CHAPTER 2

Geographic Grid: Latitudes and Longitudes

Syllabus

Geographic Grid: Latitudes and Longitudes

(a) *Concept of latitudes: main latitudes, their location with degrees, parallels of latitude and their uses.*

(b) *Concept of longitudes — Prime Meridian, time (local, standard and time zones, Greenwich Mean Time (GMT) and International Date Line (IDL). Eastern and Western hemisphere.*

(c) *Using latitudes and longitudes to find location. Calculation of time.*

(d) *Great Circles and their use.*

The earth's surface is so vast that unless a mathematical method is used, it is impossible to locate a place on it. For this reason, imaginary lines are drawn on the globe. The lines running east to west, parallel to the Equator, are called *lines of latitude*. The lines running north to south passing through the poles are called *lines of longitude*. The intersection of latitudes and longitudes pinpoint a place on the earth's surface. These criss-crossing lines form a framework known as the ***Geographic Grid***.

Eratosthenes, the Greek philosopher, who had for the first time calculated the circumference of the earth, had devised lines of latitude and longitude to locate places on the earth.

This *grid* on the globe or the map serves the same purpose as the system of *coordinates* on the *x*-axis and *y*-axis on a graph paper. In this case the *x*-axis is represented by lines of latitude (horizontal) and *y*-axis, by lines of longitude (vertical).

LINES OF LATITUDE

- *Lines of Latitude are the imaginary lines joining all places having the same latitude towards* ***north or south of the Equator.***
- A latitude is the angular distance of a place north or south of the Equator.
- A latitude is marked in degrees, with Equator being 0 degrees.
- Latitudes are calculated according to the angle a place makes with the centre of the earth.
- Since the lines of latitude are parallel to the Equator and each other, they are called *parallels of latitude.*
- Each parallel of latitude is a full circle. However, only the Equator is a Great Circle.

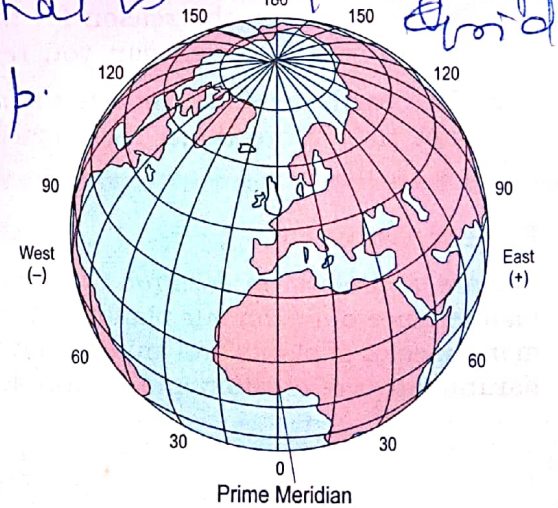

Fig. 2.1. The Geographic Grid

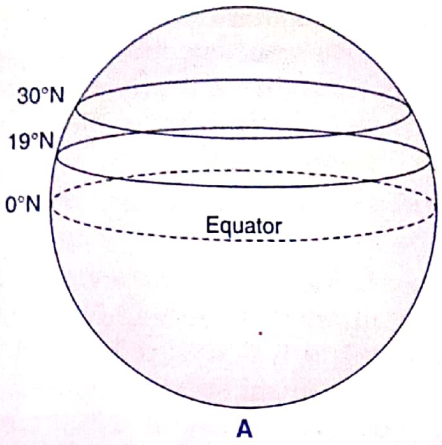

Fig. 2.2. (a) Latitude degrees are measured from the Equator to its north or south

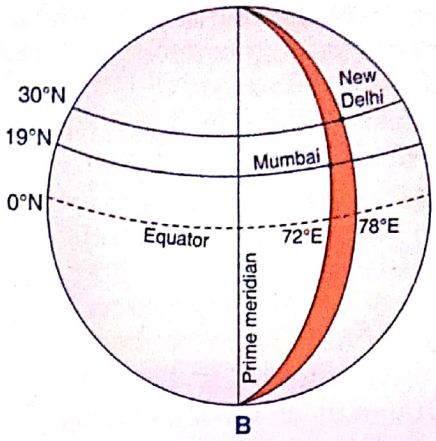

Fig. 2.2. (b) Longitude degrees are measured from the Prime meridian to its east or west

- The lines of latitude are not of equal length and become smaller as we move towards the poles. At 60° latitude, in each hemisphere the length of the circle is half the length of the Equator. At the poles these lines are just points or dots.

