CHAPTER 3 Rotation and Revolution

Syllabus

Rotation and Revolution: *Rotation - direction, speed and its effects (occurrence of day and night, the sun rising in the east and setting in the west, Coriolis effect)*

Revolution of the earth and its inclined axis — effects: the variation in the length of the day and night and seasonal changes with Equinoxes and Solstices.

The earth, like all other planets in the Solar System revolves round the sun in an elliptical orbit and it also rotates on its axis. These two motions of the earth are known as *revolution* and *rotation*, respectively. Many phenomena on earth like day and night, seasons, winds and ocean currents depend on these motions.

ROTATION OF THE EARTH

Rotation is the spinning of the earth on its axis from west to east once in 24 hours. The axis is the imaginary line passing through the centre of the earth as it does on the globe. The two end points through which the axis passes are known as the North Pole and the South Pole. The axis is tilted at an angle of 23½° from the vertical. This means that if a line were drawn parallel to the plane of the earth's orbit, the axis would make an angle of 66½° to this line as shown in Fig. 3.1.

Characteristics of Rotation

1. **Direction:** The earth completes one rotation from west to east on its axis in 23 hours, 56 minutes, 4.09 seconds (roughly in 24 hours).
2. **Inclination of Axis:** The earth is always tilted in the same direction (towards the Pole Star) as it moves round the sun. *The angle at which the earth is tilted is known as the* ***inclination of the earth's axis.***
3. **Speed:** The speed of earth's rotation at the Equator is 1670 km per hour (circumference of the earth is 40,075 km, which is covered in 24 hours). The speed decreases towards the poles.

Effects of the Rotation of the Earth

1. **Occurrence of Day and Night** are caused by the rotation of the earth on its axis. This

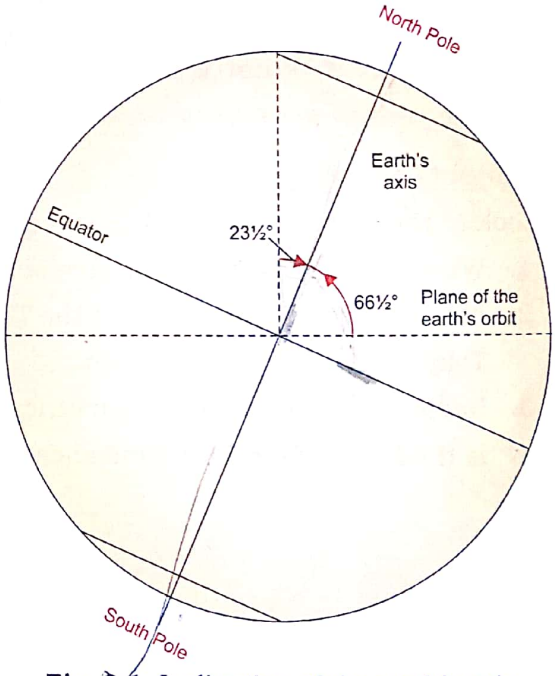

Fig. 3.1. Inclination of the earth's axis

is because parts of the earth which face the sun have ***day*** and the parts which do not face the sun have ***night***. This happens with precision and progression and not suddenly. The time when the sun begins to cast its light in the sky is known as *dawn*. At noon, the sun is overhead. At *dusk*, it is twilight and the sun is seen disappearing in the sky. At night, it is completely dark. Duration of the day and night is not equal at all places on the earth because of the inclined axis. The length of days varies with respect to the seasons as well as latitude.

2. **Sunrise and Sunset** are caused by the rotation of the earth from west to east. This happens because due to the earth's rotation, every part of the earth's surface faces the sun at some time or the other. The part of the earth that moves from darkness into the sun's rays, experiences ***sunrise*** and when it moves away from the sun's rays, it experiences ***sunset***.

3. ***Coriolis Effect*** *refers to the force experienced by any object moving over the surface of a rotating body such as the earth.* The Coriolis Effect plays an important role in the movement of air (winds) and water (ocean currents) on the earth. Due to its effect, the winds and ocean currents move clockwise and are deflected to the right in the Northern Hemisphere and move in the anticlockwise direction and are deflected to the left in the Southern Hemisphere.

