from the Earth to the Sun is at right angles to its orientation at the solstices. It is evident that, in March and September, the Earth's spin axis lies at 90° to the radius vector from the Sun, and that its tilt towards or from the Sun, is zero. The most direct rays from the Sun at noon is on the equator, and the Sun will be 90° above the horizon at noon, if the observer is located on the equator.

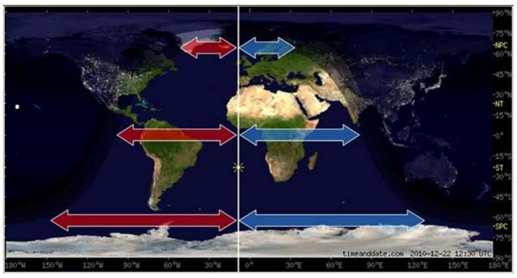
These dates in March and September are called the 'equinoxes', because the length of day and night at all positions on the Earth's surface is equal. March 21 is the 'Autumnal Equinox', and September 23 is the 'Spring Equinox', the seasonal definitions again referring to the Southern Hemisphere.

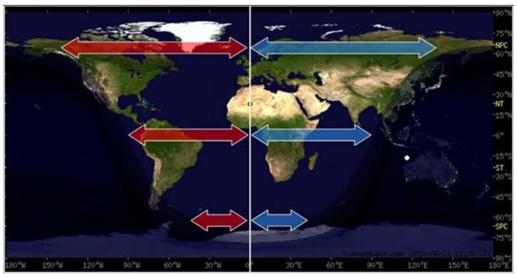
1.2.4 The Day

The day is defined as the time taken for the Earth to complete one 360° rotation with respect to a specified datum.

1.2.4.1 The Apparent Solar Day

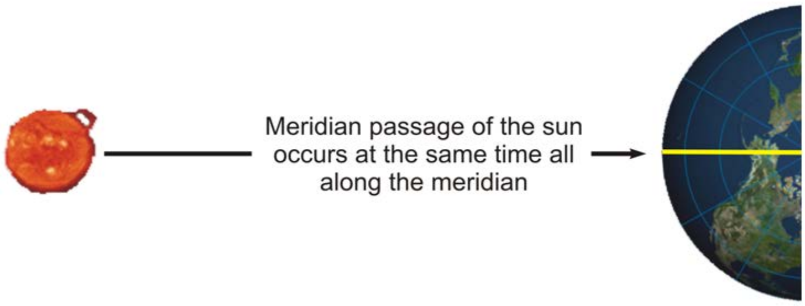
Before the invention of mechanical clocks, a time system based upon the Sun itself was devised. While the times of sunrise and sunset were observed to vary greatly throughout the year due to the large annual change in the Sun's declination, the time at which the Sun crossed the observer's meridian - noon - was seen to provide a stable reference.



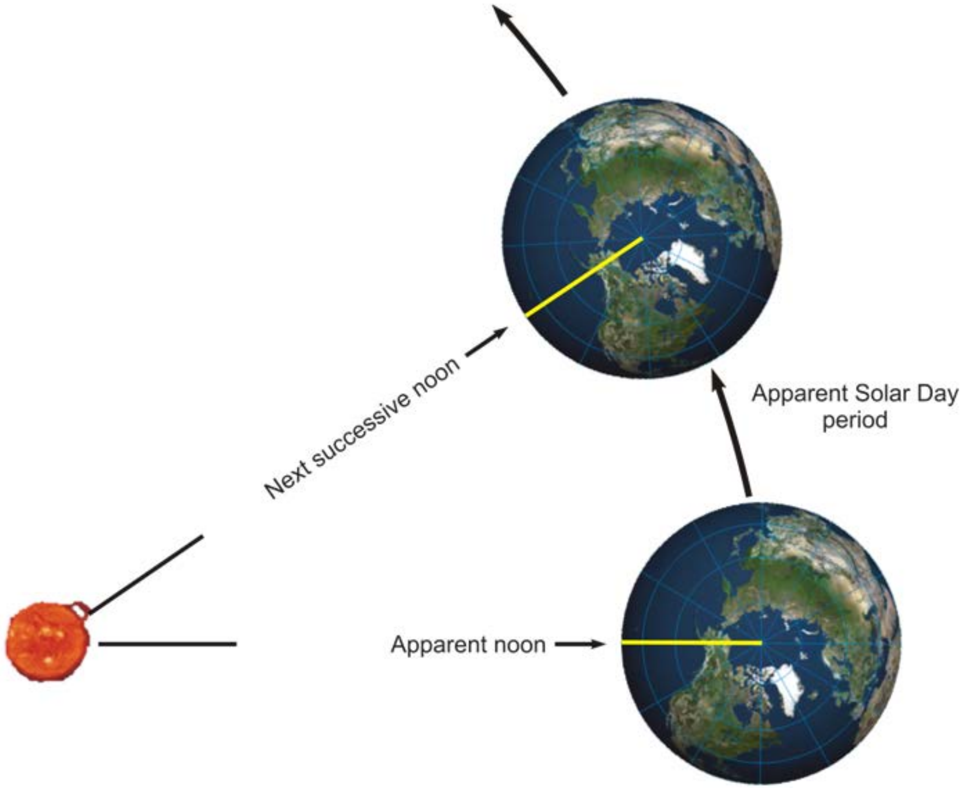


Furthermore, all observers on a particular meridian experience noon at the same instant, i.e. the time of noon is not affected by the Sun's declination or the observer's latitude. This is because the meridian and its associated anti-meridian form a great circle that lies in a flat plane passing through the centre of the Earth. Irrespective of the orientation of the Earth's spin axis, this extended meridional plane sweeps through the centre of the Sun twice in each daily rotation.

In one of these occasions the Sun transits the observer's meridian (the upper transit) and, on the other the observer's anti-meridian (the lower transit). During upper transit, the Sun reaches its highest elevation above every point on the observer's meridian, and its azimuth measured from the observer's position is either 000°(T) or 180°(T).



By convention, the day starts at midnight, so solar time actually commences with the lower transit, and date changes occur at midnight.



However, slightly more than one revolution will be completed between the two successive midnights, because of the movement of the Earth in its orbit around the Sun, i.e. an apparent solar day is slightly longer than the period required for one full revolution of the Earth about its axis.

The additional rotation is just under one degree per day, equivalent to 3 minutes and 56 seconds of time.

1.2.4.2 The Mean Solar Day

The Mean Sun is the basis of all practical systems of timekeeping, and use of the word 'mean' in terms like 'Greenwich Mean Time' and 'Local Mean Time' signifies that the time standard is based upon the mean Sun. The 'Mean Solar Day' is then defined as the time interval between two successive upper transits of the mean Sun.

The mean solar day is arbitrarily divided into 24 hours, each consisting of 60 minutes, each minute consisting of 60 seconds. Hence, the second is defined as 1/86,400 of a mean solar day.

The difference between the apparent solar day and the mean solar day is always less than one minute, but the differences are cumulative over significant periods of time. For example, at the Greenwich meridian on 12 February, mean noon is 14.3 minutes earlier than apparent noon, and on 3 November, mean noon is 16.4 minutes later. These discrepancies are barely noticeable, and any minor disadvantage is greatly outweighed by the benefits of a uniform time standard.

1.3 Presentation of Date and Time

Date: 6 digits (3 pairs) in the sequence: YEAR—MONTH—DAY

Time: 6 digits (3 pairs) in the sequence: HOURS—MINUTES—SECONDS

These elements are combined in the sequence YEAR—MONTH—DAY—HOURS—MINUTES—SECONDS to give the standard format numerical expression of date and time. These expressions are called Date/Time groups.

For most flight planning and navigation purposes, it is sufficient to specify the day of the month followed by hours and minutes. Normally a pilot is dealing with short time intervals (less than 30 hours) so it is clearly evident which year and month is involved. Similarly, seconds are normally too short a time interval to be of concern to a pilot in aircraft operations, so they are omitted from the time expression. Thus in normal operations date and time are expressed as a 6 figure date/time group

Six Figure Date/Time Group Example: 23 July 11:45am is expressed as the six figure date/time group 231145.

NOTAMS, which deal with quite long time periods, often extending over several months, specify the month in the date, and when appropriate the year. NOTAMS can use six figure, eight figure or ten figure date/time groups.

Eight Figure Date/Time Group Example: 16 October 2018 at 08:45pm is expressed as the eight figure group 10162045.

Ten Figure Date/Time Group Example: 25 December 2014 at 12:15pm is expressed as the 10 figure date/time group 1412251215.

To suit the requirements of mankind, time in hours and minutes can be expressed in terms of Local Mean Time (LMT), Coordinated Universal Time (UTC) and Local Standard Time (LST).

1.4 Local Mean Time (LMT)

At any given meridian, the mean solar day commences when the mean Sun transits the observer's anti-meridian, and mean noon occurs at the instant of upper transit (overhead the observer's meridian). The time system based upon the observer's meridian is called Local Mean Time (LMT), and it is obvious that every meridian will keep its own LMT. Furthermore, every point along a given meridian will observe the same LMT because all will experience noon at the same instant, and this will be different from the LMT at every other meridian.

LMT is defined as the angle converted to time, measured west from the observer's anti-meridian to the meridian of the Mean Sun.

This time difference will equal the difference in longitude (arc) expressed in time units. The **further East** a place is, the **further ahead** it is, in **LMT**.

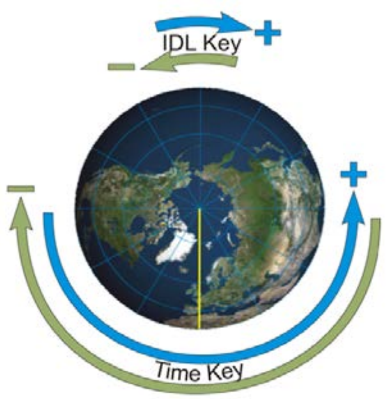
In air navigation Local Mean Time (LMT), because of the obvious inconveniences, is normally only a consideration when extracting data from graphs and tables depicting the rising and setting of celestial bodies. Pilots use these tables and graphs to determine the LMT of astronomical events such as the Beginning and End of Daylight, Sunrise, Sunset, etc.

1.4.1 Arc to Time

From the definition of the mean solar day we observed that one day is equivalent to 360° of Earth rotation, and hence, to 360° change of longitude relative to the mean Sun. We use this relationship to convert 'arc to time' and 'time to arc' as follows:

Time	Arc (Longitude)
1 day	360 degrees
24 hours	360 degrees
1 hour	15 degrees
4 minutes	1 degree
1 minute	15 minutes
4 seconds	1 minute

Hence, if we know the d-long (change in longitude) between any two points, we can immediately determine the difference between their respective LMTs, either by calculation using the above conversions, or by referring to an arc-to-time table.



