

Time

- Year* The period of time in which the earth makes one complete orbit around the Sun.

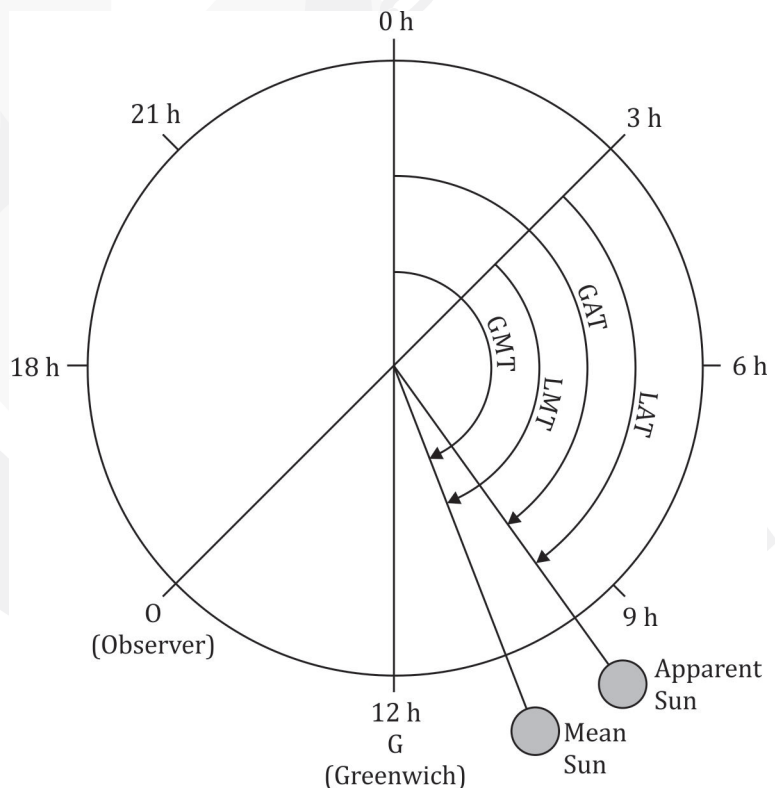
- Day* The period of time in which the earth makes one complete rotation on its own axis.

- Apparent Solar Day* The period of time of two successive transits of the Sun over the same meridian. Due to the changing of inclination of the earth's equator throughout the year, the apparent solar day is not constant.

- Mean Solar Day* The average of a large number of apparent solar days, or the period of time of two successive transits of the Mean Sun over the same meridian, and equal to 24 hrs.

- Sidereal Day* The period of time of two successive transits of a star over the same meridian, and equal to 23 hr 56 min 04 sec of Mean Time.

- Lunar Day* The period of time of two successive transits of the Moon over the same meridian. It is variable, but the average is 24 hr 50 min of Mean Time.



Greenwich Apparent Time (G.A.T) The westerly hour angle of the Apparent Sun (True Sun), measured from the lower brand of the Greenwich Meridian.

Local Apparent Time (L.A.T.) The westerly hour angle of the Apparent Sun measured from the lower brand of the observer's meridian.

Greenwich Mean Time (G.M.T.) The westerly hour angle of the fictitious Mean Sun from the lower brand of the Greenwich meridian. In the Nautical Almanac, GMT is referred as U.T. (Universal Time).

Local Mean Time (L.M.T.) The westerly hour angle of the fictitious Mean Sun from the lower brand of the observer's meridian.

GMT and UT Calculation Formula

$$GMT = UT = \frac{GHA_{(Mean\ Sun)}}{15} + 12$$

If UT is greater than 24 hours, then subtract 24 hours

Zone Time

The earth is divided into 24 zones, each 15° of longitude wide. The time of each zone is the LMT of the middle meridian. Starting from the Greenwich Meridian, which extends from 7½°E to 7½°W, as zone 0, then, depending whether the zone is on the western or eastern longitude, it will indicate (+) or (-) for obtaining the UT. The zone +12 and zone -12 in the same area extends from 172½°W to 172½°E. The zone number can be found by converting the longitude into time, and will be the nearest whole hour.

Zone number = Longitude in time rounded up to nearest time

*If east longitude, then zone number is negative (-);
If west longitude, then zone number is positive (+)*

The longitude can be converted into time by using the "Conversion of Arc to Time" table in the Nautical Almanac, or by calculating the movement of the sun at 15° per hour, as follows:

$$\text{Longitude in time} = \frac{\text{Longitude}}{15^\circ}$$

Example 1 Find the zone number of longitudes 62°51'W, 69°12'W, 45°36'E, 164°54'E:

$$\text{Longitude in time} = \frac{62^\circ 51'}{15^\circ} = 4^h 11^m 24^s \quad \therefore \text{Zone number} = +4$$

$$\text{Longitude in time} = \frac{69^\circ 12'}{15^\circ} = 4^h 36^m 48^s \quad \therefore \text{Zone number} = +5$$

$$\text{Longitude in time} = \frac{45^\circ 36'}{15^\circ} = 3^h 02^m 24^s \quad \therefore \text{Zone number} = -3$$

$$\text{Longitude in time} = \frac{164^\circ 54'}{15^\circ} = 10^h 59^m 36^s \quad \therefore \text{Zone number} = -11$$