4. **The sun, the moon and the stars seem to move from east to west.** This is because the earth spins from west to east. This effect is similar to what one experiences while looking at trees from a moving train.

5. **Centrifugal force** is an apparent outward force that acts on a rotating object. It is always directed outward, i.e., away from the axis of rotation. The speed of rotation has created a centrifugal force resulting in a bulge in the middle portion of the earth and flattened top at the poles.

6. **Rotation causes difference in time over** various places on the earth. The difference in time is 4 minutes for each degree of longitude [24 hours (1440 minutes) divided by 360°].

7. **The side of the earth** towards the sun constantly gains heat and the side away from the sun constantly loses heat by radiating it into outer space. In this respect rotation of the earth in a tilted position on its axis has the following advantages:

   (i) The short rotational period makes the variation of temperature between day and night moderate.

   (ii) Rotation in combination with Revolution (earth's movement round the sun) causes seasons and variations in the lengths of day and night over different places on earth.

INCLINATION OF EARTH'S AXIS AND ITS SIGNIFICANCE

As we have said rotation is the spinning of the earth on its axis from west to east. The axis is the imaginary line passing through the centre of the earth on which it rotates. The earth's axis is not vertical. It makes an angle of 23½° with the vertical or 66½° with the plane of the Earth's orbit.

Let us imagine that the earth had a vertical axis. Then at all places on the earth, the length of day and night would have been equal as shown in the Fig. 3.2.

(i) Place L at the Equator would be at position L' after 12 hours.

Distance LO = Distance OL'

∴ Length of day = Length of night.

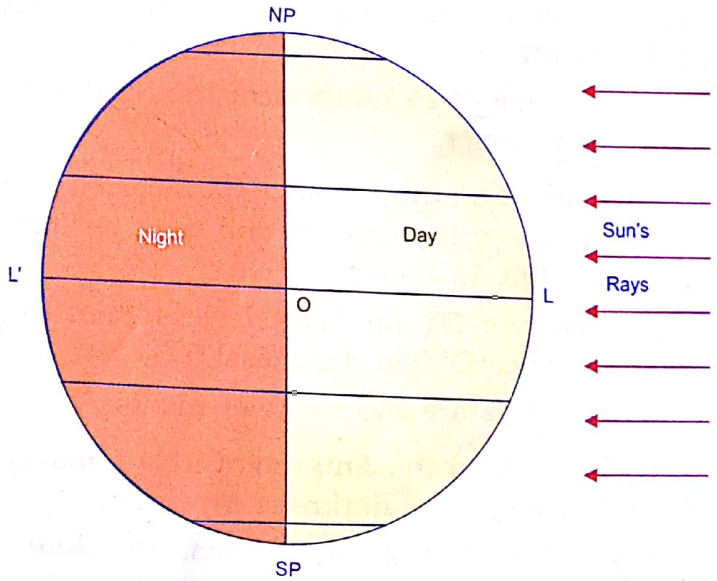

Fig. 3.2. Hypothetical Vertical Axis

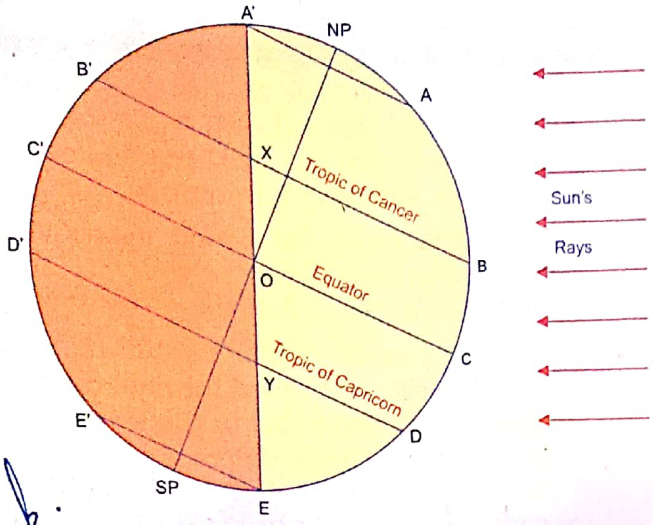

Fig. 3.3. Inclined Axis

(ii) Similarly at all places on the earth, the length of day and night would be equal if the axis of the earth was not inclined.