To determine the sense of the difference, we observe that the mean Sun moves from east to west, so the easterly longitude will have the later LMT (be further ahead in time).

The key alongside shows that if we change our position in an easterly direction (counter clockwise when viewed from above the north pole) we have to add the time difference to calculate LMT, and subtract if we go in the opposite direction.

Arc to time conversion is also presented in tabular form in the Air Almanac, Jeppesen Volume 1, and the AIP although the latter two are restricted to the band of longitudes covering a particular region.

AIP Australia | 25 NOV 04 | GEN 2.7 - 7

CONVERSION OF ARC TO TIME

DEGREES						MINUTES					
	Time			Time			Time			Time	
Long Deg	Hours	Min	Long Deg	Hours	Min	Long Min	Min	Sec	Long Min	Min	Sec
110	7	20	140	9	20	0	0	00	30	2	00
111	7	24	141	9	24	1	0	04	31	2	04
112	7	28	142	9	28	2	0	08	32	2	08
113	7	32	143	9	32	3	0	12	33	2	12
114	7	36	144	9	36	4	0	16	34	2	16
115	7	40	145	9	40	5	0	20	35	2	20

<u>Example</u>: Converting LMT to LMT using Arc to Time:

The LMT at Parafield (34°48'S, 138°38'E) is 1200 (noon). What is the LMT at Perth International (31°56'S, 115°58'E)?

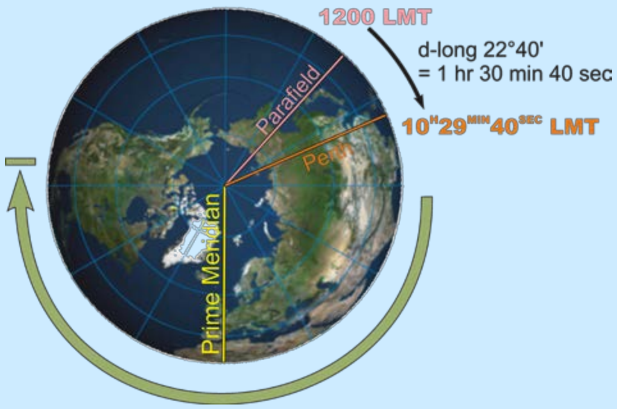
D-long = 138°38' – 115°58'

= 22°40'

22° = 1 hr 28 min

40' = 2 min 40 sec

∴ 22°40' = 1 hr 30 min 40 sec



Perth is further west than Parafield so the LMT at Perth is earlier (behind Parafield in time).

∴ LMT at Perth = 12:00 - 1:30:40

= 10:29:20

From the above we see that LMT is the time reference that most closely synchronises 'the time' with the position of the Sun. This is important for some purposes, e.g. the specification of local sunrise and sunset, but is impractical for everyday use because it would require a different time standard for every meridian.

The table below (next page) is for converting expressions of arc to their equivalent in time; its main use is for the conversion of longitude for application to LMT (added if west, subtracted if east) to give UTC, or vice versa.

The table blow is an extract from the UK Air Almanac and covers a much wider range of longitudes than the Arc to Time table in the Australian AIP or Jeppesen (Tables & Codes section).

During the CASA CPL Navigation Exam (CNAV) the candidate will be expected to make use of the Arc to Time table found in either the AIP Australia or the

Australian Jeppesen.

CONVERSION OF ARC TO TIME

°	h m	°	h m	°	h m	°	h m	°	h m	°	h m	′	m s
0	0 00	60	4 00	120	8 00	180	12 00	240	16 00	300	20 00	0	0 00
1	0 04	61	4 04	121	8 04	181	12 04	241	16 04	301	20 04	1	0 04
2	0 08	62	4 08	122	8 08	182	12 08	242	16 08	302	20 08	2	0 08
3	0 12	63	4 12	123	8 12	183	12 12	243	16 12	303	20 12	3	0 12
4	0 16	64	4 16	124	8 16	184	12 16	244	16 16	304	20 16	4	0 16
5	0 20	65	4 20	125	8 20	185	12 20	245	16 20	305	20 20	5	0 20
6	0 24	66	4 24	126	8 24	186	12 24	246	16 24	306	20 24	6	0 24
7	0 28	67	4 28	127	8 28	187	12 28	247	16 28	307	20 28	7	0 28
8	0 32	68	4 32	128	8 32	188	12 32	248	16 32	308	20 32	8	0 32
9	0 36	69	4 36	129	8 36	189	12 36	249	16 36	309	20 36	9	0 36
10	0 40	70	4 40	130	8 40	190	12 40	250	16 40	310	20 40	10	0 40
11	0 44	71	4 44	131	8 44	191	12 44	251	16 44	311	20 44	11	0 44
12	0 48	72	4 48	132	8 48	192	12 48	252	16 48	312	20 48	12	0 48
13	0 52	73	4 52	133	8 52	193	12 52	253	16 52	313	20 52	13	0 52
14	0 56	74	4 56	134	8 56	194	12 56	254	16 56	314	20 56	14	0 56
15	1 00	75	5 00	135	9 00	195	13 00	255	17 00	315	21 00	15	1 00
16	1 04	76	5 04	136	9 04	196	13 04	256	17 04	316	21 04	16	1 04
17	1 08	77	5 08	137	9 08	197	13 08	257	17 08	317	21 08	17	1 08
18	1 12	78	5 12	138	9 12	198	13 12	258	17 12	318	21 12	18	1 12
19	1 16	79	5 16	139	9 16	199	13 16	259	17 16	319	21 16	19	1 16
20	1 20	80	5 20	140	9 20	200	13 20	260	17 20	320	21 20	20	1 20
21	1 24	81	5 24	141	9 24	201	13 24	261	17 24	321	21 24	21	1 24
22	1 28	82	5 28	142	9 28	202	13 28	262	17 28	322	21 28	22	1 28
23	1 32	83	5 32	143	9 32	203	13 32	263	17 32	323	21 32	23	1 32
24	1 36	84	5 36	144	9 36	204	13 36	264	17 36	324	21 36	24	1 36
25	1 40	85	5 40	145	9 40	205	13 40	265	17 40	325	21 40	25	1 40
26	1 44	86	5 44	146	9 44	206	13 44	266	17 44	326	21 44	26	1 44
27	1 48	87	5 48	147	9 48	207	13 48	267	17 48	327	21 48	27	1 48
28	1 52	88	5 52	148	9 52	208	13 52	268	17 52	328	21 52	28	1 52
29	1 56	89	5 56	149	9 56	209	13 56	269	17 56	329	21 56	29	1 56
30	2 00	90	6 00	150	10 00	210	14 00	270	18 00	330	22 00	30	2 00
31	2 04	91	6 04	151	10 04	211	14 04	271	18 04	331	22 04	31	2 04
32	2 08	92	6 08	152	10 08	212	14 08	272	18 08	332	22 08	32	2 08
33	2 12	93	6 12	153	10 12	213	14 12	273	18 12	333	22 12	33	2 12
34	2 16	94	6 16	154	10 16	214	14 16	274	18 16	334	22 16	34	2 16
35	2 20	95	6 20	155	10 20	215	14 20	275	18 20	335	22 20	35	2 20
36	2 24	96	6 24	156	10 24	216	14 24	276	18 24	336	22 24	36	2 24
37	2 28	97	6 28	157	10 28	217	14 28	277	18 28	337	22 28	37	2 28
38	2 32	98	6 32	158	10 32	218	14 32	278	18 32	338	22 32	38	2 32
39	2 36	99	6 36	159	10 36	219	14 36	279	18 36	339	22 36	39	2 36
40	2 40	100	6 40	160	10 40	220	14 40	280	18 40	340	22 40	40	2 40
41	2 44	101	6 44	161	10 44	221	14 44	281	18 44	341	22 44	41	2 44
42	2 48	102	6 48	162	10 48	222	14 48	282	18 48	342	22 48	42	2 48
43	2 52	103	6 52	163	10 52	223	14 52	283	18 52	343	22 52	43	2 52
44	2 56	104	6 56	164	10 56	224	14 56	284	18 56	344	22 56	44	2 56
45	3 00	105	7 00	165	11 00	225	15 00	285	19 00	345	23 00	45	3 00
46	3 04	106	7 04	166	11 04	226	15 04	286	19 04	346	23 04	46	3 04
47	3 08	107	7 08	167	11 08	227	15 08	287	19 08	347	23 08	47	3 08
48	3 12	108	7 12	168	11 12	228	15 12	288	19 12	348	23 12	48	3 12
49	3 16	109	7 16	169	11 16	229	15 16	289	19 16	349	23 16	49	3 16
50	3 20	110	7 20	170	11 20	230	15 20	290	19 20	350	23 20	50	3 20
51	3 24	111	7 24	171	11 24	231	15 24	291	19 24	351	23 24	51	3 24
52	3 28	112	7 28	172	11 28	232	15 28	292	19 28	352	23 28	52	3 28
53	3 32	113	7 32	173	11 32	233	15 32	293	19 32	353	23 32	53	3 32
54	3 36	114	7 36	174	11 36	234	15 36	294	19 36	354	23 36	54	3 36
55	3 40	115	7 40	175	11 40	235	15 40	295	19 40	355	23 40	55	3 40
56	3 44	116	7 44	176	11 44	236	15 44	296	19 44	356	23 44	56	3 44
57	3 48	117	7 48	177	11 48	237	15 48	297	19 48	357	23 48	57	3 48
58	3 52	118	7 52	178	11 52	238	15 52	298	19 52	358	23 52	58	3 52
59	3 56	119	7 56	179	11 56	239	15 56	299	19 56	359	23 56	59	3 56

1.5 Greenwich Mean Time (GMT)

Greenwich Mean Time (GMT) is the Local Mean Time along the meridian of longitude that runs through the Royal Observatory at Greenwich.

1.6 Prime Meridian

The Greenwich Meridian is designated 000°E/W longitude, and is the Prime Meridian.

1.7 Coordinated Universal Time

A possible solution would be the adoption of a single time standard for the whole world and this, too, has practical application, e.g. in aviation. For many years the standard internationally accepted was Greenwich Mean Time (GMT), i.e. the LMT at the Greenwich meridian. More recently, advances in the technology of atomic clocks resulted in a new and more precise time standard called Coordinated Universal Time (UTC), accepted by ICAO in 1984. UTC is based upon new definitions and new and more accurate methods of measurement, but for practical purposes there is no discernible difference between UTC and GMT. It is now correct to use UTC rather than GMT, but numerous references to GMT will still be found in older books and publications. In such cases, the two terms can be considered synonymous.