Main Latitudes

There are 181 parallels of latitude at 1° interval.

- **Equator** is the longest line of latitude. It represents 0° latitude.
- **The North Pole** (90° N) is located at an angular distance of 90° north of the Equator.
- **The South Pole** is located at an angular distance of 90° south of the Equator.
- **The Tropic of Cancer** (23½°N) is a line of latitude located 23½° north of the Equator.
- **The Tropic of Capricorn** (23½°S) is a line of latitude located (23½°S) south of the Equator.
- **The Arctic Circle** represents 66½°N latitude. The Arctic Circle marks the limit of the north polar region surrounding the North Pole.
- **The Antarctic Circle** represents 66½°S latitude. The Antarctic Circle marks the limit of the south polar region around the South Pole.

Northern and Southern Hemisphere

The Equator that runs midway between the poles divides the earth into two equal hemispheres known as the *Northern Hemisphere* and the *Southern Hemisphere.*

The Poles—North Pole and South Pole—are opposite to each other at the extreme ends of the sphere. They are each located at 90° angular distance north or south of the Equator.

The length of the Equator is equal to the circumference of the earth or 40,075 km. Since the circumference of a circle is equal to 360°, the 1° angular distance is roughly equal to 111 km.

Uses of Latitudes

The lines of latitude form one of the coordinates of the grid system. The lines of latitude have the following uses:

To find the location of a Place: Latitudes give us the location of a place north or south of the Equator. Such a location is known as an *absolute location.*

To measure the distance of a Place: Distances are calculated with reference to the Equator at right angle to the place. We can therefore, measure the distance of any place from the Equator based on its degree of latitude. For example, the latitude

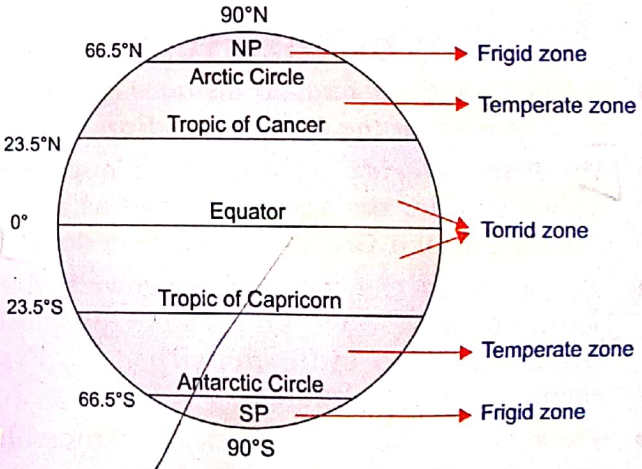

Fig. 2.3. Important Parallels of Latitudes

of Mumbai is 19°N and that of New Delhi is 30°N. We know that 1° latitude = 111 km. We can say that Mumbai is 2109 km (111 × 19°) away from Equator. Similarly, New Delhi is 3,330 km (111 × 30°) away from Equator.

Heat Zones: Besides helping us to locate places on maps and charts, lines of latitude divide the earth into distinct *heat belts*. The lines of latitude indicate the general climate of the area by applying the principle of heat zones or thermal zones of the earth. Thus, latitudes enable us to divide the whole earth into different climatic zones.

- **The Torrid or Tropical Zone:** The area lying between the Tropic of Cancer (23½°N) and Tropic of Capricorn (23½°S) mark the limits of the *Torrid* (meaning very hot) *Zone*. It is also called the *Tropical Zone*. It is the hottest zone of the earth.
- **The Temperate Zones:** Two other important lines of latitude based on temperature are the *Arctic Circle* (66½°N) and the *Antarctic Circle* (66½°S). Between the Arctic Circle and the Tropic of Cancer as well as between the Antarctic Circle and the Tropic of Capricorn lie the two *Temperate Zones* — the North Temperate (23½°N to 66½°N) and the South Temperate zones (23½°S to 66½°S). In this region, the climate is moderate, i.e., neither too hot nor too cold.
- **The Frigid Zones:** Between the Arctic Circle and the North Pole and between the Antarctic Circle and the South Pole are the two *Frigid Zones* of the earth. These are the polar regions and receive the sun's slanting rays. In these two zones, very low temperatures are recorded.

