

# 1. LOCAL TIME AND STANDARD TIME



## Let's recall.

- Why does the duration of day and night keep changing?
- How many longitudes can be drawn on a world map keeping an interval of  $1^\circ$  each?
- The apparent movement of the sun from east to west is a result of what?
- What is the direction of the rotation of the earth?
- While the earth rotates, how many longitudes face the sun daily?
- At which longitude does the date change?
- How was time measured in olden days?
- In present times, what are the instruments used for time measurement?

## Geographical explanation

We get up early in the morning, brush our teeth and take a bath. Then we have breakfast and go to school. We study in our classrooms. We return home. We go to the playground to play in the evening. We have dinner; brush our teeth and go to sleep. We keep doing similar activities throughout the day. Considering our daily routine, we need to decide the time for all our activities.

In olden days, people used to take the help of various tools and also depend on various natural events for the measurement of time. On the basis of observation and experience, they divided the day into the following parts: from sunrise to sunset, **daytime** and from the sunset to the next sunrise **nighttime**. A whole day meant the duration from one sunrise to the next. Earlier, natural events and instruments like Ghatikapaatra (a bowl with a minute hole at its base which would float in a large water filled

vessel.); sand timer, etc. were used to tell time.

The Earth takes 24 hours i.e. one day to complete one rotation. We consider the direction where the sun rises to be the east. Thus, the Earth rotates from west to east. As a result we experience, sunrise, noon, sunset and midnight. During rotation, the longitudes in the western part face the sun gradually while those in the east experience darkness. The longitude which faces the sun experiences sunrise while, on the other hand, the one in the darkness experiences sunset.

While travelling in a bus, we often see trees, electric poles, buildings, etc outside the window. They appear to be moving in the opposite direction. Actually, they are stationary and our bus is moving forward. Similarly, because of the rotation of the earth, we feel that the sun is changing its position from east to west daily.



## Try this.

Perform this activity in the kho-kho ground on a bright sunny day. Consider the following points:

- ✓ Choose one pole on the ground that stays under the sun for the whole day for this activity.
- ✓ Observe the directions in which the

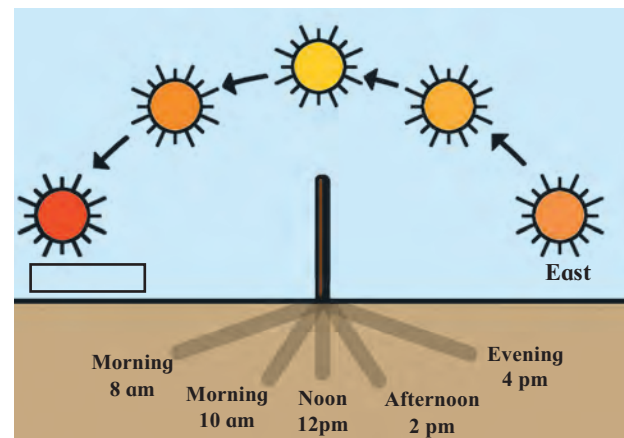


Figure 1.1: The different locations of the sun during the day and changes occurring in the shadow

shadow of this pole falls at different times of the day.

- ✓ Measure the shadows and record in your notebooks.
- ✓ Note the relative directions of the shadows and the sun in your notebook. (Fig 1.1)
- ✓ Where is the sun located in the sky when the shadow is the shortest?
- ✓ At what times are the shadows longest during the day?

### Geographical explanation

You would have realized by observation that the shadows in the early morning and evening were the longest while those at the noon were the shortest. Because of the change in the apparent location of the sun in the sky, the length and direction of the shadow of the pole kept changing. See figure 1.1. This is because a specific part of the earth faces the sun during rotation and moves forward. See figure 1.2. Incidentally, we also experience that it is cooler in the morning and evening and warmer in the afternoon.