Despite its widespread application in aviation and other fields, UTC is not suitable for everyday use, as except for a narrow band of longitudes about the Greenwich meridian, clocks keeping UTC indicate times that are inconsistent with the observed position of the Sun. Therefore, we need to find a compromise that, on the one hand, keeps local clock times reasonably aligned with the actual position of the Sun, while, on the other, reducing to an acceptable level the number of different time standards. The system of time zones provides the required compromise.

Example: Converting LMT to UTC using Arc to Time:

The LMT at Parafield (34°48'S, 138°38'E) is 1200 (noon). What is the time at Parafield in UTC?

D-long = 138°38'

138° = 9 hr 12 min

38' = 2 min 32 sec

∴138°38' = 9 hr 15 min

Longitude East, UTC Least

Longitude West, UTC Best

Parafield is East of Greenwich, so the LMT at Parafield is later than UTC (ahead of UTC).

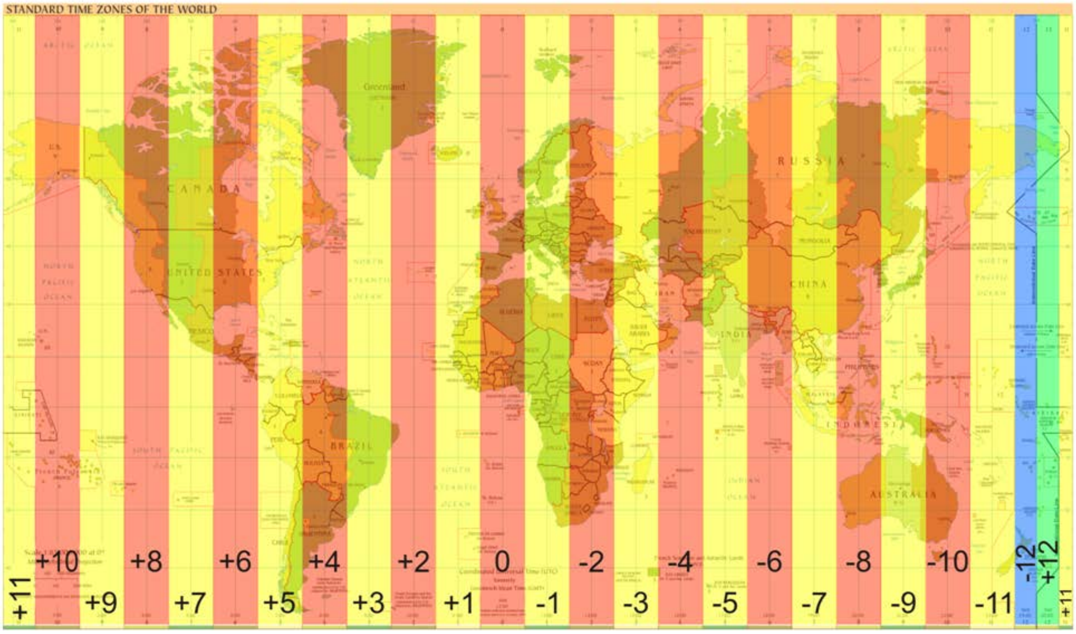
∴UTC at Parafield = 12:00 - 09:15

= 02:45

1.8 Time Zones and Standard Times

The world is divided into 24 zones, each 15° of longitude in width, and each keeping the LMT of its central meridian. The system starts at the Greenwich meridian, and every point within the longitude band 07°30'W to 07°30'E, keeps UTC as its zone time (figure 7). UTC is also referred to as Zulu time.

Points on the eastern extremity of the zone therefore keep clock time that is 30 minutes behind LMT, and those on the western extremity keep clock time that is 30 minutes ahead. Thus, the maximum 'error' in the system is 30 minutes, and this is of minor concern when weighed against the convenience of a single time zone within a large longitudinal area. (15° of longitude at the latitude of Adelaide extends some 1,350km).



The time zones adjacent to the Greenwich zone have as their central meridians 15°E and 15°W respectively. The clock time within the eastern zone is UTC+1 hour and in the western zone, UTC-1 hour. Subsequent time zones, each differing by one hour from its predecessor, are established with central meridians at 15° intervals. These zones are numbered according to the number of hours that must be added or subtracted from that particular zone time to obtain UTC. The number of the Greenwich zone is zero, zones west of Greenwich have progressively increasing positive numbers and zones to the east have progressively increasing negative numbers.

The system of zone times is a good one, but it is not applied rigidly if a zone boundary is inconveniently located with respect to a state or national boundary. Clearly, it would be undesirable to divide an island, state or nation into two time zones if a small adjustment of the zone boundary would allow the whole area to be included in one zone.

Many such alterations to zone boundaries have been made throughout the world resulting in 'Standard Times' that differ from the local zone time, so it is not advisable to rely on longitude alone when determining the time kept in a particular region. The information is provided in Standard Time tables in the Air Almanac, but for examination purposes the information will be provided as part of the question.

In the examination you could be required to compute the local standard time (LST) date and time of arrival for a flight of stated duration, with a given departure time, to a destination keeping a different LST. You could also be expected to work back towards a required departure time from a stated arrival time due to curfew restrictions or other operational requirements.

Example 1: LST to LST Calculations:

Find the date and LST of arrival for a flight of 13 hours duration departing from Sydney, Australia at 7 AM on Wednesday 10 July 2012 for Los Angeles, USA. The difference from Zulu for Sydney is UTC+10 and Los Angeles is UTC-8.

10 Jul	06:00	LST	Depart Sydney, Australia
	-10:00		Time difference from UTC
09 Jul	20:00	UTC	Depart Sydney, Australia
	+13:00		Flight Time
10 Jul	09:00	UTC	Arrival Los Angeles, USA
	-08:00		Time difference from UTC
10 Jul	01:00	LST	Arrival Los Angeles, USA

Standard Time Factors (STF) are used to convert between UTC and LST. If a time is given or required to be in LMT, then the Arc to Time table should be used to convert between UTC and LMT.

For problems involving flight times, curfews or time spent on the ground, always apply these time values to UTC when doing time conversions.

Example 2: LST to LST Calculation (2):

Sydney (Australia) airport is closed to arrivals until 05:30 AM LST. What is the earliest available LST departure from Narita (Japan) for a flight of 10.5 hours duration to arrive Sydney at 05:30 AM LST on 11 December? Sydney uses UTC+11 and Narita uses UTC+9.

11 Dec	05:30	LST	Arrive Sydney, Australia
	-11:00		Time difference from UTC
10 Dec	18:30	UTC	Arrive Sydney, Australia
	-10:30		Flight Time
10 Dec	08:00	UTC	Depart Narita, Japan
	+09:00		Time difference from UTC
10 Dec	17:00	LST	Depart Narita, Japan

In the CASA CPL Navigation Examination (CNAV), the time difference from UTC will be provided for the locations in question, if they are at international airports located outside Australia. The standard time factors used for the different states/territories of Australia can be found in the Jeppesen, Tables and Codes Section, page AU11

In practical flying these factors can be obtained from various documents, the UK Air Almanac being one such document. See the next page for an extract of the UK Air Almanac.

STANDARD TIMES (Corrected to June 1985)

LIST I — PLACES FAST ON G.M.T. (mainly those EAST OF GREENWICH)

The times given below should be } added to G.M.T. to give Standard Time. / subtracted from Standard Time to give G.M.T.

Place	h	m
Admiralty Islands	10	
Afghanistan	04	30
Albania *	01	
Algeria	01	
Amirante Islands	04	
Andaman Islands	05	30
Angola	01	
Annobon Island	01	
Australia		
Australian Capital Territory *	10	
New South Wales1 *	10	
Northern Territory	09	30
Queensland	10	
South Australia *	09	30
Tasmania *	10	
Victoria *	10	
Western Australia *	08	
Austria*	01	
Bahrain	03	
Balearic Islands *	01	
Banaba	11	30
Bangladesh	06	
Belgium *	01	
Benin (Dahomey)	01	
Botswana, Republic of Brunei	02	
Brunei	08	
Bulgaria *	02	
Burma	06	30
Burundi	02	
Cameroon Republic	01	
Caroline Islands, west of long. E. 135 °	09	
long. E. 135 ° to E. 150 °	10	
long. E. 150 ° to E. 160 °	11	
east of long. E. 160 °	12	
Central African Republic	01	
Chad	01	
Chagos Archipelago[2]	05	
Chatham Islands	12	45
China[3]	08	
Christmas Island, Indian Ocean	07	
Cocos Keeling Islands	06	30
Comoro Islands (Comoros)	03	
Congo Republic	01	
Corsica *	01	
Crete *	02	
Cyprus, Ercan *	02	
Larnaca *	02	
Czechoslovakia *	01	
Denmark *	01	
Djibouti	03	

Place	h	m
Egypt, Arab Republic of.	02	
Equatorial Guinea. Republic of	01	
Estonia	03	
Ethiopia	03	
Fernando Póo	01	
Fiji	12	
Finland *	02	
France *	01	
Friendly Islands	13	
Gabon	01	
Germany, East *	01	
West[4] *	01	
Gibraltar *	01	
Greece *	02	
Guam	10	
Holland (The Netherlands) *	01	
Hong Kong	08	
Hungary *	01	
India	05	30
Indonesia, Republic of		
Bali, Bangka, Billiton, Java, Madura, Sumatra	07	
Flores, Kalimantan, Lombok, Sulawesi, Sumba, Sumbawa, Timor	08	
Aru, Irian Jaya, Kai, Moluccas, Tanimbar	09	
Iran	03	30
Iraq *	03	
Israel *	02	
Italy *	01	
Japan	09	
Jordan *	02	
Kamchatka Peninsula	12	
Kampuchea, Democratic	07	
Kenya	03	
Kiribati Republic [5]	12	
Korea, North	09	
Republic of (South)	09	
Kuril Islands	11	
Kuwait	03	
Laccadive Islands	05	30
Laos	07	
Latvia	03	
Lebanon *	02	

* Summer time may be kept in these countries.
[1] Except Broken Hill Area which keeps 09^h 30^m.
[2] Except Diego Garcia which keeps 06^h.
[3] All the coast, but some areas may keep summer time.
[4] Including West Berlin.
[5] Except Banaba which keeps 11^h 30^m.