LINES OF LONGITUDE

- *A longitude is the angular distance of a place east or west of the* ***Prime Meridian.***
- The ***Prime Meridian*** is the line of longitude whose angular distance is defined as 0°. It passes through Greenwich near London.
- The lines to the west of Greenwich are suffixed with °'W' and those east of Greenwich are suffixed with °'E'. For example 60°W and 60°E.
- There are a total of 360 lines at 1° interval.
- The lines of longitude are also called *Meridians of Longitude*. 'Meridian' is derived from the Latin word *meridianum'* meaning noon. The sun crosses a meridian at noon. All places on a particular meridian will have noon at the same time.
- All meridians of longitude converge at the poles and are thus of equal length.
- The Prime Meridian is numbered as 0°. The others are numbered between 0° to 180°E or W. The line 180°E and W refer to the same meridian. It is diametrically opposite to the 0° longitude. Thus 0° and 180° meridian together make a full circle round the earth. Proceeding at 1° interval from both East and West, other full circles will be 1°– 179°, 2°–178°, 60°– 120° and so on. Of the two lines in any segment, one will be in the east and the other in the west. The sum total of two lines will always be 180°. Individually all lines of longitude are semicircles.
- The two diametrically opposite lines make a full circle also known as the *Great Circle*.
- The distance between two lines of longitude is maximum at the Equator (111 km). The distance decreases gradually as one moves towards the poles.

LONGITUDE AND TIME

The lines of longitude, as stated earlier, are also known as the 'Meridians'. At a particular moment of time, if it is 12 Noon at a given longitude, it must be 12 Noon at all places on this longitude.

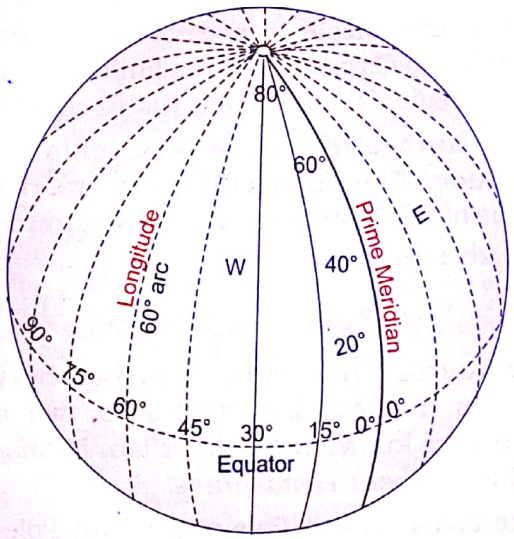

Fig. 2.4. Lines of Longitude

There are total of 181 parallels of latitude at 1° interval

There are 360° lines at 1° interval

Difference between Lines of Latitude and Lines of Longitude

Latitude	Longitude
1. A latitude is the angular distance of a place north or south of the Equator.	1. A longitude is the angular distance of a place east or west of the Prime Meridian.
2. Lines of Latitude are parallel to the Equator and each other.	2. All meridians of longitude converge at the poles.
3. Each parallel of latitude is a full circle. The lines of latitude are not of equal length and become smaller on moving towards the poles.	3. Individually all lines of longitude are semicircles and of equal length.
4. Latitude degrees are measured from the Equator to its north or south.	4. Longitude degrees are measured from the Prime meridian to its east or west.
5. The distance between two lines of latitude is approximately 111 km.	5. The distance between two lines of longitude is maximum at the Equator, i.e., 111 km, but it goes on decreasing on moving towards the poles. It is 0° at the poles.
6. Lines of latitude are used to find the location of a place, to measure the distance of a place and to divide the whole earth into different heat or climatic zones.	6. Lines of longitude are used to find the local and standard time of a place. Along with the lines of latitude, the longitudes are used to locate places on the globe or a map.

