After studying this lesson, you can get a good understanding of,
★ the difference in time in various countries.
★ the reasons for the difference.
★ standard time using time zones.
★ the time in other countries using Greenwich Meridian.
★ how the day is changed.
★ the International Date Line.

"My son, we just reached Singapore after a 4 hour flight. We are advised by the airport authorities to change the time in our watches according to the time here".

★ A telephone message to a son, from a father who has gone on a foreign tour.

"The match between Sri Lanka and West Indies for the C.B. trophy in the triangular tournament would commence at 1000 h at the National stadium of Trinidad in West Indies. Sri Lankans will be given the opportunity to watch the opening of the match, live at 1930 h."

★ A television News

From the two statements above, you can understand that there is a difference in the times at the same moment in different countries. What is the reason for this?

We have learnt that the Earth is spherical in shape and also it is inclined by $23\frac{1}{2}^\circ$ to the vertical. You can see this when you observe the model of the globe in the school. The Earth rotates from West to East about its own axis. The Earth gets day and night as a result of this. You also know that it takes one day which is 24 hours to rotate one round about its own axis.

21.1 Latitudes and Longitudes

It is convenient to explain the globe by separating the globe into two sections namely, the Northern hemisphere and the Southern hemisphere. The North pole is in the Northern hemisphere and the South pole is in the Southern hemisphere. The
imaginary line which separates the Northern hemisphere and Southern hemisphere which is equidistant from the North pole and the South pole is the equator. The imaginary lines drawn parallel to the equator are latitudes. The imaginary lines drawn from the North pole to the South pole perpendicular to the equator are longitudes. They are also known as meridians.

The longitude passing through Greenwich in England is the Greenwich Meridian, and is considered as the $0^\circ$ longitude.

In the next page globe the longitudes are marked as $0^\circ, 20^\circ, 40^\circ$ ..... from the Greenwich Meridian, to the West and East as Western longitudes and Eastern longitudes respectively.

The time taken by the Earth to rotate one round around its own axis is $360^\circ$

\[
\begin{align*}
\text{Time taken to rotate through } 1^\circ &= 01 \text{ Day} \\
&= 24 \text{ h} \\
&= 24 \times 60 \text{ Minutes} \\
&= \frac{24 \times 60}{360^\circ} = 4 \text{ Minutes}
\end{align*}
\]

\[
\therefore \text{The number of longitudes which it passes through 1 hour} = \frac{360^\circ}{24} = 15^\circ
\]
Relationship Between Longitudes and Time Zones.
The change of time within $1^\circ$ is 04 minutes. 
The time taken to pass through longitude $15^\circ$ is 01 hour.

When comparing with the time on the Greenwich Meridian, for every degree to the East of it the time is increased by 4 minutes and to the West, the time is decreased by 4 minutes. This happens because the Earth rotates from the West to the East and the sun rises first to the East.

21.2 Local Time

The time in any country of the world when considered based on the longitude on which it is situated starting from the Greenwich Meridian is called the local time.

Sri Lanka is situated on $80^\circ$ longitude. Let us find the time in Colombo when the time in Greenwich is 0600 h.

\[
\begin{align*}
\text{Time for } 15^\circ & = 01 \text{ hour} \\
\therefore \text{Time different for } 80^\circ & = \frac{80}{15} \text{ hours} \\
& = 5 \frac{5}{15} \text{ hours} \\
& = 5 \text{ hours} 20 \text{ minutes}
\end{align*}
\]

\[
\begin{align*}
\frac{5}{15} \text{ h} & = \frac{5}{15} \times 60^4 \text{ minutes} \\
& = 20 \text{ minutes}
\end{align*}
\]

Since Colombo is situated to the East of Greenwich Meridian the time difference should be added to the time in Greenwich.

The local time in Colombo = 0600 h + 5 h 20 minutes = 1120 h

Batticaloa in Sri Lanka is situated on $81^\circ$ East longitude. When the Greenwich time is 0600 h, the local time in Batticaloa will be 1124 h. This can be found by the same method.

Here we can see that in the same country, there can be different local times according to the different longitudes. This will be a problem for administrative work in a country. To avoid this situation, the globe is divided into time zones. The countries within a time zone use a standard time as an accepted rule.
21.3 Time Zones

The longitude passing through Greenwich is considered as the $0^\circ$ longitude, and the shaded part of $15^\circ$ indicated by $\frac{7^\circ}{2}$ West and $\frac{1^\circ}{2}$ East of the Greenwich Line is considered as the zero time zone. From this time zone, $15^\circ$ longitude zones to the East are positive time zones and are denoted by $+1$, $+2$, $+3$, $\ldots$. Time zones to the West of the zero time zone, are negative time zones and are denoted by $-1$, $-2$, $-3$, $\ldots$. With the help of the given diagram, we will see how the $12^{th}$ zone is formed after the $11^{th}$ zone.