Calculate the Universal Time and Zone Time

$$UT = LMT \begin{matrix} -(E) \text{ Longitude in time} \\ +(W) \text{ Longitude in time} \end{matrix} \quad ZT = UT \begin{matrix} +(E) \text{ Zone Number} \\ -(W) \text{ Zone Number} \end{matrix}$$

Example 2 Find UT and ZT if the Local Mean Time on 25th of March is 0730 at longitude 65°45'E:

$$\text{Longitude in time} = \frac{\text{Longitude}}{15^\circ} = \frac{65^\circ 45'}{15^\circ} = 4^h 23^m$$

$$\therefore \text{Zone number} = -4$$

$$\begin{aligned} UT &= LMT - (E) \text{ Longitude in time} & ZT &= UT + (E) \text{ Zone Number} \\ &= 25^d 07^h 30^m - 04^h 23^m & &= 25^d 03^h 07^m + 4 \\ &= 25^d 03^h 07^m & &= 25^d 07^h 07^m \end{aligned}$$

Example 3 Find UT and ZT if the Local Mean Time on 29th of July is 0530 at longitude 164°15'E:

$$\text{Longitude in time} = \frac{\text{Longitude}}{15^\circ} = \frac{164^\circ 15'}{15^\circ} = 10^h 57^m$$

$$\therefore \text{Zone number} = -11$$

$$\begin{aligned} UT &= LMT - (E) \text{ Longitude in time} & ZT &= UT + (E) \text{ Zone Number} \\ &= 29^d 05^h 30^m - 10^h 57^m & &= 28^d 18^h 33^m + 11 \\ &= 28^d 29^h 30^m - 10^h 57^m & &= 28^d 29^h 33^m \\ &= 28^d 18^h 33^m & &= 29^d 05^h 33^m \end{aligned}$$

The time is expressed in the format of date, hour and minute, e.g., 29^d05^h30^m; when subtracting the time in the above case, 05^h30^m is smaller than 10^h57^m, so we have to subtract one day, which equals 24 hours, then add to the hour to become 29^h30^m, to make calculation easier.

Example 4 Find UT and ZT if the Local Mean Time on 15th of August is 15:30 hrs at longitude 50°20'W:

$$\text{Longitude in time} = \frac{\text{Longitude}}{15^\circ} = \frac{50^\circ 20'}{15^\circ} = 3^h 21^m$$

$$\therefore \text{Zone number} = +3$$

$$\begin{aligned} UT &= LMT + (W) \text{ Longitude in time} & ZT &= UT - (W) \text{ Zone Number} \\ &= 15^d 15^h 30^m + 3^h 21^m & &= 15^d 18^h 51^m - 3 \\ &= 15^d 18^h 51^m & &= 15^d 15^h 51^m \end{aligned}$$

Example 5 Find UT and ZT if the Local Mean Time on 4th of October is 18:25 hrs at longitude 150°50'W:

$$\text{Longitude in time} = \frac{\text{Longitude}}{15^\circ} = \frac{150^\circ 50'}{15^\circ} = 10^h 03^m$$

$$\therefore \text{Zone Number} = +10$$

$\begin{aligned} \text{UT} &= \text{LMT} + (\text{W}) \text{Longitude in time} \\ &= 4^d 18^h 25^m + 10^h 03^m \\ &= 4^d 28^h 28^m \\ &= 5^d 04^h 28^m \end{aligned}$	$\begin{aligned} \text{ZT} &= \text{UT} - (\text{W}) \text{Zone Number} \\ &= 5^d 04^h 28^m - 10 \\ &= 4^d 28^h 28^m - 10 \\ &= 4^d 18^h 28^m \end{aligned}$
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Example 6 Your vessel is conducting survey works in Indian Ocean which keeps zone -5. Your company in Singapore (Zone -8) requires making telephone contact daily at 0900 of Singapore time. What is the ship's time when you should make the call daily?

ZT _{Singapore}	0900	
ZN _{Singapore}	<u> -8</u>	(Zone-8)
UT	0100	
ZN _{Ship}	<u> +5</u>	(Zone-5)
ZT _{Ship}	0600	

The ship should make the call at 0600 of ship's time in the same day

Example 7 Your vessel is in the Atlantic near Nova Scotia, Canada. The ship keeps the zone time +4. The ship has a problem with DP system and you wish to speak with a manufacturer's technician in Norway (zone -1) at 0830 Norway local time. What is the ship's time when you should make the call?

ZT _{Norway}	0830	
ZN _{Norway}	<u> -1</u>	(Zone-1)
UT	0730	
ZN _{Ship}	<u> -4</u>	(Zone +4)
ZT _{Ship}	0330	

You should make the call at 0330 (ship's time) on the same day.