The Earth makes a complete circle on its axis—it covers 360° longitudes in 24 hours. That is to say, it covers every 15° longitudes in one hour or 1° longitude every 4 minutes. Thus, if it is 12 Noon at 0° longitude, it must be 4 minutes past 12 Noon towards the east at the next 1°E longitude or at 15°E longitude it must be 1 p.m. Towards the west, it will be 1 hour less because the Earth rotates from West to East as the sun first rises in the East. *For the purpose of memorising, EGA-WLS formula is used. EGA stands for East-Gain-Add and WLS means West-Lose-Subtract.* This in other words means that for each 1° longitude towards the East, 4 minutes are to be added and each 1° longitude towards the West, 4 minutes are to be subtracted.

Eastern and Western Hemisphere

The Prime Meridian, together with the 180° longitude usually divides the earth into *the Eastern* and *Western Hemispheres.* This division holds good practically for all purposes. However, any two diametrically opposite lines can also divide the earth into two equal hemispheres.

LOCAL TIME

The ***local time*** of any place is obtained by the overhead sun at noon. For each degree of longitude, the local time varies by 4 minutes. For example, the longitude of Mumbai is 73°E and that of New Delhi is 77°E. If it is 12 Noon at Mumbai (73°E) it must be 16 minutes past 12 Noon at New Delhi at the same time (77°E – 73°E = 4° longitude difference. 1° longitude = 4 minutes 4° longitude = 16 minutes which is to be added because Delhi lies to the east of Mumbai). This means that there will be a huge time difference between Gujarat in the west and Assam in the east. Every place at a different longitude will have its own local time.

TIME ZONES AND STANDARD TIME

Time Zones

To overcome the confusion while allowing the interplay of natural forces to operate, the earth has been divided into *24 Time Zones* according to the number of hours in a day. Each zone covers 15° longitude (360 ÷ 24). The time for the whole zone is determined on the basis of the central meridian of that place. While countries with smaller east-west extent like India have only one Standard Time Zone, countries like Russia, Canada, USA have more than one Time Zones.

Standard Time

The uniform time based on a central meridian is

known as the ***Standard Time.*** *Standard time must always be divisible by 7½°.* This allows time to be reckoned by a unit of half-an-hour and not smaller differences.

Greenwich Mean Time

Further, while fixing the Time Zones, the time at Greenwich (0° longitude) has been selected as *the mean* time. Thus, if it is 12 Noon at Greenwich, at 15°E longitude, the time will be 1 pm and at 30°E longitude, the time will be 2 pm. The time fixed with reference to Greenwich is called *the Greenwich Mean Time* or *GMT.*

Indian Standard Time (IST)

In our country, 82°30'E is the central meridian. It passes through Mirzapur near Allahabad (Prayagraj). It is known as the *Standard Meridian of India.* While fixing the Indian Standard Time with respect to the Greenwich Mean Time, we have to add 82°30'× 4 minutes = 330 minutes or 5½ hours. This means that India is 5½ hours ahead of GMT. Thus if it is 9 AM at London it must be 9 + 5.30 or 14.30 hrs or 2.30 PM in India.

Worked Out Example for calculating the Time at a place

Example: It is 5.30 p.m. in India when the Prime Minister's radio broadcast made from Montreal in Canada was heard. What must have been the time at Montreal?

Solution 1: After consulting the atlas we find Montreal lies 74°W.

Time in India = 1730 hrs (5:30 PM)
∵ India is ahead of GMT = 5 hrs 30 m
∴ Time at Greenwich = 1200 hrs. (noon)
∴ Montreal Time difference with respect to GMT
= 296 min. (74 × 4 min.)
= 4 hours 56 minutes
Montreal is to the west of GMT, its time
= 12 hrs – 4 hours 56 min.
= 7:04 a.m.

Solution 2: Standard Meridian of India = 82½°E
Standard Meridian of Montreal = 74°W
Total meridians = 156½°
Meridian = 4 minutes
156½ ° meridian = 626 minutes (156½° ×4)
= 10 hrs 26 minutes