### LOCAL TIME :

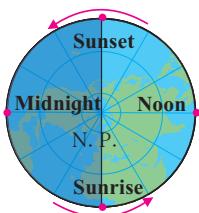


Figure 1.2 : Rotation and the relative location of the sun

As soon as the sun starts moving up in the sky after sunrise, the length of our shadow reduces. Normally, the length of the shadow is shortest at noon. As the sun moves towards the horizon in the afternoon, the length of our shadow increases again by evening. The noon time is the same at any given longitude across the earth i.e. from the North Pole to the South Pole. The time of a place as decided by the location of the sun in the sky, is known as its **local time**.

In the regions lying in between the polar circles and the poles, the daytime could be more

than 24 hours depending upon the season. As a result, understanding the timings of sunrise, noon, sunset and midnight at these places becomes important. At the poles, the daytime and the duration of the day lasts around 6 months. To tell the time of sunrise or sunset at the poles, one has to consider the date. When the sun rises on a specific day, it moves around the horizon and therefore, here, the length of the shadow cannot be considered for telling the noon time.



### Think about it.

- At the poles, sunrise occurs on one equinox and sun sets on the next equinox. If you happen to be at any of the poles during this time, then what would be the route of the sun in the daytime?
- On which day, would the sun appear at the highest point in the sky?

Different longitudes have different timing for sunrise, noon and sunset. When it is noon at Mumbai, it wouldn't be the same at Kolkata. Because Kolkata lies to the east of Mumbai, it would already be afternoon in Kolkata.

The local time of a place on the earth's surface is determined with reference to its noon time. This implies that places lying on the same longitude have the same local time. There is no difficulty when local time is used for a small



### Always remember -

- The earth takes almost 24 hours to complete one rotation (  $360^\circ$  ).
- The earth rotates by  $360^\circ / 24 \text{ hours} = 15^\circ$  in one hour around its own axis.
- The earth takes 60 minutes / 15 degrees = 4 minutes to cover  $1^\circ$
- This means that for each degree of longitude, the local time differs by 4 minutes.

area. When people living in a larger area across different longitudes have to interact with each other, then using the local time could lead to chaos and confusion. In such cases, using the local time is not convenient.



### Try this.

The local time of a place can be calculated with reference to the time at the Prime Meridian. Examine the examples given below.

#### Example 1 :

Mashad, a town in Iran, is located on the  $60^\circ$  E longitude. When it is 12 noon at Greenwich, calculate the local time of Mashad town.

**Statement :** As we move towards the east of the Prime Meridian, the local time increases by 4 minutes for every longitude.

The difference between the longitudes of Greenwich and Mashad

$$= 60^\circ$$

$$\text{Difference in local time} = 60 \times 4$$

$$= 240 \text{ minutes}$$

$$= 240 \div 60 \text{ minutes}$$

$$= 4 \text{ hours}$$

This implies that the time at Mashad would be \_\_\_\_\_ in the \_\_\_\_\_.

#### Example 2 :

Manaus city in Brazil is located on  $60^\circ$  W longitude. What would be the local time at Manaus when it is 12 noon at Greenwich?

**Statement :** -----  
-----

The difference in longitudes between the two places :

$$= \boxed{\phantom{000}}$$

$$\text{Total difference in time} = \boxed{\phantom{00}} \times \boxed{\phantom{00}}$$

$$= \boxed{\phantom{00}} \text{ minutes}$$

$$= \boxed{\phantom{00}} \div 60 \text{ minutes}$$

$$= \boxed{\phantom{00}} \text{ hours}$$

As Manaus is located to the \_\_\_\_\_ of Greenwich, the local time of Greenwich is ----- of Greenwich time by ----- hours. And, therefore, when it is noon at Greenwich, it would be ----- at Manaus.



### Can you tell ?

We have studied that the local time is different in different parts of the world. The daily routine of the people there, is determined according to the local time in those places. Figure 1.3 shows the local times of different longitudes. Study this map and answer the following questions. Use the relation between degrees and time for this.

- Between which longitudes does the region experience daytime?
- Which longitudes experience noon and midnight respectively?
- Edward from New Orleans is on which longitude?
- What is the time at Accra city?
- At the same time, what is Sharad from Patna and Yakaito from Japan doing? What time is it in these cities?
- Select any one longitude. Calculate the local time of the longitudes lying  $1^\circ$  to the west and east of this longitude.