The effect of the inclined axis on the duration of day and night is that their duration differs as shown in the Fig. 3.3.

(i) At the Equator place C would be at position C' after 12 hours.

Distance CO = Distance OC'

∴ Length of day = Length of night.

(ii) On the Tropic of Cancer place B will be at B' after 12 hours.

But distance BX is greater than B'X.

∴ Days are longer than nights.

(iii) On the Arctic Circle place A will be at position A' after 12 hours. AA' remains in continuous light in summer for six months.

∴ Day of 24 hours near the North Pole in summer.

(iv) Place D on the Tropic of Capricorn in the Southern Hemisphere will be at position D' after 12 hours.

Distance DY (in light) is less than the distance D'Y (in darkness)

∴ Days are shorter than nights.

(v) Place E on the Antarctic Circle remains in continuous darkness in winter.

∴ Night for 24 hours near the South Pole in winter for six months.

Effect of the Inclined Axis on the duration of day and night

- The duration of day and night is not equal at all places.
- The time of the day at any place is determined by the height of the sun in the sky.
- If the axis of the earth was vertical instead of inclined, places on earth would have the same temperature throughout the year.
- If the earth did not revolve around the sun even then with its inclined axis there would be no seasons.

Effect of the Inclined Axis on Seasons

The path of the earth around the sun is known as *elliptic*. It passes through the centre of both the earth and the sun. The earth's axis is not perpendicular to the plane of the elliptic, but is tilted at an angle of 66½° to it. The axis is, therefore, inclined at an angle of 23½° from the perpendicular to this plane. As a result of this, in the course of the earth's movement around the sun, the North Pole remains inclined towards the sun for a part of the year while the South Pole is tilted away from it. For the remaining part of the year, the situation is reversed, the North Pole being tilted away from the sun and the South Pole being inclined towards it. On earth this gives rise to the changing seasons and the varying lengths of day and night. If the earth's axis were perpendicular to the plane of orbit, there would be equal nights and days at all places on the earth, at all times of the year and there would also be no seasons.

WHY WE DO NOT FEEL THE MOTIONS OF THE EARTH?

Rotation and revolution are the two chief motions of the earth. If we were to feel these motions it would make life uncomfortable. The force of gravity keeps everything attached to the earth. This keeps all objects at rest with reference to the motions of the earth. Using this principle and Newton's First Law of Motion (which states that a body remains at rest or uniform motion unless compelled to change that state by an external force acting on it), scientists have proved that the earth rotates on its axis.

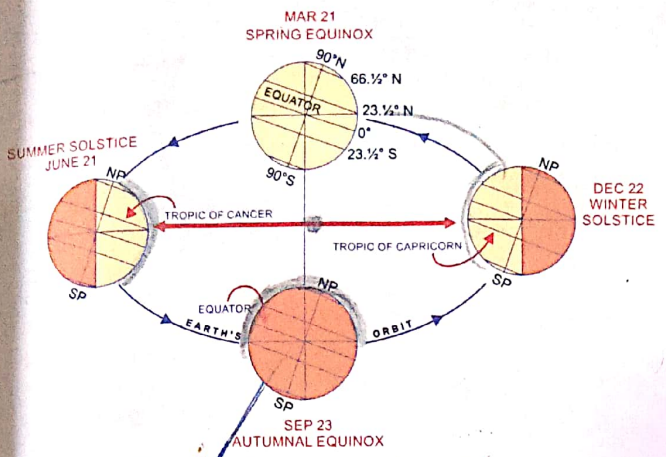

Fig. 3.4. Revolution of the Earth

Tilted axis and revolution of the earth create heat zones which is explained later in this Chapter.

REVOLUTION OF THE EARTH

The earth revolves round the sun in an elliptical orbit. This motion, together with rotation, makes earth's environment complex.

Characteristics of Revolution

Imp.

(i) The earth moves round the sun in an elliptical orbit at an average speed of 29.8 kilometres per second or about 100,000 kilometres per hour.

(ii) When the earth is closer to the sun, the gravitational pull makes the earth move faster than when it is away from the sun. Thus, the speed of revolution is not uniform.