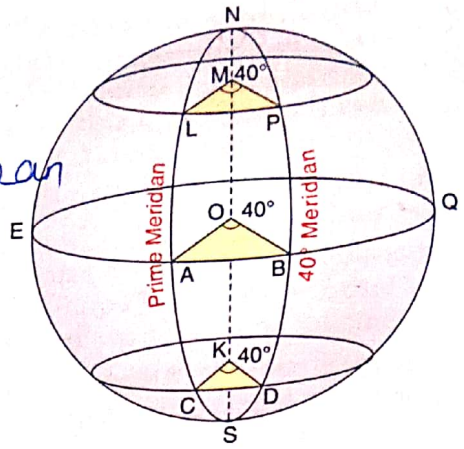

Fig. 2.5. Places on the same longitude have the same time — Places K, O and M have each 40° longitude. If it is 12 noon at K, it will also be 12 noon at O and M

Montreal is to the west of Delhi, therefore, time difference will be deducted = 1730 hrs – 1026 hrs = 7.04 a.m. in Montreal.

∴ The Prime Minister made his broadcast at 7.04 AM from Montreal which was received at 5.30 p.m. in India.

INTERNATIONAL DATE LINE

The line of longitude 180° is one and the same for East or West of the Prime Meridian. Since it is diametrically opposite to the Greenwich Meridian it causes a time difference of a full day on crossing the line. The time difference works out to 12 hours (180° × 4 min) from either side. Thus, on crossing the line, a day is gained or lost. When crossing from the east, time will be

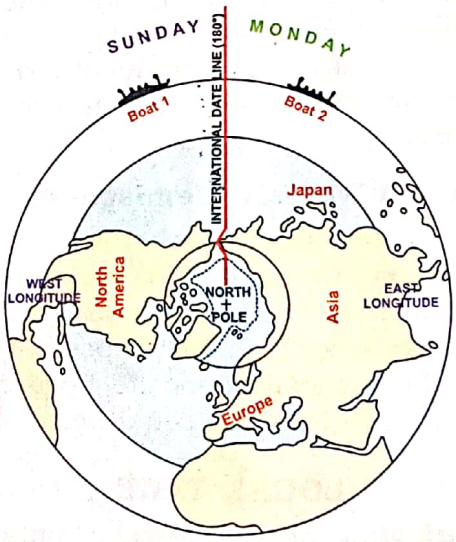

Fig. 2.6. The International Date Line

12 hours ahead and while crossing from the west time will be 12 hours behind. If it is 8 PM Monday, 25th December at Greenwich, it will be 8 AM Tuesday, 26th December on crossing the 180° line. But if one were to travel from the west, it will be 12 hours behind or 8 AM Monday, 25th December. When the time lost and gained is computed together, the difference works out to full 24 hours at 180°E and W. (In the above example, the difference between 8 AM Monday 25th December and 8 AM Tuesday 26th December is 24 hours.)

The *International Date Line* (IDL) is the 180° line. When crossing this date line the date changes. See Fig. 2.6. The boat 1 on the left is sailing to the right, that is eastwards. When crossing the International Date Line Sunday becomes Monday, so that a day is lost. When the boat 2 on the right (which is sailing westwards) crosses the International Date Line Monday becomes Sunday, so that a day is gained.

To avoid the confusion of having different dates within the same country, the Date Line bends and goes zig-zag at the Bering Strait between Siberia and Alaska and at Fiji, Tonga, New Zealand and some other Islands.

LOCATING PLACES

With the help of the grid, we can locate places on the globe or the map, if we know the latitude and longitude of these places.

Worked Out Examples

The latitude and longitude of three places is given below. Pinpoint these places on the globe.

(i) New York = Latitude 41°N and Longitude 74°W

(ii) New Delhi = 30°N and 77°E

(iii) Mumbai = 19°N and 73°E

First look at the data of New York. It is a common practice to write first the latitude and then the longitude of a place. For locating the above, identify the relevant latitudes and longitudes. Where the two lines meet, or the point at which they cross each other, lies the place which is to be located.