### Think about it.

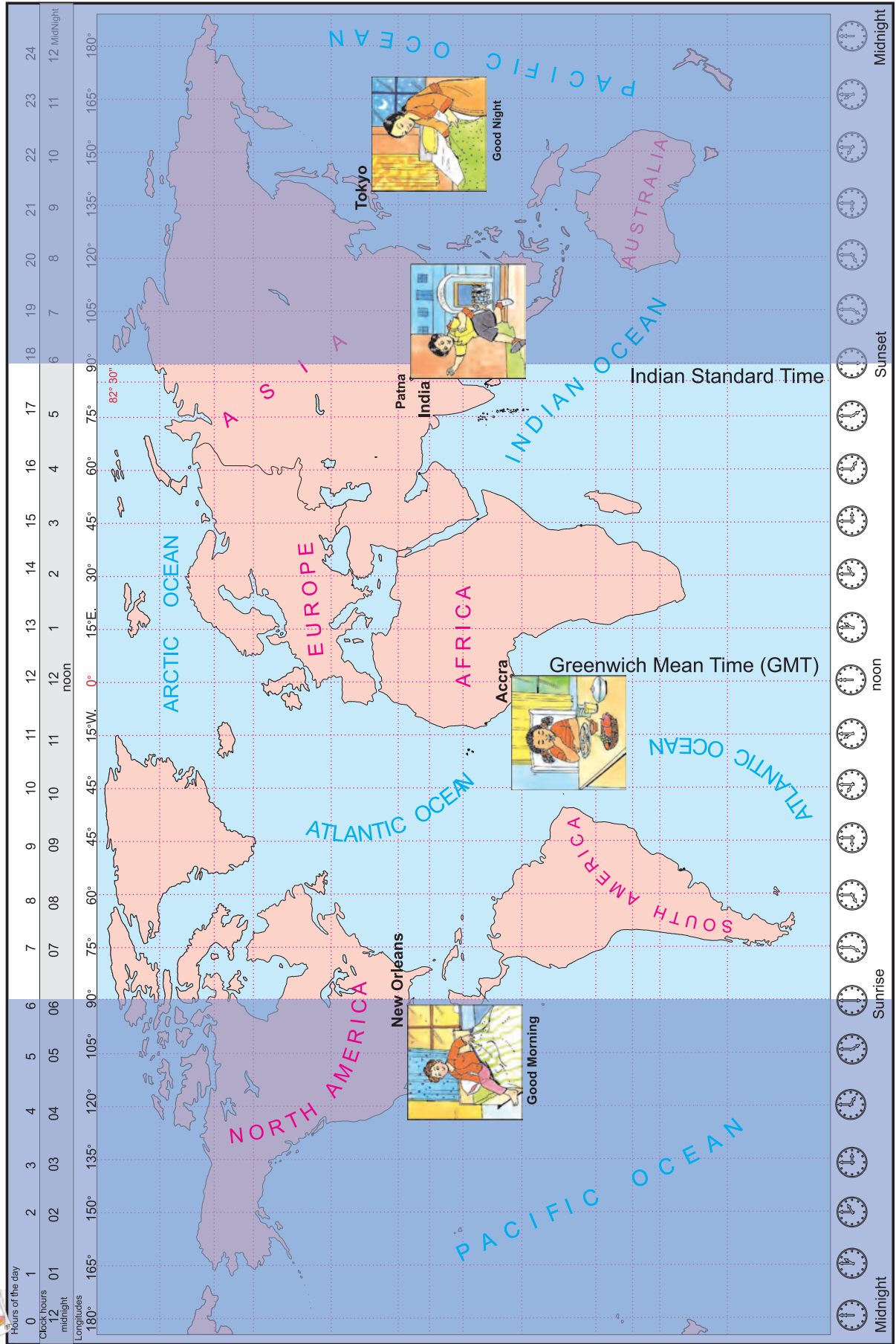
- What is the maximum number of local times that can there be in the world?
- How many longitudes pass the sun in one hour?