(iii) The period taken by the earth to make one complete round of the sun is 365 days, 5 hours, 48 minutes and 45.51 seconds which is taken as 365 days and 6 hours. The length of one Solar year is 365 days. The remaining 6 hours are adjusted every 4 years into one complete day and added to the month of February. When February has 29 days, that year is known as a leap year having 366 days.

(iv) The earth's axis is always inclined to its orbital plane at an angle of 66½°. The motion of the earth is from west to east or in the same direction as the rotation.

Effects of Revolution

1. *Seasonal Changes:* The amount of heat that a place receives on earth depends on the angle at which the sun's rays reach it. When a place receives vertical sun rays the place gets hot. This is because the amount of heat in the direct vertical rays is concentrated on a small area, whereas the same amount of heat is spread over a larger area, in the case of the oblique rays. We have already noted that the tilt of the earth's axis causes the seasons.

Revolution causes different seasons i.e., the changing weather conditions due to differences in the heating of the earth. Revolution is an annual cycle; so, the seasons repeat year after year.

2. *Inclination of axis and seasonal changes:* Since the earth is tilted, the seasonal changes are not abrupt.

3. *Perihelion and Aphelion positions:* The earth's orbit is the path along which the earth travels around the sun.

This path is elliptical in shape. Due to this elliptical orbit of the earth, the distance between the earth and the sun varies. When the earth is closest to the sun the position is called *perihelion* and when it is farthest the position is called *aphelion.*

At *aphelion* the distance of the sun is 152 million km. While at its closest at perihelion the earth is 147.3 million km away from the sun.

Owing to the elliptical orbit, the minimum distance of the earth from the sun is reached on or about January 3rd every year. It is winter in the Northern Hemisphere when the axis is tilted away from the sun. While the tilt makes the Northern Hemisphere cool in winter, its

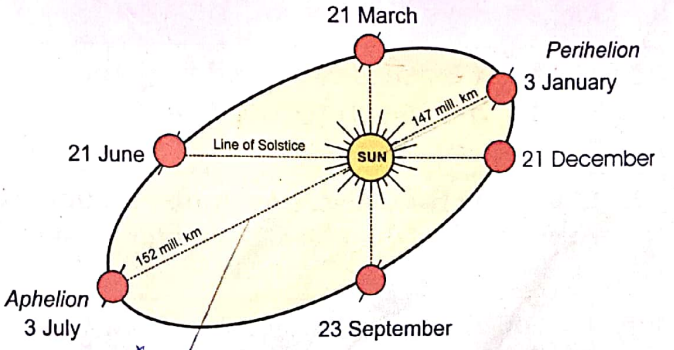

Fig. 3.5. Perihelion and Aphelion Positions

comparative nearness to the sun helps to make the Southern Hemisphere warm in summer.

On January 3, the earth in its orbit is closest to the sun. This time of the earth is said to be Perihelion. On about July 4, the earth is farthest from the sun, at this time the earth is said to be Aphelion.

4. *Creation of heat zones:* The spherical shape of the earth along with its movements around the sun causes the difference in the angles at which the sun's rays fall on the earth's surface. This causes difference in the distribution of heat on the earth's surface. As a result the world has been divided into three distinct heat or temperature zones.

(a) The Torrid Zone: This zone stretches between 23½° N and S latitudes and more or less receives the vertical rays of the sun. As a result, this region experiences moderately warm climate throughout the year.

(b) The Temperate Zone: In between the Torrid and the Frigid zones i.e., between 23½° North and South and 66½° North and South lies the Temperate Zone. In this zone the sun's rays fall obliquely and hence the region experiences a moderate climate.

(c) The Frigid Zone: This zone extends from 66½° N to 90° N (or North Pole) and 66½° S to 90° S (or the South Pole). Since the sun's rays fall extremely obliquely in this region, the region experiences extremely cold climate.