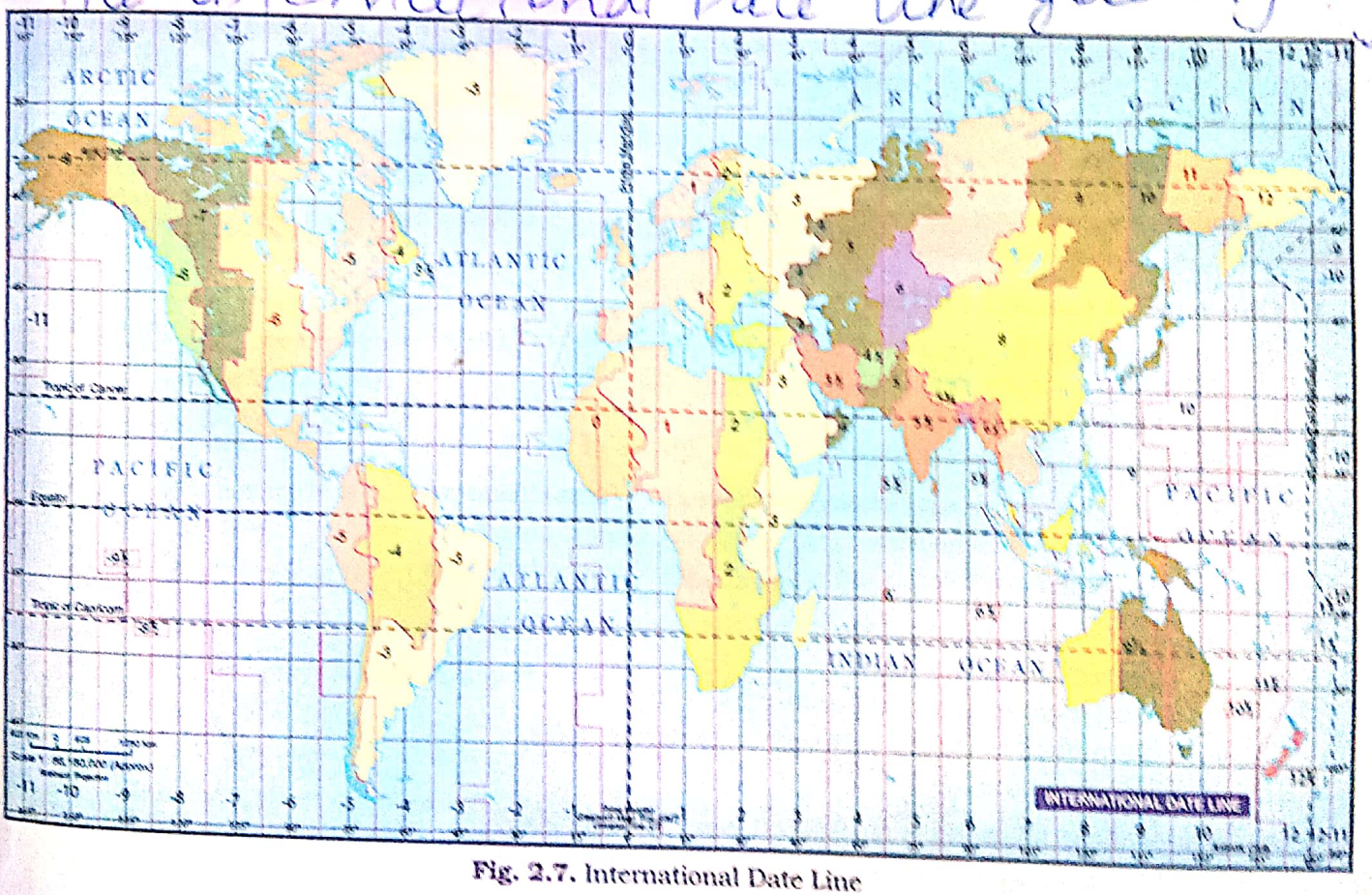

Fig. 2.7. International Date Line

GREAT AND SMALL CIRCLES

A great circle is a circle that is drawn on the surface of a sphere (such as the earth) that has a radius equal to the radius of the sphere, and whose centre is also the sphere's centre. The Equator is the only latitude that is a great circle. All longitudes are a part of a great circle.

Circles which do not pass through the centre of the earth are the small circles. All the parallels of latitudes other than the Equator are small circles. Arcs of great circles are the shortest route between two points on a sphere.

Characteristics of a Great Circle

(i) A great circle is a theoretical circle formed by the intersection of the earth's surface and an imaginary plane that passes through the centre of the earth and divides it into two equal parts.

(ii) All such circles must pass through or touch the centre of the circle.

(iii) Infinite number of circles that touch the two opposite ends of the sphere can be drawn on a sphere.

(iv) Intersecting great circles always bisect each other.