### Do you know ?

When the sun is directly overhead at a place on the earth, it is noon over there. While telling the time between midnight and noon, we put a.m. in front of the time. This means Ante Meridiem. When the longitudes cross the noon time, then the time is past midday or afternoon. The time in between noon and midnight is denoted by p.m. means Post Meridiem.

**Make friends with maps!**



**Figure 1.3**



### Use your brain power!

➤ Tick ✓ the time in the boxes which you can tell without using clock.

- Sunrise
- Sunset
- Noon
- Midnight

### Geographical explanation

- Longitudes lying to the east of any longitude are ahead of the time at that longitude while those lying to the west are behind.
- As the distance between two longitudes increase, their local times also starts differing.
- If we multiply the difference between longitudes in degrees by 4 minutes, then the difference in the respective local times can be calculated.
- The difference in longitudes can be known with the help of a globe or map.

Carry out the activity given on Page 75 and 76 and understand the standard time of various locations. See if you can find out the standard time at two opposite longitudes with this activity?

### STANDARD TIME :



#### Can you tell?

- Mumbai is located at  $73^{\circ}$  E longitude. Kolkata is located at  $88^{\circ}$  E longitude. Find the difference between the longitudes of these two cities.
- If the local time at Mumbai is 3 pm then what would be the local time at Kolkata?

### Geographical explanation

Both Mumbai and Kolkata are located within India but on different longitudes. Their local times differ by an hour.

If there are different local times within a country because of longitudinal differences,

then there will be a lack of synchronization in the routine activities in the country. If each one follows their local time, discrepancies emerge in carrying out daily business in the country. Therefore, generally, the local time at the longitude which generally passes through the middle of the country is deemed to be the standard time for that country. This standard time is used all over the country.

With respect to businesses at global level, there should be compatibility between the standard times of various countries. To facilitate this, the world has been divided into 24 time zones. These time zones have been created with reference to the Prime Meridian itself.

Normally, if the difference between the longitudinal extent of the country is less than one or two hours, only one standard time is considered for the country. But if the longitudinal extent (east-west extent) is more than that, then, one standard time is not enough and in such countries, more than one standard time zones are considered.



#### Give it a try.

Look for the map of world time zones from reference books and see in which time zone India falls into?



#### Find out.

With the help of an atlas find out which countries need more than one standard time

### INDIAN STANDARD TIME :

The Indian Standard Time (IST) has been decided according to the  $82^{\circ} 30'$  E longitude which passes through Mirzapur (near Allahabad, Uttar Pradesh). This longitude passes through the middle of the country with reference to its longitudinal extent. The local time at this longitude has been selected as the standard time of the whole country. When the sun is directly overhead on this longitude, then it is assumed that it is 12 noon everywhere in India. There is no difference of more than one hour between