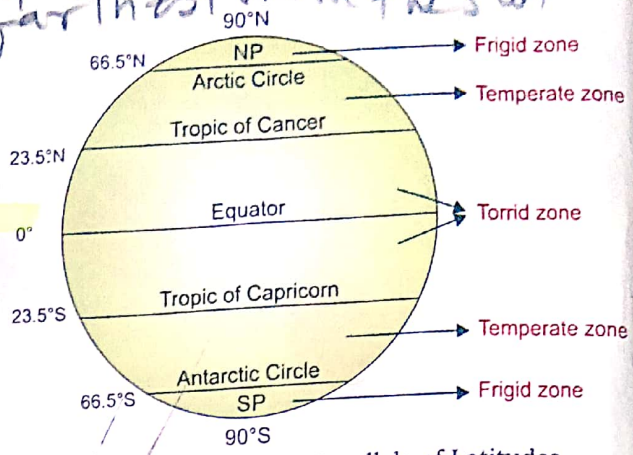

Fig. 3.6. Important Parallels of Latitudes

SOLSTICES AND EQUINOXES

The lighted part of the earth is called the ***circle of illumination.*** This circle moves with the apparent movement of the sun so that only half of the earth faces the sun at any given point of time.

1. *Solstice:* On June 21, the earth is in the position where the North Pole is tilted towards the sun. On this day the sun is overhead at the Tropic of Cancer. This day is known as the *Summer Solstice.* The Southern Hemisphere, however is tilted away from the sun and experiences winter.

On December 22, the Southern Hemisphere is tilted towards the sun, while the Northern Hemisphere is tilted away from the sun. This day is known as the *Winter Solstice.* It is

Difference between Solstice and Equinox

Solstice	Equinox
1. ***Solstice*** *refers to the time when the sun reaches its highest or lowest point in the sky at noon,* resulting in the shortest and longest days of the year.	1. ***Equinox*** *refers to time when the sun crosses the plane of the earth's Equator, making night and day of equal length.*
2. The word Solstice is derived from the Latin words 'Sol' meaning *'sun'* and *'sistere'* meaning 'to stand still'.	2. The word Equinox is derived from the Latin words *'aequus'* meaning *'equal'* and *'nox'* meaning *'night'.*
3. It happens twice a year on June 21 (summer solstice) and December 22 (winter solstice).	3. It happens twice a year, around March 21 (Spring or Vernal Equinox) and September 23 (Autumnal Equinox)
4. It happens during summer and winter.	4. It happens at the start of spring and autumn.

summer in the Southern Hemisphere and winter in the Northern Hemisphere.

2. *Equinox:* On two days in a year, the sun shines vertically over the Equator i.e., at an angle of 90°. This angle decreases as one moves away from the equator. These days are 21st March (*Spring* or *Vernal Equinox*) and 23rd September (*Autumnal Equinox*). At the Equinoxes the days and nights are of equal length throughout the world. On March 21, it is spring in the Northern Hemisphere and on September 23, it is autumn. The position is reversed in the Southern Hemisphere.

At the two equinoxes the sun is at 90° at the Equator. As one moves away from the Equator, the altitude of the sun decreases. When the apparent northward movement of the sun continues up to June 21st (summer solstice), there are variations in the duration of daylight.

ANGLE OF INCIDENCE AND DURATION OF DAYLIGHT

The angle of incidence of the sun's rays and duration of daylight at different latitudes is given in Table 3.1.

The altitude or the angle of incidence is also measured in degrees. It is calculated by subtracting the value of the latitude in degrees from 90°, the maximum reached at the Equator. For example in the above table at 66°30' N latitude, the angle of incidence would be 90° – 66°30' N = 23°30'. Similarly if a latitude of a station were only 60°, the angle of incidence would be 90° – 60° = 30°.

The table also shows that hours of daylight are always 12 hours at the Equator and they go on increasing or decreasing towards the Poles. Seasonal contrasts are maximum at mid latitudes than at the Equator or the Poles.

CYCLE OF SEASONS

The Equinoxes and the Solstices are the positions of the earth with respect to the sun on the given fixed dates. They help us to understand how seasons occur and how they are reversed in the Northern and Southern Hemispheres. When it is summer in the Northern Hemisphere, it is winter in the Southern Hemisphere. From Table 3.1 of variations in the altitude of the sun during equinoxes and solstices in different latitudes, it is observed that the duration of day and night varies according to the seasons. As a result of these variations, seasons are not the same in all parts of the earth. In general, there are four seasons i.e. *spring, summer, autumn* and *winter* corresponding to the dates of solstice and equinox (Fig. 3.4).