International date line (IDL)

In the $12^{th}$ zone, the half $\frac{7^\circ}{2}$ to the East is considered as $(+12)$ time zone and the half $\frac{1^\circ}{2}$ to the West is considered as $(-12)$ time zone. Those zones are based on the $180^\circ$ longitude and this $180^\circ$ longitude is called the International Date Line - IDL.
The region in between two longitudes of 15° is called a time zone. As the time taken by the Earth to rotate through 15° is 1 hour, the difference between two time zones is 1 hour.

The countries within a time zone use a uniform time as an accepted rule. When finding the time in any country according to its zone, 1 hour should be added to every zone to the East and 1 hour should be subtracted to every zone to the West.

Sri Lanka belongs to Madras sub zone which is \( +\frac{1}{2} \) hour. Hence time in Sri Lanka is \( +\frac{1}{2} \) hours ahead of Greenwich time.

**Example 1**

When the time in Greenwich is (i) 0000 h  (ii) 0600 h (iii) 1200 h (iv) 1800 h

Find the time in Sri Lanka which is in the \( +\frac{1}{2} \) time zone.

\( +\frac{1}{2} \) hours should be added to Greenwich time which is in the zero time zone.

Then,

<table>
<thead>
<tr>
<th>Greenwich time</th>
<th>Sri Lanka time</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) 0000 h</td>
<td>0530 h</td>
</tr>
<tr>
<td>(ii) 0600 h</td>
<td>1130 h</td>
</tr>
<tr>
<td>(iii) 1200 h</td>
<td>1730 h</td>
</tr>
<tr>
<td>(iv) 1800 h</td>
<td>2330 h</td>
</tr>
</tbody>
</table>
Example 2

What is the time in Greenwich, when the time in Sri Lanka is 2200h? (Sri Lanka is situated in the time zone $+5\frac{1}{2}$.)

The Greenwich town which is situated in the 0 time zone in the West of Sri Lanka. Therefore $+5\frac{1}{2}$ hours should be subtracted.

$\therefore$ Greenwich time when the time in Sri Lanka is 2200h = $2200 \text{ h} - 0530 \text{h}$

= 1630 h

Activity 21.1

Complete the table given below.

<table>
<thead>
<tr>
<th>Country</th>
<th>Time zone to which the country belongs</th>
<th>Time in that country</th>
<th>Greenwich time</th>
<th>Sri Lanka time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pakistan</td>
<td>+5</td>
<td>1000 h</td>
<td>1000 h</td>
<td>1000 h</td>
</tr>
<tr>
<td>America (Chicago)</td>
<td>−6</td>
<td>0200 h</td>
<td>0200 h</td>
<td>0200 h</td>
</tr>
<tr>
<td>America (Boston)</td>
<td></td>
<td>0100h</td>
<td>0600 h</td>
<td>0600 h</td>
</tr>
<tr>
<td>Australia (Melbourne)</td>
<td>+10</td>
<td>1700 h</td>
<td></td>
<td>1700 h</td>
</tr>
<tr>
<td>Australia (Canberra)</td>
<td></td>
<td>2000 h</td>
<td>2000 h</td>
<td>2000 h</td>
</tr>
<tr>
<td>Malaysia (Kuala Lampur)</td>
<td>+ 8</td>
<td>2000 h</td>
<td>2000 h</td>
<td>2000 h</td>
</tr>
<tr>
<td>Ethiopia (Adis Ababa)</td>
<td>+3</td>
<td>0300 h</td>
<td>0300 h</td>
<td>0300 h</td>
</tr>
</tbody>
</table>

Exercise 21.1

(1) Out of the given statements, mark the correct statements as "✓" and the incorrect statements as "✗".

(i) 0° longitude is the Greenwich Meridian.
(ii) The time difference between two adjacent time zones is one hour.
(iii) When the time in Greenwich is 1700 h, the time in Sri Lanka is 1130 h.
(iv) The time zones are used because of the necessity of having the same time in one country.
(v) In the continent of Australia, every city has the same time.

(2) Sri Lanka is situated in the $+\frac{5}{2}$ time zone. Complete the given table accordingly.

<table>
<thead>
<tr>
<th>Time in Sri Lanka</th>
<th>------</th>
<th>0730 h</th>
<th>------</th>
<th>2000 h</th>
<th>2359 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenwich time</td>
<td>0000 h</td>
<td>------</td>
<td>1000 h</td>
<td>------</td>
<td>------</td>
</tr>
</tbody>
</table>

(3) Boston in America is in (-5) time zone. When the time in this town is 1000 h, find the time in
(i) Greenwich.
(ii) Sri Lanka.

