Chapter 12: Earth, Moon and the Sun

Exercises — Let Us Enhance Our Learning

Q1 In Fig. 12.17, how many hours of sunlight do the North Pole and the South Pole receive during one rotation of the Earth?

SOLUTION

Fig. 12.17 shows the Earth with the North Pole (NP) at the top and the South Pole (SP) at the bottom in the June position, when the Northern Hemisphere is tilted towards the Sun.

The textbook states: 'The North Pole receives sunlight for all 24 hours in June.'

Because the North Pole is tilted towards the Sun, sunlight continuously falls on it throughout the entire rotation — it does not dip into the dark (night) side at all.

The South Pole, being tilted away from the Sun, is in complete darkness during this same period.

Therefore, during one full rotation of the Earth in this position:

— North Pole receives sunlight for 24 hours.

— South Pole receives sunlight for 0 hours (it is in darkness for all 24 hours).

Answer: North Pole: 24 hours of sunlight; South Pole: 0 hours of sunlight (complete darkness).

Q2 Fill in the blanks: (i) Stars rise in the _____ and set in the _____. (ii) Day and night are caused by the Earth's _____. (iii) When the Moon fully covers the Sun from our view, it is called a _____ solar eclipse.

SOLUTION

(i) The Earth rotates from West to East. As a result, all celestial objects — the Sun, the Moon, and the stars — appear to move from East to West across the sky.

The textbook states: 'Just like the Sun, the Moon also appears to rise in the eastward direction and set in the westward direction because the Earth rotates from West to East.'

So: Stars rise in the East and set in the West.

(ii) The textbook states: 'The Earth's rotation from West to East causes the day-night cycle.'

The side of the Earth facing the Sun experiences daytime; the opposite side

experiences night.
So: Day and night are caused by the Earth's rotation.

(iii) The textbook states: 'The observers in this area witness a total solar eclipse' — referring to the area on Earth that is in complete darkness because the Moon fully blocks the Sun.
So: When the Moon fully covers the Sun from our view, it is called a total solar eclipse.

Answer: (i) East; West. (ii) rotation. (iii) total.

Q3 State whether True or False: (i) Lunar eclipse occurs when the Sun comes between the Earth and the Moon. (ii) Sunrise happens earlier in Gujarat than in Jharkhand. (iii) In Chennai, the longest day occurs on the summer solstice. (iv) We should watch the solar eclipse directly with our naked eye. (v) Seasons occur due to the tilt of Earth's axis of rotation and its spherical shape. (vi) The Earth's revolution around the Sun causes day and night.

SOLUTION

(i) False. A lunar eclipse occurs when the Earth comes between the Sun and the Moon, causing the Earth's shadow to fall on the Moon. The textbook states: 'Sometimes the Earth can block the sunlight from reaching the Moon. This is known as a lunar eclipse.' The Sun does not come between the Earth and the Moon.

(ii) False. The Earth rotates from West to East, so sunrise first occurs in the eastern parts of India. Jharkhand lies to the east of Gujarat. Therefore, sunrise happens earlier in Jharkhand than in Gujarat. The textbook confirms: 'In India, sunrise first occurs in the eastern part.'

(iii) True. The summer solstice (~21 June in the Northern Hemisphere) is the day when the Northern Hemisphere has the longest period of daylight. Chennai, even though it is close to the equator and experiences less variation in day length, still has its longest day of the year on the summer solstice.

(iv) False. The textbook explicitly states: 'Directly viewing solar eclipse must be strictly avoided' and warns that 'even during the eclipse, the Sun is intense enough to damage the eyes and cause blindness.'

(v) True. The textbook states: 'The tilt of the Earth's axis and the spherical shape of the Earth gives rise to seasons.' Both factors together cause the different

seasons.

(vi) False. Day and night are caused by the Earth's rotation on its own axis — not by its revolution around the Sun. The textbook states: 'The Earth's rotation from West to East causes the day-night cycle.' Revolution causes the changing of the night sky and the seasons.

Answer: (i) False. (ii) False. (iii) True. (iv) False. (v) True. (vi) False.

Q4 Padmashree saw the Orion constellation nearly overhead at 8 pm yesterday. When will she see Orion overhead today?

SOLUTION

The stars appear to move across the sky each night because of the Earth's rotation. However, because the Earth also revolves around the Sun, the Earth moves slightly along its orbit each day.

This means the Earth completes a full rotation relative to the stars (a sidereal day) in about 23 hours 56 minutes, which is approximately 4 minutes less than a solar day (24 hours).