## Make friends with maps!

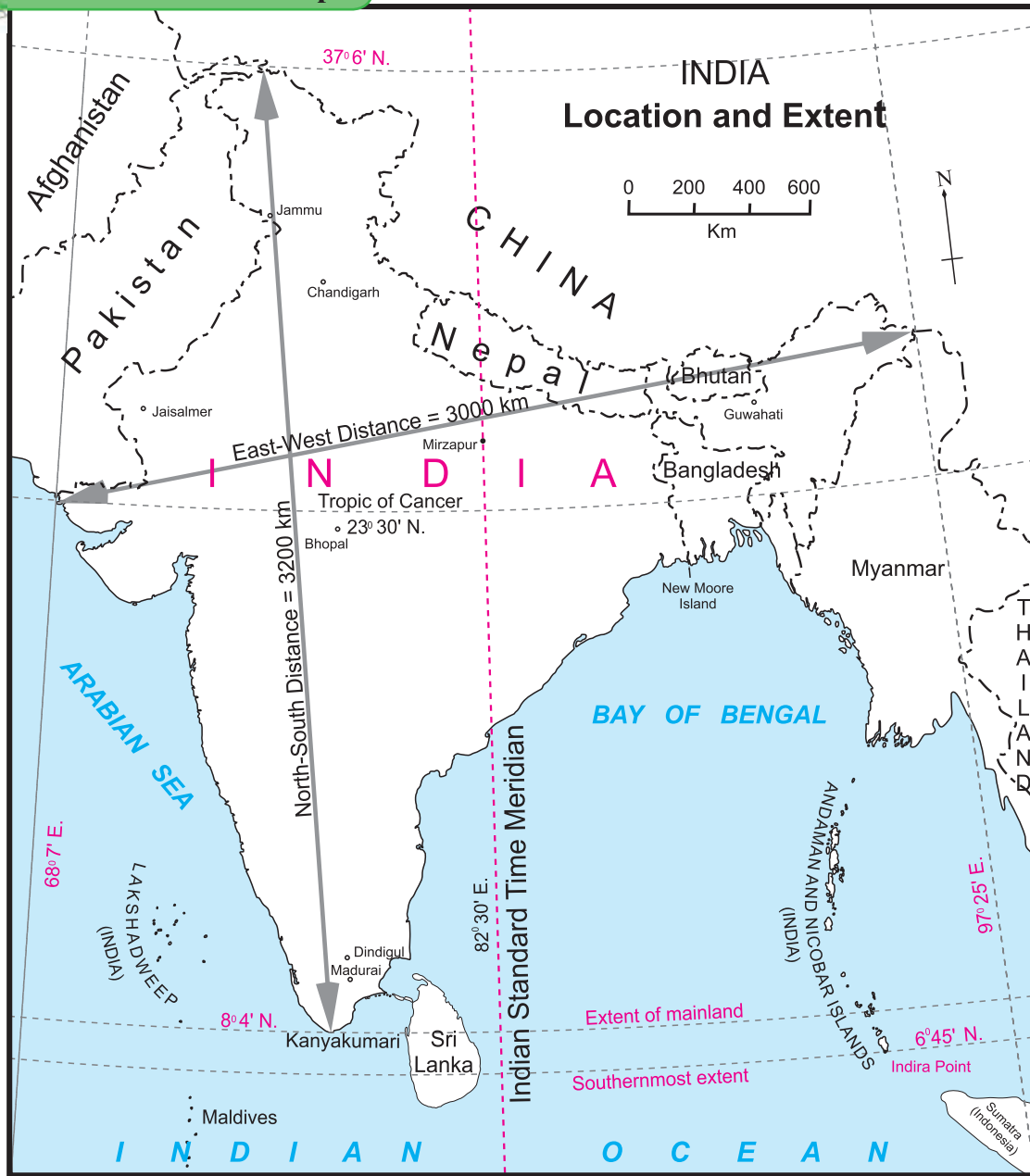


Figure 1.4

the local time at  $82^{\circ} 30'$  and other places in the country.



### Can you tell?

Look at the figure 1.4 and answer the following questions :

- Considering the longitudinal extent of India, how many longitudes with a difference of  $1^{\circ}$  can be drawn on the map?
- By how many minutes do two consecutive longitudes differ?
- What is the value of degrees of longitude at Mirzapur?
- If it is 8 a.m. at  $82^{\circ} 30' E$ , what would be the time in their clocks at the following places?
- Jammu ● Madurai ● Jaisalmer ● Guwahati
- Though the distance between them is more why doesn't the standard time differ in these places?

## Universal Standard Time :

For an international coordination between countries, the local time at Greenwich (Greenwich Mean Time) in England is considered to be the international standard time. The difference in standard times of various countries is calculated with reference to GMT. The Indian Standard Time is 5 hours 30 minutes ahead of GMT. If it is 5 p.m. at Greenwich then in India it would be 10.30 p.m.



### Give it a try.

- If it is 8 a.m. in India, what is the time in Greenwich?
- When it is 2 p.m. in India, in which countries would it be 2 p.m. too?
- When it is 9 a.m. in India, what would be the time at  $82^{\circ} 30' W$  longitude?
- What would be the time at Prime Meridian when a new day starts at  $180^{\circ}$  longitude?



### Do you know ?

National Institute of Standards and Technology (NIST), an institute in the United States of America has developed the most accurate clocks in the world. Clocks have to be adjusted by 1 second (added or subtracted) once in 20 million years.