In respect of characteristic (i) above, the Equator is the largest possible circle among lines of the latitude. The Equator and all diametrically opposite longitudes touch the centre of a circle and therefore are Great Circles.

Characteristic (iii) excludes all latitudes except the Equator. All the parallels of latitudes are small circles.

Uses of Great Circles

(i) Navigators use great circles to find the shortest distance between any two points on the earth's surface. A *Great Circle Route* is the shortest distance between two places on the earth and lies on the arc of a great circle. Using this hypothesis, the shortest route from New York to Moscow would be over the North Pole. Thus, it does not take into account restrictions such as weather or political restrictions imposed by the countries concerned. It also does not take into account, lack of landing and take off facilities for aeroplanes.

(ii) Great Circle routes are specially important for places that are on opposite sides of the globe. Most globes show great circle routes between distant ports across the Atlantic, the Pacific and the Indian Ocean.

(iii) Great circles are used by meteorologists to determine climate and weather conditions in a region.

EXERCISES

I. Choose the correct option:

1. The imaginary lines running east to west on a globe are called _____ while those running north to south are called _____.
   (a) Latitude, Longitude (b) Longitude, Latitude
   (c) Equator, Prime Meridian (d) All of the above.

2. Name the criss-crossing lines on a globe that form a framework.
   (a) Geographic Framework (b) Geographic Grid
   (c) Geographic Matrix (d) Geographic Lines

3. Which of the following is true about the lines of Latitude?
   (a) They are imaginary lines
   (b) They are parallel to the Equator
   (c) They reduce in length as we go towards the poles.
   (d) All of the above.

4. Which of the following is true about lines of longitude?
   (a) They run parallel to the Prime Meridian.

(b) They are full circles
(c) They are 360 lines at 1° interval.
(d) All of the above.

5. The distance between two lines of longitude is maximum at which latitude?
(a) Tropic of Cancer (b) North Pole (c) Equator (d) Arctic circle

6. The Earth has been divided into how many Time Zones?
(a) 48 (b) 20 (c) 12 (d) 24

7. What is Standard Time?
(a) Uniform time based on a central meridian.
(b) Time at 0° longitude
(c) Time at 82°30'E
(d) Time at 7½° longitudes at 12 noon.

8. Which of the following is true about the International Date Line?
(a) It goes zig-zag at two points. (b) The date changes as one moves across it.
(c) It is opposite the Prime Meridian. (d) All of the above.

9. A great circle is a circle drawn on the surface of a sphere with radius _____.
(a) equal to the radius of the sphere. (b) equal to half the radius of the sphere.
(c) larger than the radius of the sphere. (d) less than the radius of the sphere.

10. Which of the following are great circles?
(a) Lines of Longitudes (b) Lines of Latitudes
(c) Equator (d) Both (a) and (c)

11. In each hemisphere for which latitude the length of the circle is half the length of the Equator?
(a) 30° (b) 45° (c) 60° (d) 90°

12. The total number of the parallels of Latitude are
(a) 180 (b) 182 (c) 183 (d) 181

13. The poles are located at what angular distance from the Equator.
(a) 90° (b) 45° (c) 60° (d) 0°

14. The length of the Equator is equal to:
(a) 40,075 km (b) 40,750 km (c) 40,250 km (d) 40,525 km

15. Which of the following heat zones are correct?
(a) Frigid Zone : 66½°N to 66½°S (b) Temperate Zone : 90°N to 90°S
(c) Torrid Zone : 23½°N to 23½°S (d) All of the above.

II. Short Answer Questions

1. What is a geographic grid? How does the geographic grid serve the same purpose as co-ordinates on a graph?
2. What are lines of latitude and longitude? Who devised the lines of latitude and longitude?
3. Mention two characteristics of lines of latitude.
4. Name the two hemispheres of the earth made by the Equator. Name the thermal zones of the earth.
5. List any two uses of the lines of latitude. Express 1° angular distance in kilometres.
6. With the help of a diagram, show the important lines of latitude.
7. Which line is known as the Prime Meridian? State its importance.

8. How can the general climate of an area be described with the help of the lines of latitude?
9. Which line of longitude is used to fix the World Standard Time? State its value in degrees. State the longitudinal value in degrees of Indian Standard Meridian.
10. List any two characteristics of the Great Circles.
11. List any two uses of the Great Circles.
12. What are the Great Circle Routes? State their importance.