(4) Singapore is in (+8) time zone and West Indies Islands are in (-4) time zone.
(i) When the time in Singapore is 2000 h, what is the time in
   (a) Greenwich?
   (b) West Indies Islands?
(ii) When the time in West Indies is 1000 h, what is the time in
    (a) Sri Lanka?
    (b) Singapore?

21.4 Change of the day with the time

(i) **Dawn of a new day**

Let us inquire the way how the time in Sri Lanka is found when the time in Greenwich is 2200 h on 28-04-08, that is 10.00 in the night.

Greenwich is in zero time zone and Sri Lanka is in $+\frac{5}{2}$ time zone. Since Sri Lanka is situated to the East of Greenwich, Time in Sri Lanka is obtained by adding $5\frac{1}{2}$ hours to Greenwich time.

Greenwich time = 2200 h on 28-04-08

Sri Lankan time = 2200 h + 5h 30 minutes.

= 2730 h

= 2400 h + 0330 h
2730 h means, $3\frac{1}{2}$ hours after dawn of another new day.

Then the time in Sri Lanka is 0330 h on 29-04-08. Similarly, we will calculate the time in Greenwich when the time in Sri Lanka is 0200 h on 2008.01.14. The difference in time is $+5\frac{1}{2}$ hours. Since Greenwich is situated to the West of Sri Lanka, $5\frac{1}{2}$ hour should be subtracted.

When 2 hours is subtracted from 0200 h, we get 0000 h, that gives the dawn of 2008.01.14 when another $3\frac{1}{2}$ is subtracted the time will be 2030 h on 2008.01.13. Accordingly, when the time in Sri Lanka is 0200 h on 2008.01.14 the time in Greenwich is 2030 h on 2008.01.13.

(ii) **Passing the International date line.**

When Greenwich mean time is 0600 h on Monday 5th May 2008, the accepted time in different countries are as shown above.
180° longitude is the mid line of 12th zone. It passes over the sea avoiding land. We already know that this is called IDL. The countries on either side of this line has a difference of one day. Countries on the East side are one day ahead of the countries on the West side.

**Example** - When a plane travelling from Australia to America passing the International Date line at 0600h on 2008.03.25, the time is 0600h on 2008.03.24.

**Exercise 21.2**

(1) Complete the table using the data given regarding time zones.

(The time zone of each country in the world is included at the end of this book.)

<table>
<thead>
<tr>
<th>Time zone</th>
<th>-8</th>
<th>-6</th>
<th>-4</th>
<th>-2</th>
<th>0</th>
<th>+2</th>
<th>+4</th>
<th>+6</th>
<th>+11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td></td>
<td></td>
<td>1800 h</td>
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</table>

(2) The town, Saint Lucia in West Indies is in the (-4) time zone. A cricket match between Sri Lanka and West Indies was over at 1800 h West Indies time on 27-03-2008. Find the moment of time at which the match was over,

(i) in Greenwich time.
(ii) in Sri Lanka time along with the day.

(3) Find the time and the day in Chicago when the time in Sri Lanka is 0730 h on 01-05-2008.

(4) Find the time and the day in Dacca in Bangladesh when the time in Sri Lanka is 0730 h on 23-10-2008.

(5) Manila in Philippines is situated in the (+8) time zone. A plane leaves to Manila from Katunayaka air port at 0800 h. When it reached Manila the time in Manila was 1300 h.

(i) What is the time in Manila, when the plane left Katunayaka?
(ii) How long was the journey?
(iii) When the plane reached Manila, what was the time in Sri Lanka?
(6) Complete the table given below when the Greenwich time on 30-04-2008 is 0600 h. Include day and time in each time zone.

<table>
<thead>
<tr>
<th>Time zone</th>
<th>-10</th>
<th>-9</th>
<th>-8</th>
<th>-7</th>
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<tbody>
<tr>
<td>Day</td>
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<td>Time</td>
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<table>
<thead>
<tr>
<th>IDL</th>
<th>+7</th>
<th>+8</th>
<th>+9</th>
<th>+10</th>
<th>+11</th>
<th>+12</th>
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Summary

★ The longitude 0° passing through Greenwich in England is the Greenwich Meridian.
★ The time in other countries in the world is formed according to the time in Greenwich where the Greenwich Meridian is.
★ Each time zone has an area included by 15° longitudes.
★ The time difference between two adjoining time zones is 1 hour.
★ Sri Lanka is situated in the time zone $+5\frac{1}{2}$ and is $5\frac{1}{2}$ hours ahead of Greenwich time.
★ From the Greenwich Meridian, for the countries in the West 1 hour is subtracted for each zone while for the countries in the East 1 hour is added to each zone.
★ There are two instances where the day also changes with the time.
★ The dawn of a new day and passing the International date line are the instances where the day too changes with the time according to the Greenwich time.