Table 3.1. Angle of incidence of the sun's rays and duration of daylight

Latitude	September 23 or March 21		June 21		December 22	
	Duration of daylight (hours)	Angle of incidence (degrees)	Duration of daylight (hours)	Angle of incidence (degrees)	Duration of daylight (hours)	Angle of incidence (degrees)
90°N	12 hours	0°	24 hours	23°30'	0	0°
66°30'N	..	23°30'	24 hours	47°	0	0°
50°N	..	40°	16h 18m	63°30'	7h 42m	16°30'
23°30'N	..	66°30'	13h 27m	90°	10h 33m	43°
0°	..	90°	12 hours	66°30'	12 hours	63°30'
23°30'S	..	66°30'	10h 33 m	43°	13h 27m	90°
50°S	..	40°	7h 42m	16°30'	16h 18m	63°30'
66°30'S	..	23°30'	0	0°	24 hours	47°
90°S	..	0°	0	0°	24 hours	23°30'

Position on 21st June: It is summer solstice in the Northern Hemisphere. The rays of the sun fall vertically on the Tropic of Cancer. The duration of sunlight or day time increases from 12 hours at the Equator to 13 hours and 27 minutes at 23½° N and further to 24 hrs at 66½° N (See Table 3.1). Beyond the Arctic Circle, the regions experience 24 hours daylight. This phenomena is termed as 'midnight sun'. Norway is called land of midnight sun and many tourists flock to Norway to witness this phenomena. The sun is visible only at very low height, just above the horizon. This continues for almost three months up to autumn equinox. In the southern hemisphere it is winter.

After June 21st, the hours of sunlight in Northern Hemisphere begin to decrease from 12 hours at the equator to all nights and no days beyond the Arctic Circle. This position can also be observed in Table 3.1. The maximum position is reached on December 21st.

Position on 23rd September: On 23rd September, the sun is vertically overhead at the Equator and the days and nights are equal. It is *autumn* in the Northern Hemisphere and *spring* in the Southern Hemisphere. On September 23rd, the duration of sunlight is 12 hours on all the places on earth.

Position on 22nd December: On 22nd December, the Southern Hemisphere is tilted towards the sun. It experiences summer. Areas beyond the Antarctic Circle experience 24 hours daylight. Being a water Hemisphere, the spectacle of the Midnight Sun, though more interesting, is confined to navigators only. The South Polar region has 24 hours of sunlight continuously for many days. It is *summer* in the Southern Hemisphere and *winter* in the Northern Hemisphere.

Position on 21st March: After 22nd December, the sun again begins to move towards the Equator and on March 21st, the sun's rays fall vertically over the Equator. On this day, all places on the earth have equal days and nights. It is a repeat of the position on 23rd September only in reference to the duration of day and night but not in reference to seasons or weather. During this period it is *spring* in the Northern Hemisphere and *autumn* in the Southern Hemisphere.

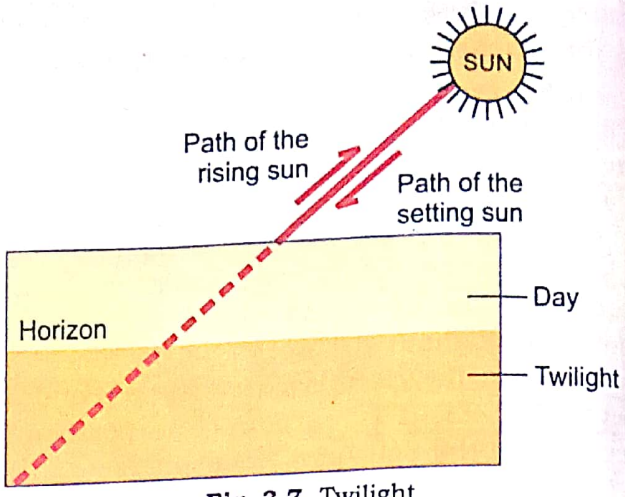

Fig. 3.7. Twilight

TWILIGHT IN LOW AND HIGH LATITUDES

It is clear that there are generally great seasonal contrasts as one moves from the Equator to the Poles. The variations in the amount of heat received at different parts of the earth during the year depend on the inclination of the sun's rays. The difference though is best explained by vertical and slanting rays of the sun, we should also remember that no place on earth has abrupt change from vertical to slanting rays or vice versa. During sunrise and sunset though the sun is below the horizon, we experience a diffused light. Much of this light is a reflection by clouds and dust particles present in the atmosphere.