Aryabhata's value for one full rotation of the Earth (given in the textbook) is 23 hours 56 minutes 4.1 seconds — very close to the accepted sidereal day.

As a result, stars appear to rise approximately 4 minutes earlier each successive day.

Calculation: 24 hours × 60 min = 1440 min (solar day); sidereal day ≈ 23 × 60 + 56 = 1436 min; difference ≈ 4 minutes.

So Orion, which was overhead at 8:00 PM yesterday, will be overhead approximately 4 minutes earlier today.

8:00 PM − 4 minutes = 7:56 PM.

Answer: Padmashree will see Orion overhead at approximately 7:56 PM today (about 4 minutes earlier than the previous day).

Q5 Nandhini saw a group of stars rising at midnight on 21 June. When will she see the same group of stars rising at midnight next year?

SOLUTION

Because stars appear to rise about 4 minutes earlier each day (due to the Earth's revolution around the Sun), over the course of one full year the accumulated

difference is approximately 4 min × 365 days = 1460 minutes ≈ 24 hours = 1 full day.

This means after exactly one year (one complete revolution of the Earth around the Sun), the same group of stars will again rise at the same time of night — midnight.

Since the Earth completes one revolution in about 365 days (and 6 hours, rounded to 365.25 days), the same stars rising at midnight on 21 June will next rise at midnight on approximately 21 June of the following year.

More precisely, the pattern repeats annually because one revolution restores the Earth to the same position in its orbit relative to the Sun and the background stars.

Answer: Nandhini will see the same group of stars rising at midnight on approximately 21 June next year — after one full year (one revolution of the Earth around the Sun).

Q6 Abhay noticed that when it was daytime in India, his uncle who was in the USA was generally sleeping as it was night-time there. What is the reason behind this difference?

SOLUTION

The Earth is a sphere that rotates on its own axis from West to East, completing one rotation in about 24 hours.

At any given moment, only half of the Earth faces the Sun and experiences daytime, while the other half is turned away from the Sun and experiences night-time.

India and the USA are located on opposite sides of the globe — India is in Asia (East) and the USA is in North America (West), separated by a large longitude difference (roughly 10–14 hours depending on time zones).

The textbook states: 'As shown in Fig. 12.5, the side facing the Sun experiences daytime, while the other side is dark and experiences night.'

When India faces the Sun (daytime in India), the USA is on the night side of the Earth — it is dark there, and people are sleeping.

This difference in day and night between India and the USA is directly caused by the Earth's rotation on its own axis.

Answer: The Earth's rotation causes different parts of the Earth to face the Sun at different times. When India faces the Sun (daytime), the USA is on the opposite, dark side of the Earth, experiencing night-time.

Q7 Four friends used the following ways to see the solar eclipse. Who among them was being careless? (i) Ravikiran used a solar eclipse goggle. (ii) Jyothi used a mirror to project the Sun's image. (iii) Adithya saw the Sun directly with his eyes. (iv) Aruna attended a programme arranged by a planetarium.

SOLUTION

The textbook clearly warns: 'Directly viewing solar eclipse must be strictly avoided. Also, do not view it through sunglasses, binoculars, or telescopes,' and states that the Sun is intense enough to damage the eyes and cause blindness even during an eclipse.

(i) Ravikiran used a solar eclipse goggle — this is a specialised, safe method of viewing a solar eclipse. He was being careful.

(ii) Jyothi used a mirror to project the Sun's image onto a screen — this is a safe indirect viewing method described in the textbook. She was being careful.

(iii) Adithya saw the Sun directly with his eyes — this is dangerous and explicitly warned against in the textbook. He was being careless.

(iv) Aruna attended a programme arranged by a planetarium — the textbook recommends this: 'Participating in such events is the best way to observe a solar eclipse since the organisers not only provide specialised eye protection for solar viewing, but also offer scientific explanations.' She was being careful.

Answer: Adithya (iii) was being careless. Directly viewing a solar eclipse with the naked eye can cause permanent eye damage or blindness.

Q8 Fill in the circles in Fig. 12.18 appropriately with one of the following: Sun, Moon, Earth. (The figure shows the geometry of a solar eclipse and a lunar eclipse, with one circle already filled as 'Sun' in solar eclipse and 'Moon' in lunar eclipse.)

SOLUTION

The figure (Fig. 12.18) shows two rows of three circles each — one row for a Solar eclipse and one for a Lunar eclipse.