STANDARD TIMES (Corrected to June 1985)

LIST I — *(Continued)*

	h	m
Lesotho	02	
Libya *.	01	
Liechtenstein	01	
Lord Howe Island *	10	30
Luxembourg *	01	
Macao.	08	
Madagascar, Democratic Republic of	03	
Malawi	02	
Malaysia		
Malaya, Sabah, Sarawak	08	
Maldives, Republic of The	05	
Malta *	01	
Mariana Islands	10	
Marshall Islands [1]	12	
Mauritius	04	
Monaco *	01	
Mongolia, West	07	
Central *	08	
East	09	
Morocco	01	
Mozambique	02	
Namibia (South West Africa)	02	
Nauru	12	
Netherlands. The *	01	
New Caledonia *	11	
New Zealand * .	12	
Nicobar Islands	05	30
Niger	01	
Nigeria. Republic of	01	
Norfolk Island	11	30
Norway *	01	
Novaya Zemlya	05	
Okinawa	09	
Oman	04	
Pakistan	05	
Papua New Guinea	10	
Pescadores Islands	08	
Philippine Republic	08	
Poland *	01	
Reunion	04	
Romania *	02	
Rwanda	02	
Ryukyu Islands	09	
Sakhalin	11	
Santa Cruz Islands	11	
Sardinia *	01	
Saudi Arabia	03	
Schouten Islands	09	
Seychelles	04	

	h	m
Sicily *	01	
Singapore	08	
Socotra.	03	
Solomon Islands	11	
Somalia Republic	03	
South Africa, Republic of	02	
South West Africa (Namibia)	02	
Spain * .	01	
Spanish Possessions in North Africa		
(Ceuta, Melilla) *	01	
Spitsbergen (Svalbard)	01	
Sri Lanka	05	30
Sudan, Republic of	02	
Swaziland	02	
Sweden *	01	
Switzerland *	01	
Syria (Syrian Arab Republic)	03	
Taiwan *	08	
Tanzania	03	
Thailand	07	
Tonga Islands	13	
Truk	10	
Tunisia .	01	
Turkey *	02	
Tuvalu Islands	12	
Uganda	03	
Union of Soviet Socialist Republics [2] *		
west of long. E. 40° .	03	
long. E. 40° to E. 52* 30'	04	
long. E. 52° 30' to E. 67° 30'	05	
long. E. 67° 30' to E. 82° 30'	06	
long. E. 82° 30' to E. 97° 30'	07	
long. E. 97° 30' to E. 112° 30'	08	
long. E. 112° 30' to E. 127° 30'	09	
long. E. 127° 30' to E. 142° 30'	10	
long. E. 142° 30' to E. 157° 30'	11	
long. E. 157° 30' to E. 172° 30'	12	
east of long. E. 172' 30'	13	
United Arab Emirates	04	
Vanuatu, Republic of *	11	
Vietnam, Socialist Republic of	07	
Wrangell Island	13	
Yemen	03	
Yugoslavia *	01	
Zaire		
Kinshasa. Mbandaka	01	
Haut-Zaire. Kasai. Kivu, Shaba	02	
Zambia, Republic of	02	
Zimbabwe	02	

* Summer time may be kept in these countries.
[1] Except the islands of Kwajalein and Eniwetok which keep a time 24^h slow on that of the rest of the islands.
[2] The boundaries between the zones are irregular; the longitudes given are approximate only.

STANDARD TIMES (Corrected to June 1985)

LIST II — PLACES NORMALLY KEEPING G.M.T.

Ascension Island	Ghana	Ireland, Northern [1]	Mauritania	Sierra Leone
Bourkina-Faso	Great Britain [1]	Irish Republic *	Portugal *	Tangier
Canary Islands *	Guinea Bissau	Ivory Coast	Principe	Togo Republic
Channel Islands [1]	Guinea Republic	Liberia	St. Helena	Tristan da Cunha
Faeroes *, The	Iceland	Madeira *	Sao Tomé	
Gambia	Ifni	Mali	Senegal	

* Summer time may be kept in these countries.
[1] Summer time. one hour in advance of G.M.T., is kept from March 29[1] 01" to October 25° 01" G.M.T., subject to confirmation.

LIST III — PLACES SLOW ON G.M.T. (WEST OF GREENWICH)

The times given below should be } *subtracted* from G.M.T. to give Standard Time. *added* to Standard Time to give G.M.T.

	h	m		h	m
Argentina	03		Cape Verde Islands	01	
Austral Islands [1]	10		Cayman Islands	05	
Azores *	01		Chile *	04	
			Christmas Island, Pacific Ocean	10	
			Colombia	05	
Bahamas *	05		Cook Islands *, except Niue	10	
Barbados	04		Costa Rica	06	
Belize	06		Cuba *	05	
Bermuda *	04		Curacao Island	04	
Bolivia	04				
Brazil, eastern [2]	03		Dominican Republic	04	
Territory of Acre	05				
western	04				
British Antarctic Territory [3]	03		Easter Island (I. de Pascua) *	06	
			Ecuador	05	
Canada			Falkland Islands [4]	04	
Alberta *	07		Fanning Island	10	
British Columbia *	08		Fernando de Noronha Island	02	
Labrador *	04		French Guiana	03	
Manitoba *	06				
New Brunswick *	04				
Newfoundland *	03	30	Galapagos Islands	06	
Northwest Territories *			Greenland [3], Scoresby Sound *	01	
east of long. W. 68°	04		Angmagssalik and west coast'	03	
long. W. 68° to W. 85°	05		Thule area	04	
long. W. 85° to W. 102°	06		Grenada	04	
west of long. W. 102°	07		Guadeloupe	04	
Nova Scotia *	04		Guatemala *	06	
Ontario *, east of long. W. 90°	05		Guyana, Republic of	03	
west of long. W. 90°	06				
Prince Edward Island *	04		Haiti *	05	
Quebec *, east of long. W. 63°	04		Honduras	06	
west of long. W. 63°	05				
Saskatchewan *			Jamaica	05	
east of long. W. 106°	06		Jan Mayen Island	01	
west of long. W. 106°	07		Johnston Island	10	
Yukon *	08		Juan Fernandez Islands	04	

* Summer time may be kept in these countries.
[1] This is the legal standard time, but local mean time is generally used.
[2] Including all the coast and Brasilia.
[3] Except South Georgia which keeps 02^h.
[4] Except Port Stanley which may keep summer time.
[5] Danmarkshavn keeps G.M.T.

STANDARD TIMES (Corrected to June 1985)
LIST III — *(Continued)*

	h	m
Leeward Islands	04	
Low Archipelago	10	
Marquesas Islands [1]	09	30
Martinique	04	
Mexico [2]	06	
Midway Islands	11	
Miquelon	03	
Nicaragua	06	
Niue Island	11	
Panama Canal Zone	05	
Panama. Republic of	05	
Paraguay *	04	
Peru *	05	
Puerto Rico	04	
Rarotonga	10	
St. Pierre and Miquelon	03	
Salvador, El	06	
Samoa	11	
Society Islands [1]	10	
South Georgia	02	
Surinam	03	
Tobago	04	
Trindade Island, South Atlantic	02	
Trinidad	04	
Tuamotu Archipelago [1]	10	
Tubuai Islands [1]	10	
Turks and Caicos Islands *	05	
United States of America		
Alabama [3]	06	
Alaska [3], east of long. W. 169° 30'	09	
Aleutian Islands, west of W. 169° 31'	10	
Arizona	07	
Arkansas [3]	06	
California [3]	08	
Colorado [3]	07	
Connecticut [3]	05	
Delaware [3]	05	
District of Columbia [3]	05	
Florida [3] [4]	05	
Georgia [3]	05	
Hawaii	10	

	h	m
United States of America (continued)		
Idaho [3] [4]	07	
Illinois [3]	06	
Indiana [4]	05	
Iowa [3]	06	
Kansas [3] [4]	06	
Kentucky [3], eastern part	05	
western part	06	
Louisiana [3]	06	
Maine [3]	05	
Marylan [3]	05	
Massachusetts [3]	05	
Michigan [3] [4]	05	
Minnesota [3]	06	
Mississippi [3]	06	
Missouri [3]	06	
Montana [3]	07	
Nebraska [3] [4]	06	
Nevada [3]	08	
New Hampshire [3]	05	
New Jersey [3]	05	
New Mexico [3]	07	
New York [3]	05	
North Carolina [3]	05	
North Dakota [3] [4]	06	
Ohio [3]	05	
Oklahoma [3]	06	
Oregon [3] [4]	08	
Pennsylvania [3]	05	
Rhode Island [3]	05	
South Carolina [3]	05	
South Dakota [3], eastern part	06	
western part	07	
Tennessee [3] [4]	06	
Texas [3] [4]	06	
Utah [3]	07	
Vermont [3]	05	
Virginia [3]	05	
Washington, D.C. [3]	05	
Washington [3]	08	
West Virginia [3]	05	
Wisconsin [3]	06	
Wyoming [3]	07	
Uruguay *	03	
Venezuela	04	
Virgin Islands	04	
Windward Islands	04	

* Summer time may be kept in these countries.

[1] This is the legal standard time, but local mean time is generally used.

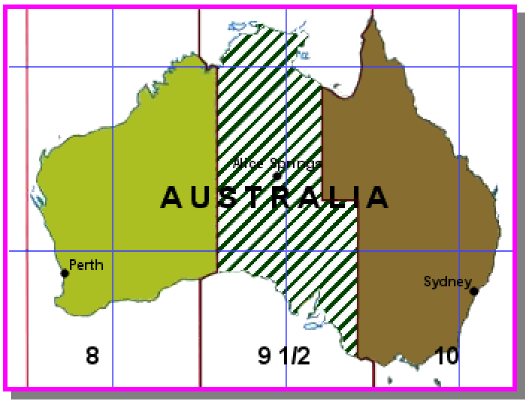
[2] Except the states of Sonora, Sinaloa. Nayarit and the Southern District of Lower California which keep 07^h, and the Northern District of Lower California which keeps 08^h.

[3] Summer (daylight-saving) time, one hour fast on the time given, is kept in these states from the last Sunday in April to the last Sunday in October, changing at $02^h\ 00^m$ local clock time.

[4] This applies to the greater portion of the state.

1.8.1 Australian Standard Times

The Australian continent fits neatly into three time zones: UTC+8, centred on 120°E, UTC+9, centred on 135°E, and UTC+10, centred on 150°E. Zone UTC+8 is observed in Western Australia with a minor modification to accommodate the state boundary, and 'Western Standard Time' is UTC +8 hours. Zone UTC+10 with similar minor modifications is used by the eastern states, 'Eastern Standard Time' being UTC +10 hours. For reasons that are somewhat obscure, South Australia and the Northern Territory do not keep Central Standard Time (UTC+9 hours), but rather, UTC+9½ hours. It is noteworthy that the central meridian of the UTC+9½ hours zone is 142°30'E, and this meridian does not even lie within the borders of the states concerned.



1.8.1.1 <u>Conversions Using Standard Times</u>

<u>Example 1</u>: Converting LST to LMT:

Find the LMT at Albany, Western Australia (longitude 117°49'E) if the standard time is 1500 on 2 December.

Albany	021500	WST
	<u>-0800</u>	standard time factor (WST = UTC + 8 hours)
	020700	UTC
	<u>+0751</u>	arc to time (Long. E UTC least)
	021451	LMT

Example 2: Converting LMT to LST:

Find the standard time at Ayers Rock, Northern Territory (longitude 130°58'E), if the LMT is 1030 on 1 July.