This period of diffused light between sunset and complete darkness is called ***dusk*** *or* ***twilight*** *and that between sunrise and full daylight is called* ***dawn.***

This phenomena of dawn and dusk is experienced more in temperate regions.

Duration of twilight has considerable influence on seasons. The duration of twilight is large beyond 50° latitude and in polar regions twilight lasts for as much as seven weeks at a stretch.

The twilight continues as long as sun is 18° below the horizon. Its duration is 1 hour and 12 minutes at the Equator. It goes on increasing towards the Poles. At the poles the duration is 50 days long during the 3 months of alternating period of day and night. This is because the period during which the refracted light is received

at the Equator is short as the sun rises and sets in a vertical path there. On the other hand, in temperate latitudes the period of refracted light is longer as the sun rises and sets in an oblique path. It is much longer at the poles, that is why the winter darkness there is only twilight.

EXERCISES

I. Choose the correct option:

1. Which of the following is true about the rotation of the earth?
   (a) The earth completes one rotation in 25:56:4.09 hrs
   (b) The earth's axis passes through the poles
   (c) The speed of rotation increases as we move towards the equator
   (d) All of the above.

2. What angle does the earth's axis make with the plane of earth's orbit?
   (a) 0° (b) 23½° (c) 66½° (d) 90°

3. An apparent outward force that acts on a rotating object:
   (a) Centrifugal Force (b) Sunset Effect
   (c) Coriolis Effect (d) Rotational Effect

4. What is the shape of the path of the earth around the sun?
   (a) Oval path (b) Spherical path (c) Elliptic (d) Coriolis

5. Which of the following is correct?
   (a) Aphelion : earth is closest to the sun
   (b) Aphelion : earth is farthest from the sun
   (c) Aphelion : moon is closest to the earth
   (d) Aphelion : the equator is closest to the sun.

6. What is the time difference between two consecutive lines of longitude?
   (a) 7½ minutes (b) 4 minutes (c) 1 minute (d) 3 minutes

7. Which of the following is true about the revolution of the earth around the sun?
   (a) It results in the cycle of seasons (b) The direction of motion is the same as rotation
   (c) The speed is not uniform (d) All of the above.

8. Which of the following is true about the perihelion position of the earth?
   (a) It is farthest from the sun. (b) It occurs on 3 January.
   (c) The speed of revolution is the least. (d) All of the above.

9. The lighted part of the earth is called the _____.
   (a) Circle of Light (b) Circle of Illumination
   (c) Circle of Solstice (d) Circle of Equinox

10. Perihelion : 147.4 million km :: _____ 152 million km
    (a) Aphelion (b) Equinox (c) Solstice (d) All of the above.

11. Which of the following is true about the aphelion?
    (a) Occurs on 4 July. (b) Summer in northern hemisphere
    (c) Speed of revolution is maximum (d) All of the above.

12. Solstice : Summer/Winter :: _____ Spring/Autumn
    (a) Solstice (b) Equinox (c) Vernal (d) None of the above.

13. Name the phenomenon when the regions beyond the Arctic Circle experience 24 hours daylight.
    (a) Daylight sun (b) Midnight sun (c) Arctic sun (d) Regional sun

14. The period of diffused light between sunset and complete darkness is called
(a) dawn (b) dusk (c) twilight (d) Both (b) and (c)

15. The duration of twilight:
(a) increases to the poles
(b) might last for as much as 7 weeks at the poles
(c) is as long as the sun is 18° below the horizon
(d) all of the above.