III. Structured Questions

1. (a) State the five lines of latitude.
   (b) What is the significance of these lines of latitude?
   (c) Give a geographical reason for each of the following:
      (i) Lines of latitude are called parallels of latitude.
      (ii) Lines of latitude are not of equal length.
      (iii) Lines of latitude carve out the heat zones of the earth.
   (d) Draw a well labelled diagram showing the different heat zones of the world.
2. (a) Describe the lines of longitude.
   (b) State the use of the lines of longitude in relation to distance and time.
   (c) Give a geographical reason for each of the following:
      (i) Lines of longitude are called meridians of longitude.
      (ii) Lines of longitude are of same length.
      (iii) Diametrically opposite lines of longitude and the Equator are called Great Circles.
   (d) Draw a well labelled diagram to show that places on the same longitude have the same time.
3. (a) State the meaning of the International Date Line.
   (b) State with an example how time lost or gained is computed with reference to the International Date Line.
   (c) Give a geographical reason for each of the following:
      (i) The International Date Line deviates and goes zig-zag near some islands in the Pacific Ocean.
      (ii) The Greenwich time is called the Greenwich Mean Time.
      (iii) Great Circles are the shortest routes between two places.
   (d) State with one practical example how is time of a place found with the help of longitudes.

IV. Time-related Questions:

An Example:

A cricket match was to be held at Birmingham at 9 a.m. local time. The position of Birmingham is 5° W. Calculate the time the viewers have to tune their television in Sydney 151°E.

Answer:

The local time at Birmingham is 9 a.m.

The location of Birmingham is 5° W of Prime Meridian.

The GMT would be 9:20 a.m. [9:00hrs + (5°×4min) = 9:00hrs + 20 min = 9:20 a.m.

Sydney is located at 151°E of Prime Meridian

At any point of time Sydney would be 151 × 4 = 604min = 10hrs 4 min ahead of GMT

(Sydney is to the East of the Prime Meridian so local time would be ahead of GMT)

heat Zones.

When it is 9:20 a.m. GMT the local time at Sydney would be 19:24hrs or 7:24pm (9:20 + 10:04)
In order to watch the Birmingham match at Sydney the viewers would have to tune their televisions at 7:24 p.m. local time.

Answer the following questions:

1. An important programme was to be broadcast from Mumbai at 7:30 p.m. This was heard by some Indian sailors near Ivory Coast in West Africa at 20°W longitude. What was the local time there?
2. What is the longitude of a place where the local time is 1:15 p.m., when it is 4 a.m. at Chicago (88°W)?
3. Calculate the time at Durban (longitude 30°E) when the time is 7:00 a.m. at New York (75°W).
4. Calculate the longitude of a place where the local time is 6:00 a.m., when the time is 9:00 p.m. at New Delhi on longitude 77°E.
5. Calculate the local time at Singapore (104°E) when it is 6:00 p.m. at Greenwich.
6. Calculate the location of a place where the local time is noon when it is 7:30 p.m. at Greenwich.
7. What is the time and day at Mumbai (73°E) when it is Sunday 10:30 p.m. at Shillong (92°E)? Give a reason to support your answer.

⇒ They are remiciely of equal lenght.

V. Thinking Skills

same lenght

1. Find the latitude of your city and state how has this influenced the climate of your city.
2. Your home town is located at a place which receives the slanting rays of the sun. How is the temperature of your home town different from your boarding school, located at a place that receives the vertical rays of the Sun?
3. Find out the name of the country which has the maximum number of time zones in the world. What is reason behind a country having many time zones and others like India have just one time zone.
4. When you were waiting to welcome New Year in India on December 31, some countries of the world like Australia, New Zealand and Japan have already welcomed New Year. What is the reason for this?

VI. Project/Activity

Look at the map of the Time Zones (Fig. 2.7) and answer the following questions:

1. What is the Longitudinal degree of IST _____?
2. If it is 2 a.m. IST what will be the Time at
   Tokyo _____, London _____, San Francisco _____?
3. Name the place which is diametrically opposite of India.
4. Is the Indian Standard Time ahead of San Francisco Time? Give reasons for your answer.

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