Ayers Rock		130°58'E (arc-time calculation)
011030	LMT	$\frac{130°}{15°}$ = 8 hrs (0.667 hrs remain)
- 0844	arc-time	
010146	UTC	0.667hrs x 60 = 40 minutes
+ 0930	ST factor	$\frac{58'}{15'}$ ≈ 4 minutes
011116	CST	130°59'E = 8 hrs 44 minutes

Example 3: Converting LMT to LST (2):

Find the standard time at Sydney, New South Wales, (longitude 151°10'E) if the LMT is 1200 on 8 October.

Sydney		151°10'E (arc-time calculation)
081200	LMT	$\frac{151°}{15°}$ = 10 hrs (0.067 hrs remain)
- 1005	arc-time	
080155	UTC	0.067hrs x 60 = 4 minutes
+ 1000	ST factor	$\frac{10'}{15'}$ ≈ 1 minute
081155	EST	151°10'E = 10 hrs 05 minutes

NOTE:

i. Careful layout is important to avoid confusion, especially regarding dates.

ii. Standard Times are normally close to Local Mean Times.

1.8.2 Summer Time or Daylight Saving Time

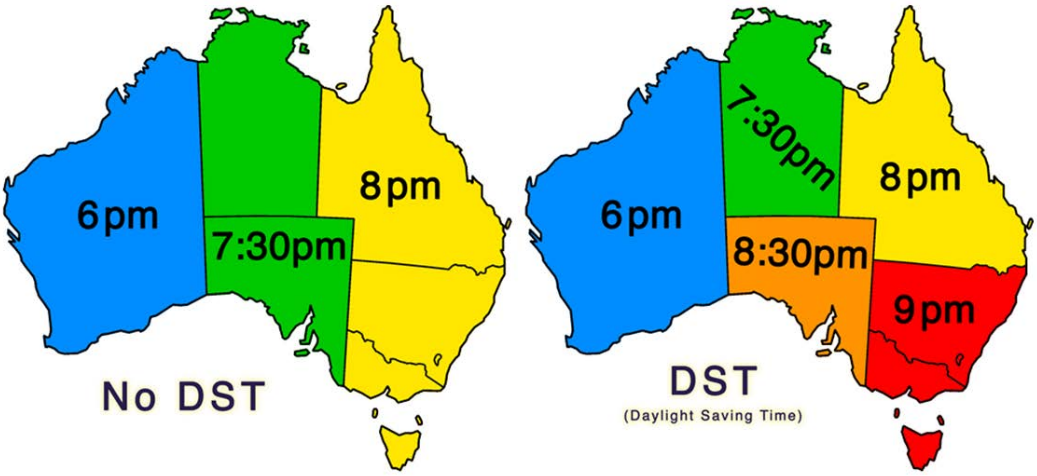
During the local summer months, many regions throughout the world observe 'Summer Time' or 'Daylight Saving Time'. Summer time is obtained by moving the clock one hour ahead of the local standard time.

For example in South Australia 'Central Summer Time' is observed from October to March each year, and is UTC+10½ hours.

Summer time is only of practical benefit when the length of daylight considerably exceeds the length of darkness, i.e. during the summer months in non-tropical latitudes. In that situation, it is deemed to provide an additional hour of 'useful daylight' by utilising daylight from the otherwise unused period in the early morning, but the claimed 'benefit' is by no means generally accepted.

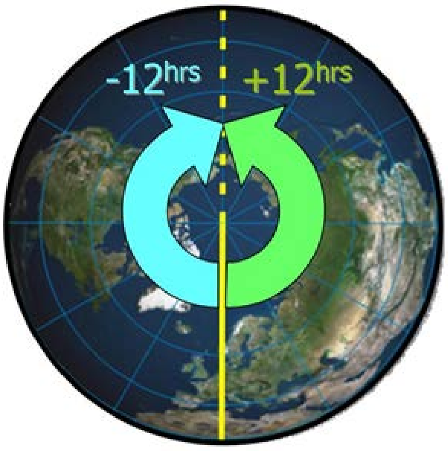
Internationally, regions that regularly adopt daylight saving are identified in the previously mentioned lists in the Air Almanac. The dates on which the change to/from summer time occurs, are promulgated in NOTAMs.

In Australia summer time is kept by all the states, except Western Australia, the Northern Territory and Queensland.



1.9 The International Date Line

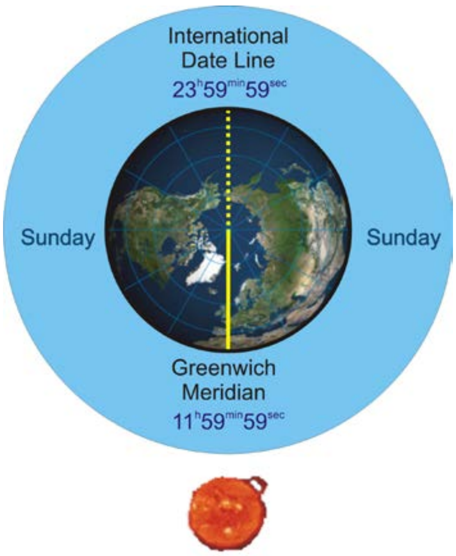
Proceeding west from Greenwich, we reach time zone number 11, bounded by 157°30'W and 172°30'W, with central meridian at 165°W. Similarly, if we proceed east from Greenwich, we reach time zone number -11. The next zone, centred on 180E/W and bounded by 172°30'W and 172°30'E would, apparently, be numbered 12 if we approach westward from Greenwich, or -12 if we approach eastward from Greenwich. Thus, at the 180° meridian itself, we experience a time difference of 24 hours on either side of the meridian.



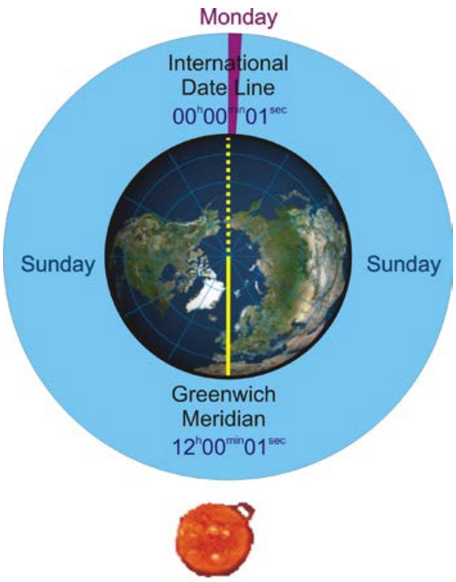
(UTC + 12) - (UTC - 12) = 24 hours

In other words the date changes at that point, the region to the west of the 180° meridian being in Monday, and the region to the east in Sunday. For this reason, the 180° meridian is also referred to as the International Date Line (IDL).

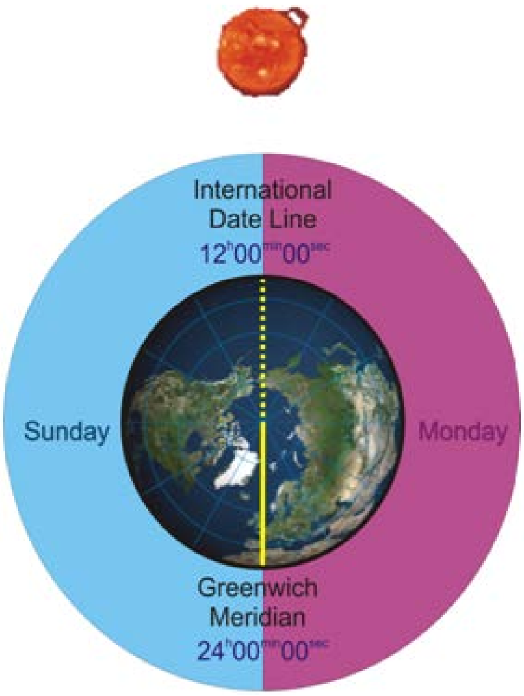
To understand how this happens, consider the figure below in which the mean Sun is just about to cross the Greenwich meridian. The LMT at Greenwich is 11h59min59sec, and the LMT at the IDL is 23h59min59sec. In that instant, the day over (almost) the whole world is Sunday.



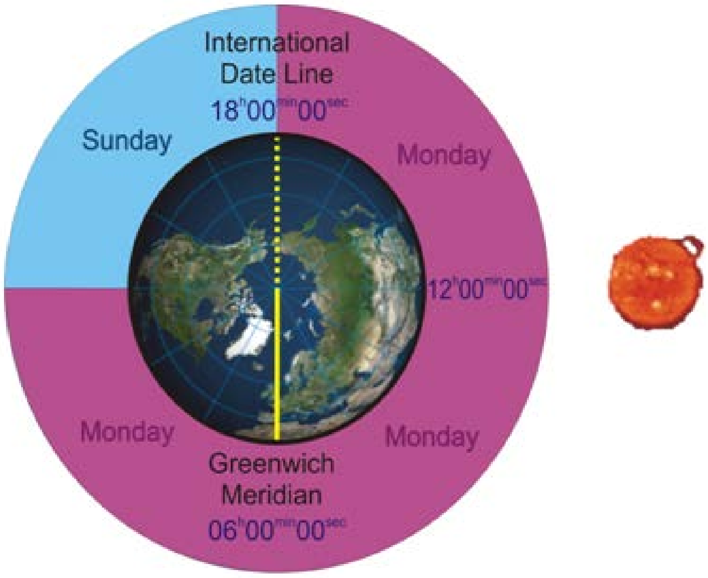
Two seconds later in the figure below, the time at Greenwich is 12h00min01sec and at the IDL, 00h00min01sec on Monday. As the mean Sun moves from east to west around the Earth the LMT at the Sun's anti-meridian is always 0000 or 2400, and always marks the point of local change of day from Sunday to Monday.

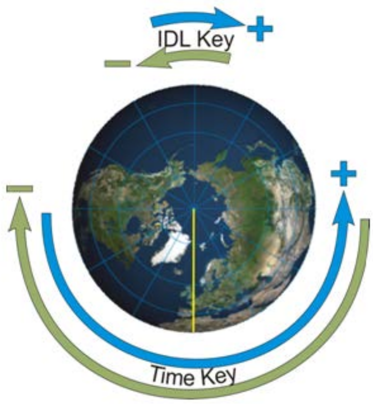


In the next figure, the Sun is over the IDL; it is midnight at Greenwich and the Greenwich day is changing from Sunday to Monday. At this point, the hemisphere to the west of the IDL is in Monday, and the hemisphere to the east is still in Sunday.