16. World Standard Time : 0° :: Indian Standard Time : _____
(a) 23½° (b) 72½° (c) 66½° (d) 82½°

17. Greenwich Mean Time : _____ :: Indian Standard Time : 12:00 pm
(a) 6:30 am (b) 5:30 am (c) 6:30 pm (d) 5:30 pm

18. World Standard Time : _____ :: Indian Standard Time : Standard Meridian of India
(a) World Standard Meridian (b) Prime Meridian
(c) International Date Line (d) Greenwich Mean Time

II. Short Answer Questions

1. What is meant by the inclination of earth's axis? At what angle is the earth's axis inclined?
2. Name the two chief motions of the earth.
3. Describe two characteristics of rotation.
4. State two effects of the rotation of the earth.
5. Mention any two possible consequences if the axis of the earth was vertical instead of inclined.
6. State one reason why we do not feel the motions of the earth.
7. What is an elliptic?
8. Define 'revolution'.
9. State two chief characteristics of the revolution of the earth.
10. Mention two effects of revolution.
11. What do you understand by perihelion and aphelion?
12. On which two days are the days and nights equal all over the world and why? What name do you give to these days?
13. Which is the longest and which is the shortest day in the Northern Hemisphere and why?
14. On which dates does the sun shine vertically overhead at (a) Equator, (b) Tropic of Cancer, (c) Tropic of Capricorn?
15. Why is noon is hotter than morning?
16. Why are days and nights equal at all places on earth on September 23? What are the seasons in the Northern and the Southern Hemispheres on this date?
17. What is meant by Summer Solstice? When do we have Summer Solstice in the Northern Hemisphere?
18. What is meant by Equinox?
19. What will be the duration of daylight on March 21st at 23°30'N and 66°30'S latitudes? Give reason.
20. What is the relationship of seasons between the Northern and Southern Hemispheres?
21. Briefly describe the cycle of seasons with the change in inclination of the sun's rays. Which temperature zone receives almost vertical rays of the sun and which zones receive slanting rays?
22. How is the duration of twilight influenced by seasons?
23. How has the phenomenon of the 'Midnight Sun' come about?
24. Mention one effect of seasons in low and high latitudes.
25. Draw a well labelled diagram to show changes in the altitude of the midday sun at different times of the year.

III. Distinguish between the following

(i) Rotation and Revolution.
(ii) Vertical and Slanting Rays.
(iii) Equinox and Solstice.

IV. Structured Questions

1. (a) What is meant by rotation of the earth? State three effects of the rotation of the earth.
   (b) What is the effect of the inclined axis of the earth on day and night?
   (c) Give a geographical reason for each of the following:
      (i) Kuala Lumpur rotates faster on the earth's axis than London.
      (ii) We always see the sun rising in the east.
      (iii) Norway is called the Land of the Midnight Sun.
   (d) Draw a well labelled diagram to show inclination of the earth on its axis.

2. (a) Describe how the duration of sunlight changes from the Equator to the Poles with respect to the angle of incidence during the solstices.
   (b) Describe how seasons are made and reversed between the Northern and Southern Hemispheres.
   (c) Give a geographical reason for each of the following:
      (i) The length of day and night is not equal at all places on the earth.
      (ii) The period of twilight and dawn increases polewards.
      (iii) 25th of December in New Zealand may be one of the hottest days of the year.
   (d) Draw a well labelled diagram to show the tilt of the earth's axis and how the revolution causes seasons and variation in the length of day and night.

V. Thinking Skills

1. Imagine If the earth stops its rotation on its axis. What would be its impact on the inhabitants of the earth? Give examples to support your answer.
2. You travel for winter vacation to Australia from India. What type of climate will be there in Australia? Give reasons to support your answer.
3. On June 21, your uncle who lives in New York experiences summer, whereas your cousin who lives in Jakarta, experiences winter. Give reasons to support your answer.

VI. Project/Activity

1. With the help of a Power Point Presentation show
   (i) change of seasons in the Northern Hemisphere.
   (ii) the apparent path of the sun from the Equator to North Pole.
2. Draw a diagram to show the winter solstice and answer the following questions.
   (i) Name the correct date depicted in your diagram.
   (ii) Name the latitude where the sun is shining vertically overhead.
   (iii) Name the part of the globe where there is night on this date.
   (iv) Name the latitude on which length of the day will be 24 hours.
   (v) Give the date when the earth will be directly opposite to the above position.
   (vi) What will be the vertical position of the sun on that date?
   (vii) What is the effect of the inclination of the earth upon the length of day and night?
   (viii) What will be the probable length of day and night on that date?

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