In India, the National Physical Laboratory of India, (NPL) New Delhi gives services of accurate time-keeping. The clocks used here are accurate up to 1 lakh part of a second.

As accurate time is required for space research, artificial satellite launching, etc., these clocks are used in these activities.



### Do you know ?

#### Jantar-Mantar: Astronomical Observatories

Maharaja Sawai Jaisingh II, the king of Jaipur, Rajasthan, was a great astronomer, mathematician and architect. He built five astronomical observatories called Jantar-Mantar at Ujjain, Varanasi, Jaipur, Delhi and Mathura.

The one at Mathura doesn't exist today but one can visit the other four. Even today, one can know the exact time upto seconds through shadows. Jantar Mantar do not only house sundials, but they are complete astronomical observatories. One can observe the sky from here too.

With the help of instruments at Jantar-Mantar, it is still possible to see astronomical observations. After the advent of modern instruments, now these instruments are more of a 'cultural heritage'.



### Think about it.

- In which of the following countries, does only one standard time exist?
  - Mexico ● Sri Lanka ● New Zealand ● China
- Why does a country having a large latitudinal extent have only one standard time?

## Exercises

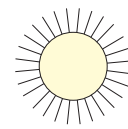
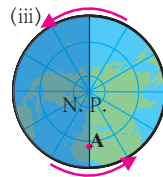
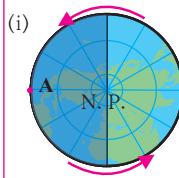
**Q 1. Complete the sentence by selecting the correct option:**

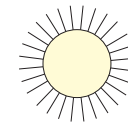
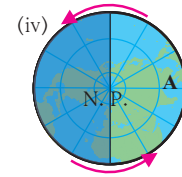
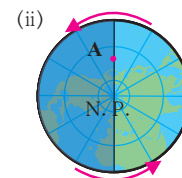
- (a) The earth requires 24 hours for one rotation. In one hour,
- (i) 5 longitudes will face the sun
  - (ii) 10 longitudes will face the sun
  - (iii) 15 longitudes will face the sun
  - (iv) 20 longitudes will face the sun
- (b) To calculate the difference between the local times of any two places on the earth,
- (i) the noon time at both the places should be known
  - (ii) the difference in degrees of their longitudes should be known
  - (iii) the difference in standard times of both the places should be known

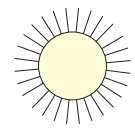
(iv) Changes need to be made according to International Date Line

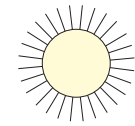
(c) The difference between the local time of any two consecutive longitudes is

- (i) 15 minutes
- (ii) 04 minutes
- (iii) 30 minutes
- (iv) 60 minutes










**Q 2. Give geographical reasons:**

- (a) The local time is decided by the noon time.
- (b) The local time at Greenwich is considered to be the international standard time.
- (c) The standard time of India has been decided by the local time at  $82.5^\circ$  E longitude.
- (d) Canada has 6 different standard times.

**Q 3. Answer in brief:**

- (a) If it is 12 noon at  $60^\circ$  E longitude, then explain what would be the time at  $30^\circ$  W longitude?
- (b) How is the standard time of a place determined?

c) A football match being played at Sao Paulo, Brazil started in India at 6 am IST. Explain what would be the local time at Sao Paulo?

**Q 4. If it is 10 pm on 21<sup>st</sup> June at Prime Meridian, write the dates and time at A, B and C in the table.**

Place	Longitude	Date	Time
A	$120^\circ$ E		
B	$160^\circ$ W		
C	$60^\circ$ E		

**Q 5. Write the situations of place A shown in these diagrams in the boxes below them :**

- (i) Sunrise (ii) midnight (iii) noon (iv) Sunset

**Activity:**

- (a) Look for the actual granny's clock in Shri Acharya Atre's poem : "Aajiche Ghadyal " ( granny's clock). Look for this poem on the internet or in reference books.
- (b) Find out the velocity of the earth's rotation in km/ hour.

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