As shown in the next figure, continued progression of the mean Sun further increases the sector of the Earth in Monday, and reduces the sector still in Sunday. Finally, as the mean Sun approaches the Greenwich meridian again, its anti-meridian obliterates the last remaining sector still in Sunday, and the process commences again with a new day at the IDL.





From this we observe that, if we cross the IDL from east to west, e.g. from Australia to the US, we move from Monday back to Sunday. Crossing from west to east, we move from Sunday on to Monday.

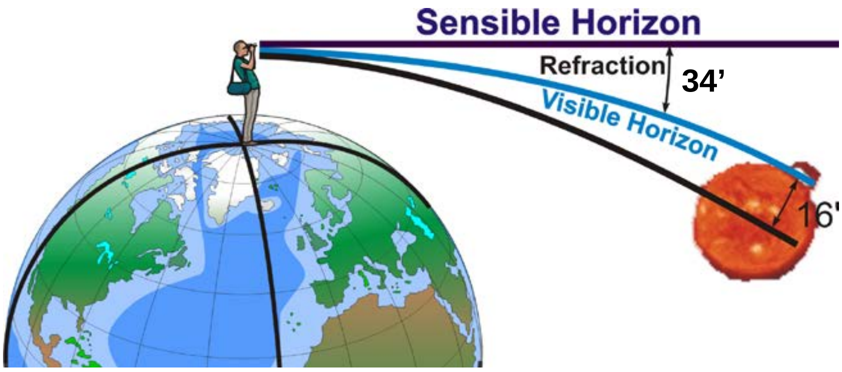
It is generally recognised that a discontinuity will occur somewhere, irrespective of the system of longitude or zone time that we might adopt. The existing system is optimal, because it places the discontinuity in the middle of a large expanse of ocean where it causes the least possible inconvenience.

However, like the standard time boundaries, the IDL is not rigidly aligned with the 180° meridian, deviations occur as necessary to avoid populated areas.

1.10 Sunrise and Sunset

To an observer standing on the Earth it appears as if the sun rises in the east, moves across the sky and then sets in the west. This apparent motion of the sun is caused by the movement of the Earth around its own axis and its orbit around the sun.

The rising and setting of the sun is taken to occur when its upper edge is on the visible horizon, i.e. as it becomes visible in the morning and disappears in the evening. Light refraction puts the visible horizon 00°34' below the sensible (i.e. as sensed by instruments) horizon. The semi-diameter of the sun is 00°16'. Thus, when the upper edge of the sun is on the visible horizon, its centre is actually some 00°50' (0.8°) below the sensible horizon. When flying at high altitude, the time of sunrise is earlier and the time of sunset is later than at sea level.



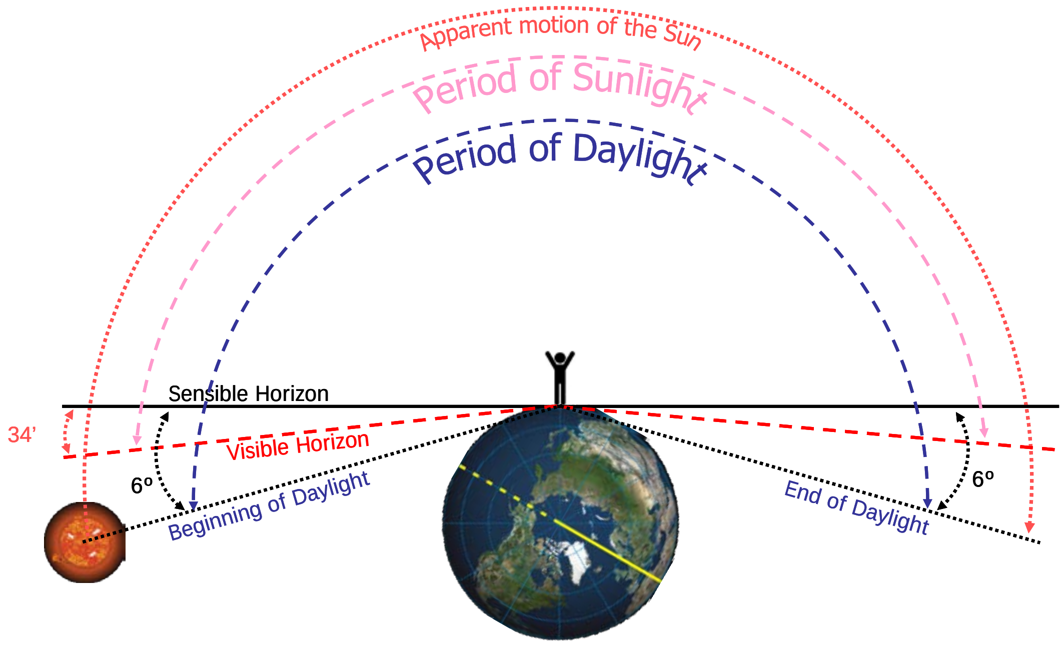
The LMT at which sunrise (SR) and sunset (SS) occurs varies with latitude and date only; longitude has no effect. The variation in LMT of these phenomena is caused by the angle of tilt of the Earth's spin axis to the Earth's orbital plane. This causes the apparent sun to change latitude between 23½° N/S over the period of a year, giving rise to the seasons.

1.10.1 Beginning and End of Daylight

Because the Earth's atmosphere refracts and scatters light, considerable useful daylight is available before sunrise and after sunset. This period is called 'twilight' and is defined arbitrarily as follows:

Morning Civil Twilight (MCT) is that period that begins before sunrise and Evening Civil Twilight (ECT) is that period that ends after sunset, in both cases when the centre of the Sun is 6° below the horizon.

Modern day aviators are concerned mainly with civil twilight. In particular, in Australia daylight is defined as that period between the beginning of MCT and the end of ECT, and day-VFR flight is permitted only within that period.



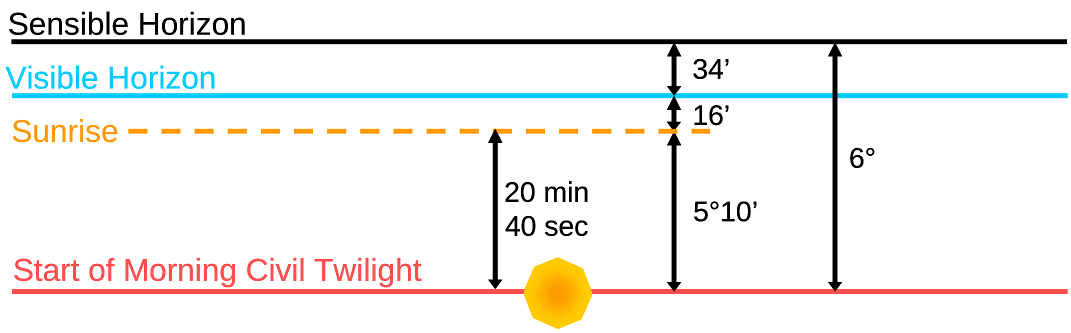
Beginning of Daylight (BoD) = Beginning of Morning Civil Twilight.
End of Daylight (EoD) = End of Evening Civil Twilight

1.10.2 Duration of Twilight

As mentioned before, Morning Civil Twilight begins when the centre of the sun is 6° below the sensible horizon and twilight ends when the sun rises, i.e. when the centre of the sun is 50' below the sensible horizon.

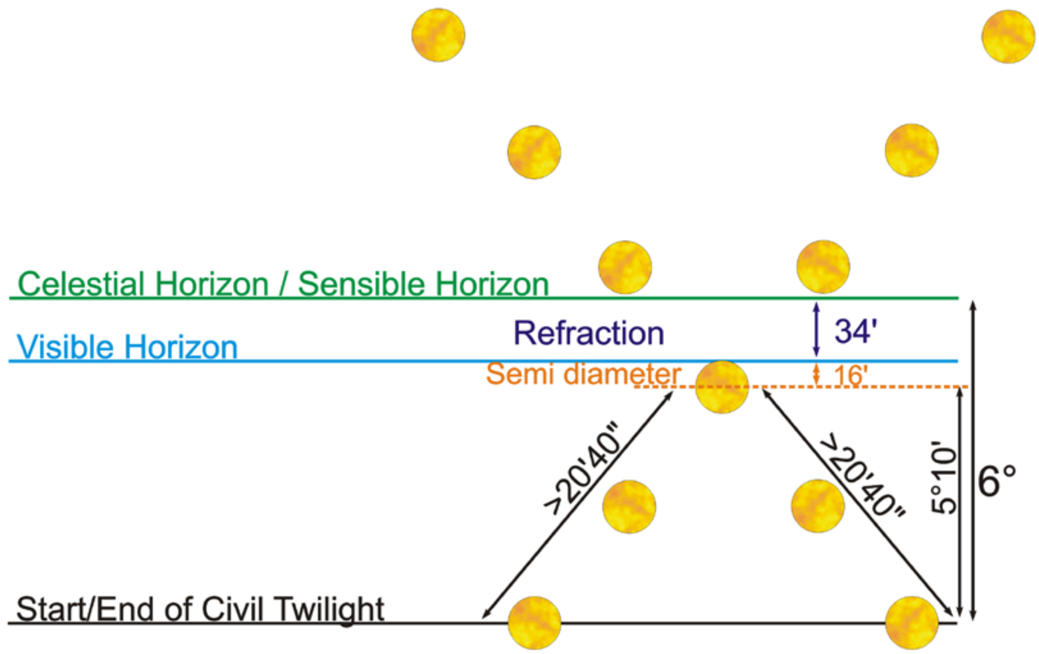
In the evening, twilight starts at sunset and ends when the centre of the sun is once again 6° below the sensible horizon.

The total duration of twilight would therefore be 5°10' of Earth rotation and as the Earth rotates at 15° per hour, the length of twilight would be 20mins 40sec.



This is the duration of twilight at the equator, since it is only at the equator that the sun rises and sets at an angle of 90° to the horizon.

The further a place is from the equator, the angle at which the sun crosses he horizon as it rises or sets becomes smaller, increasing the time that twilight will last at that latitude.



At latitudes beyond 66.5°, during certain times of the year, twilight can last multiple calendar days.

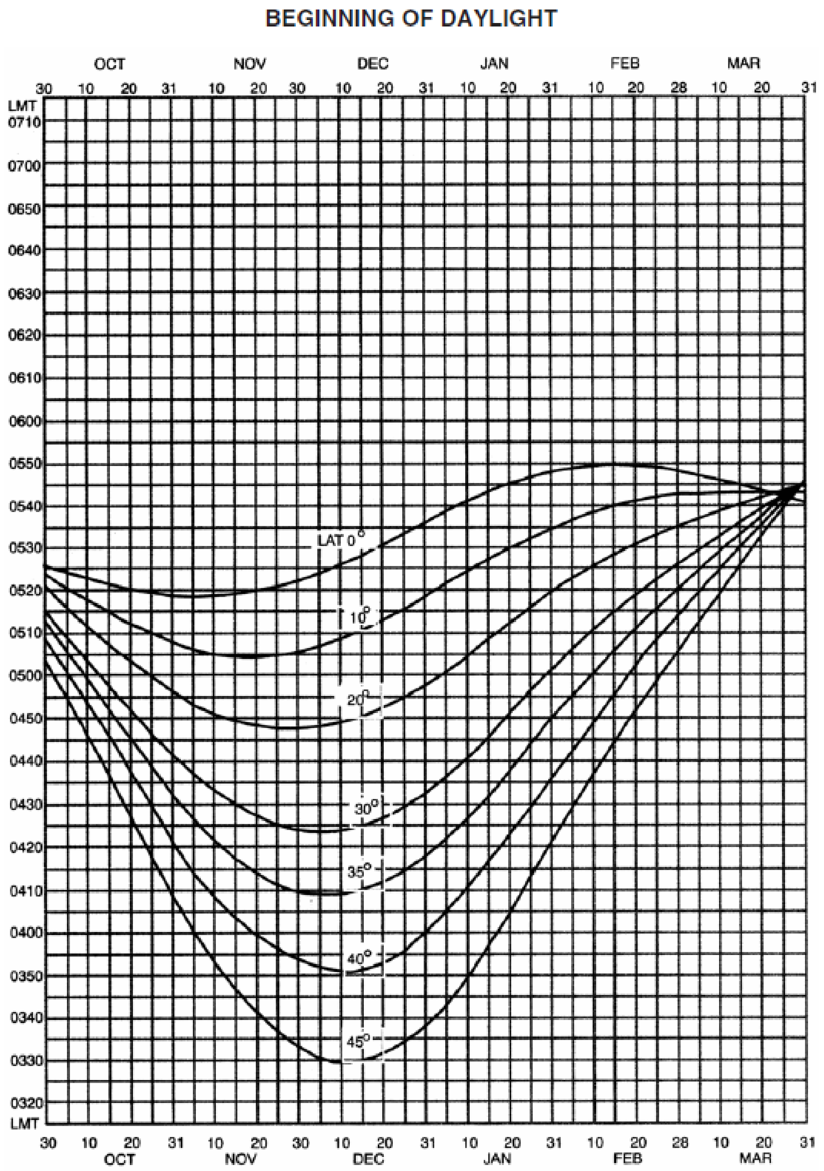
1.10.3 Daylight and Darkness Graphs

The LMT for beginning and end of daylight can be extracted from the Daylight and Darkness graphs in the AIP or Jeppesen. Refer to Jeppesen Volume 1 - Tables and Codes - AU13 to AU16. The instructions for the use of these graphs can also be found on page AU11 (in the same section).

If the time for BoD or EoD is required in any other format than LMT, then it should be converted as per the methods mentioned previously in this chapter.

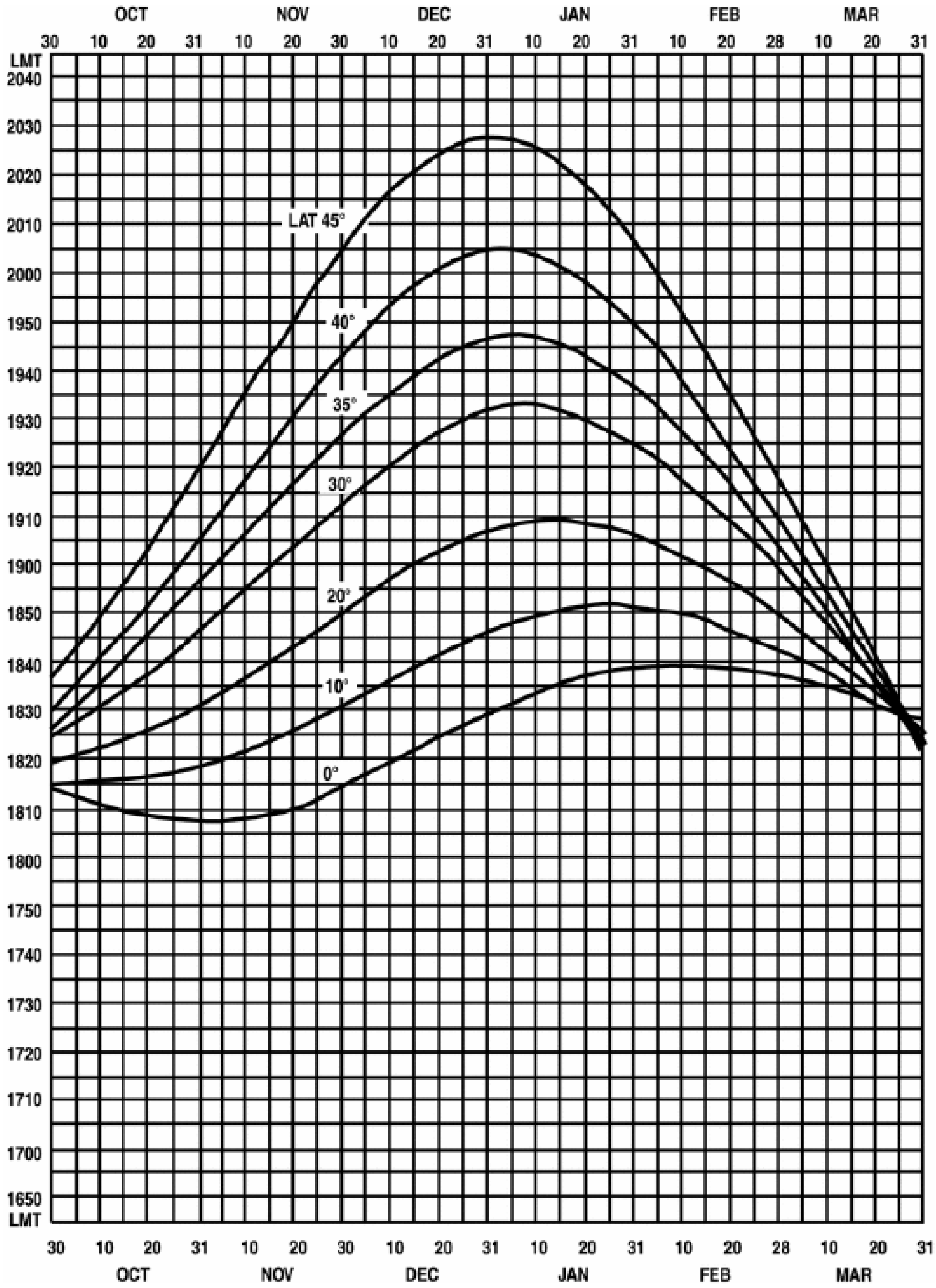
Remember that all flying times, holding periods or curfews should be applied to UTC during any time conversion calculation.

Two examples of the Beginning and End of Daylight graphs, for the time period October to March, can be found below.



Enter the graph with date and latitude (to nearest degree) and extract the LMT for BoD

END OF DAYLIGHT



Enter the graph with date and latitude (to nearest degree) and extract the LMT for EoD.

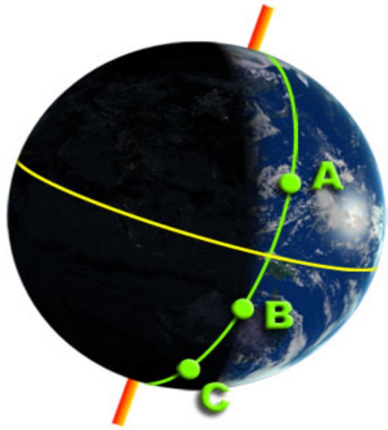
1.10.4 Factors Affecting the LMT of BoD and EoD

Only two factors affect the LMT of BoD or EoD namely: Latitude and Date

The time of Beginning of Daylight and End of Daylight changes with change in latitude as follows:

Places A, B and C all have the same Local Mean time because they are all on the same meridian and:

- 'A' is in daylight.
- 'B' is experiencing the beginning of daylight.
- 'C' is still in darkness.



Even though each place has the exact same LMT, the BoD at 'A' has already happened some time ago, 'B' is experiencing BoD at this time and 'C' will only experience BoD at a future time.

During the summer months in the Southern Hemisphere, places located further south will have longer periods of daylight than places in the north, even if they are on the same meridian. This is caused by the tilt in the earth's spin axis (66½° to the orbital plane) and the planet's South Pole being tilted towards sun during this time of year.

The further south a place is (position 'C') the earlier the BoD time and the later the EoD times will be. The places further north (position 'A') will experience later times for BoD and earlier times for EoD.

This situation will be reversed during the winter months, where places further north (position 'A') will have earlier LMT for BoD and later LMT for EoD than the places located further south (position 'C').

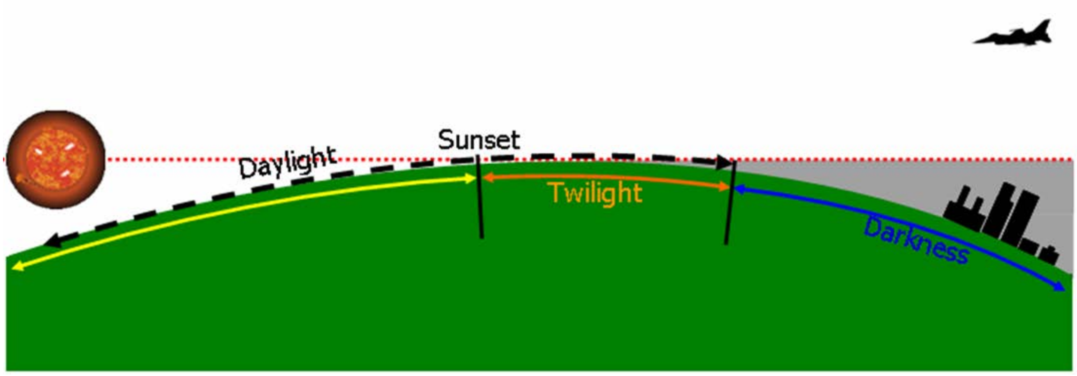
> Therefore only the latitude of the observer and the day of the year will affect the local mean time of beginning and end of daylight.

> The UTC for beginning and end of daylight is affected by the latitude and longitude of the observer, as well as the time of the year.

The beginning of daylight and end of daylight graphs assume a perfect horizon in terms of the LMT given and certain terrain features and/or environmental conditions will cause daylight to begin later and end earlier than the times shown in the beginning and end of daylight graphs. Those factors are:

High ground to the east will cause BoD to be later than the time specified by the graph and high ground to the west will cause EoD to be sooner than the LMT given by the graph.

Altitude can also play a role. An aircraft flying at altitude might still be within daylight and the ground below could already be experiencing the End of Daylight. To the pilot descending for landing at such an airfield it will create the illusion that it's becoming darker much faster than usual. A similar situation could occur in the morning where the ground below the aircraft is still in darkness, yet to experience BoD, and the aircraft is already in daylight.



A VFR pilot (unless night VFR rated) shall not depart from an airport:

- Before first or after last light.
- Unless the pre-flight planned ETA at the destination (or alternate) is at least 10 minutes before last light, after allowing for any required holding. (CASA requirement) Jeppesen - Air Traffic Control - AU504.

1.11 Time Conversions

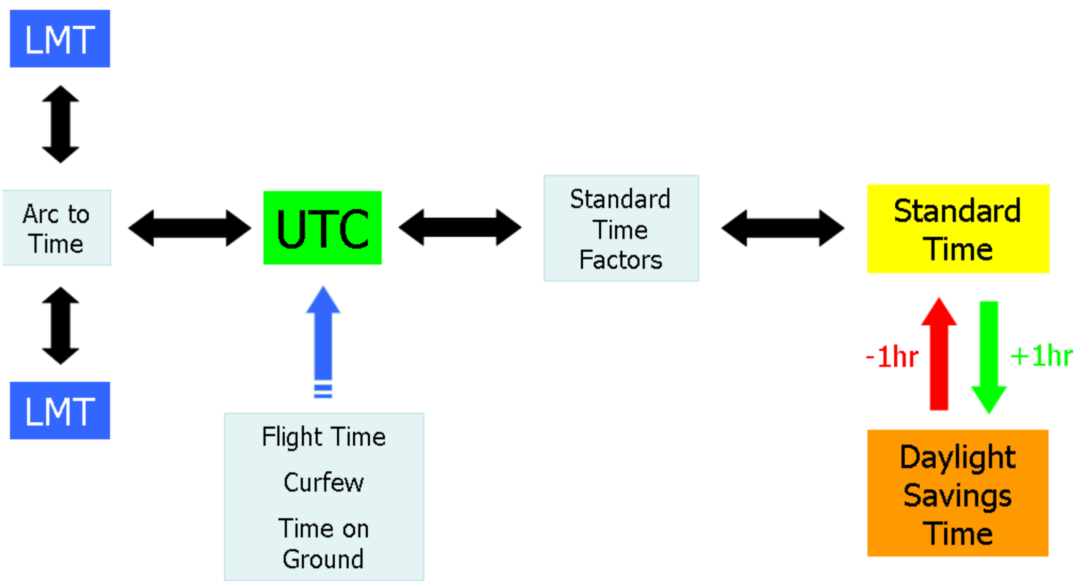
Aviation and associated activities are conducted with reference to UTC, although some phenomena of importance, e.g. sunrise, twilight, etc. are presented in terms of LMT. Meanwhile, the general population regulates all its activities in local standard time or daylight saving time as applicable. The airline pilot operates in all these environments, and so must be proficient in changing from one time reference to another, both quickly and accurately. This requires sound knowledge of the underlying theory, and extensive practice in applying arc-to-time, time-to-arc and standard time conversions.

1.11.1 Technique for Examination Time Problems

UTC truly is 'universal time' for aviation. All times are expressed in UTC, therefore all calculations involving time should be worked in UTC. Always convert LMT or any standard time to UTC, before performing any calculations involving flight time intervals, rest periods, etc. When all calculations are completed, the answer can then be converted into the time standard required by the examiner.

When Doing Time Calculations:

- Write the problems neatly and logically.
- Label every step with date and time format (LMT, UTC or LST).
- Do not work in LMT or LST - change to UTC immediately, especially when applying flight times.



1.12 Worksheet - Time

1. If LMT at X (35°S 100°E) is 0610 on 4 January, UTC is:

   a. 1250 on 4 January

   b. 2330 on 4 January

   c. 2330 on 3 January

   d. 2330 on 5 January.

2. If UTC at Z (65°N 114°W) is 2145 on 3 August, LMT is:

   a. 1409 on 3 August

   b. 0521 on 4 August

   c. 2145 on 3 August

   d. 0736 on 3 August.

3. The LMT at F (46°N 74°E) is 1430 on 16 June, the LMT at G (83°N 117°W) is:

   a. 0934 on 16 June

   b. 1722 on 16 June

   c. 0314 on 17 June

   d. 0146 on 16 June.

4. If UTC at P (13°S 87°E) is 1653 on 11 November, the UTC at R (25°S 125°E) is:

   a. 1653 on 11 November

   b. 1925 on 11 November

   c. 1421 on 11 November

   d. 2241 on 11 November.

5. If UTC at A is 2215 on 31 August, the LMT at B (63°S 106°E) is:

   a. 2215 on 31 August

   b. 0519 on 1 September

   c. 0511 on 31 August

   d. 0511 on 30 August.

6. Universal Coordinated Time (UTC) is:
   a. Eight hours ahead of Western Standard Time
   b. Ten hours behind Eastern Standard Time
   c. Ten hours behind Western Standard Time
   d. Eight hours ahead of Eastern Standard Time.

7. The time equivalent to 150°15' of longitude is:
   a. Ten hours and ten minutes
   b. Eleven hours
   c. Ten hours and one minute
   d. Impossible to calculate without stating east or west.

8. At 200130 EST the CST, WST and UTC respectively are:
   a. 200100, 192330 and 191530
   b. 200100, 200330 and 201130
   c. 200000, 192300 and 191530
   d. 192400, 200330 and 201130.

9. Beginning of Daylight on 30 November at 35° South is:
   a. 0410 UTC
   b. 0410 LMT
   c. 1927 LMT
   d. 1925 UTC.

10. You wish to depart Jandakot W.A. (32°06'S 115°53'E) three hours before end of daylight on 25 January. The end of daylight at Jandakot on 25 January is:
   a. 211133 UTC
   b. 251933 WST
   c. 250850 UTC
   d. 251150 UTC.

11. You plan to depart Adelaide (34°57'S, 138°32'E) 75 minutes after BoD on 10 December, ETD Adelaide would therefore be:

    a. 091856 UTC

    b. 091955 UTC

    c. 092011 UTC

    d. 100410 UTC.

12. You plan to depart Mudgee for Bankstown 30 minutes after beginning of daylight on 10 June, ETD Mudgee would therefore be:

    a. 100630 UTC

    b. 092103 EST

    c. 100703 EST

    d. 100633 EST.

13. You plan to arrive at Parkes thirty minutes before end of daylight on 31 August. The last light at Parkes on 31 August is:

    a. 311086 UTC

    b. 311836 UTC

    c. 310843 UTC

    d. 310813 UTC

14. You plan to depart Hoxton Park (33°54.6’S 150°51.1’E) on 25 May, and arrive at Hay (34°34’S 144°49.8’E) 50 minutes before end of daylight. If you allow 3 hours and 10 minutes for the flight, the latest time you may depart Hoxton Park is:

    a. 251750 EST

    b. 251350 EST

    c. 250350 EST

    d. 252339 EST.

15. What is the difference in the LMT in Belgrade (44°50’N 20°18'E) and Liverpool (53°20’N 02°55'W)?

    a. 1 hour 33 minutes

    b. 2 hours 24 minutes

    c. 0 hours 34 minutes

    d. 1 hour 10 minutes.

16. Find the LMT in Tokyo, Japan (35°35'N 140°E) if the ST is 1425 hours on 16 January. Standard Time in Japan is UTC + 9:

    a. 1405 16 January

    b. 2005 15 January

    c. 0845 17 January

    d. 1445 16 January.

17. Find the ST in Fairbanks, Alaska (64°50'N 148°W) if the LMT is 0614 hours on 18 February. Standard Time Fairbanks, Alaska, USA is UTC – 9:

    a. 0106 19 February

    b. 0706 18 February

    c. 1122 17 February

    d. 0522 18 February.

18. Find the LMT in Vancouver, British Columbia (49°11'N 122°W) if the ST is 0008 hours on 4 March. Standard Time Vancouver, British Columbia is UTC – 8:

    a. 0016 4 March

    b. 0800 3 March

    c. Midnight 4 March

    d. 1616 4 March.

19. On which of the following dates will there be the earliest UTC of the beginning of daylight at Parafield?

    a. 15 March

    b. 19 June

    c. 12 September

    d. 25 December.

20. On which of the following dates will there be the longest period of daylight at Tokyo (35°33'N 139°46'E)?

    a. 21 March

    b. 22 June

    c. 23 September

    d. 22 December.

21. Which of the following places would have the latest LMT of beginning of daylight on 22 December?

    a. Seoul (37°26'N 127°07'E)

    b. Muscat (23°38'N 58°33'E)

    c. Helsinki (60°19'N 24°58'E)

    d. Salalah (17°02'N 54°06'E).

22. Which place would have the latest LMT of end of daylight on the 22 June?

    a. Balikpapan (01°16'S 116°54'E)

    b. Bandung (06°54'S 107°35'E)

    c. Broome (17°57'S 122°14'E)

    d. Buenos Aires (34°34'S 058°25'W).

23. You are planning a VFR flight on 15 February from Broken Hill (32°00'S 141°28'E) to Port Lincoln (34°36'S 135°53'E). Port Lincoln requires an alternate and you nominate Adelaide (34°57'S 138°32'E). Adelaide requires 30 minutes holding.

    Flight times are as follows:

    Broken Hill to Port Lincoln - 2 hours 25 minutes

    Port Lincoln to Adelaide - 40 minutes

    Calculate the latest UTC time of departure from Broken Hill in accordance with visual flight rules:

    a. 0635

    b. 1607

    c. 0624

    d. 1538.

24. Sunrise in Mandalay, Burma (21°56'N 096°08'E) occurs at 0545 LMT on 8 September. Standard Time Burma is UTC+6Hrs 30Mins. What is the Standard Time of sunrise?

    a. 0550

    b. 1215

    c. 1840

    d. 1650.

25. What is the period of daylight available for a flight from Tennant Creek (S19°38' E134°11') to Cairns (S16°53' E145°45') on 20 December?
    a. 14hrs 51mins
    b. 13hrs 19mins
    c. 14hrs 05mins
    d. 13hrs 55mins

26. What amount of daylight is available for a flight from Parafield, SA (S34°47.6' E138°38') to Tamworth, NSW (S31°05' E150°50.8') on 10 January?
    a. 14hrs 21mins
    b. 8hrs 51mins
    c. 9hrs 39mins
    d. 13hrs 33mins

1.12.1 Worksheet Answers

1C	11C	21C
2A	12C	22A
3D	13D	23C
4A	14B	24A
5B	15A	25B
6B	16D	26A
7C	17B	
8A	18C	
9B	19D	
10D	20B	