Solar eclipse row (left to right): the LEFT circle is already filled as 'Sun'. The two blank circles are the middle and right ones.

The eclipse geometry is Sun → Moon → Earth: the Moon comes between the Sun and the Earth, blocking sunlight from reaching Earth.
So the middle circle = Moon, and the right circle = Earth.

Lunar eclipse row (left to right): the RIGHT circle is already filled as 'Moon'. The two blank circles are the left and middle ones.
The eclipse geometry is Sun → Earth → Moon: the Earth comes between the Sun and the Moon, casting its shadow on the Moon.
So the left circle = Sun, and the middle circle = Earth.

Answer: Solar eclipse (Sun → Moon → Earth): the blank circles are Moon and Earth. Lunar eclipse (Sun → Earth → Moon): the blank circles are Sun and Earth.

Q9 The Moon is much smaller than the Sun, yet it can block the Sun completely from our view during a total solar eclipse. Why is it possible?

SOLUTION

The ability of an object to block another from view depends not only on its actual physical size but also on its distance from the observer — this is called apparent size.
The textbook explains this using the example of a thumb: 'You can cover the entire head of your friend with the help of your thumb, even though your thumb is much smaller than the actual size of your friend's head.' This is because the thumb is much closer to the eye than the friend's head.
Similarly, the Moon is much smaller than the Sun in actual physical size. However, the Moon is also much closer to the Earth than the Sun is.
The textbook states: 'The apparent sizes of the Moon and the Sun in the sky are similar when viewed from the Earth. This is so because though the Moon is much smaller in physical size than the Sun, the Moon is much closer to us compared to the Sun.'
Because the apparent sizes are similar, the Moon can appear to exactly cover the disc of the Sun as seen from Earth, blocking all sunlight from a small area on Earth's surface — this is a total solar eclipse.

Answer: Although the Moon is much smaller than the Sun, it is also much closer to the Earth. As a result, the Moon's apparent size (as seen from Earth) is similar to the Sun's apparent size, allowing the Moon to completely block the Sun's disc during a total solar eclipse.

Q10 The Indian cricket team matches in Australia are often held in December. Should they pack winter or summer clothes for their trip?

SOLUTION

Australia is located in the Southern Hemisphere.

The textbook explains: 'The seasons and length of daytime are reversed in the Southern Hemisphere as compared to the Northern Hemisphere. There, it is winter in June and summer in December.'

In December, the Northern Hemisphere (where India is located) experiences winter, while the Southern Hemisphere (where Australia is located) experiences summer.

This is because in December, the Southern Hemisphere is tilted towards the Sun, receiving more intense sunlight for a longer duration.

Therefore, when the Indian cricket team travels to Australia in December, they will be going into summer conditions.

They should pack summer clothes for their trip.

Answer: The Indian cricket team should pack summer clothes. December is summer in Australia because Australia is in the Southern Hemisphere, where seasons are the reverse of those in the Northern Hemisphere.

Q11 Why do you think lunar eclipses can be seen from a large part of the Earth when they happen, but total solar eclipse can be seen by only a small part of the Earth?

SOLUTION

The key difference lies in the size of the shadow that falls on the Earth or Moon.

During a lunar eclipse:

The Earth comes between the Sun and the Moon. The Earth is a large body, so its shadow (umbra) is large enough to cover the entire Moon. When the Moon enters this large shadow, the eclipse is visible from the entire hemisphere of Earth that is facing the Moon at that time — roughly half the Earth's surface.

During a solar eclipse:

The Moon comes between the Sun and the Earth. The Moon is much smaller than the Earth. The textbook states: 'The shadow of the Moon falls on a small area on the surface of the Earth.' Only the small area within the Moon's narrow shadow (umbra) experiences a total solar eclipse.

The textbook also notes: 'Due to the Earth's rotation and the motion of the Moon in its orbit, the Moon's shadow moves across the surface of the Earth. Thus, the total solar eclipse is visible only for a few minutes.'

In summary: The Earth casts a large shadow (big enough to cover the whole Moon), so a lunar eclipse is visible from a large part of Earth. The Moon casts a very small shadow on Earth, so only a small area sees a total solar eclipse.

Answer: The Earth's shadow is large enough to cover the entire Moon, so a lunar eclipse is visible from the whole hemisphere facing the Moon. But the Moon's shadow is tiny and falls on only a small area of the Earth's surface, so a total solar eclipse is visible from only a small region.

Q12 If the Earth's axis were not tilted with respect to the axis of revolution, explain what would be the effect on seasons?

SOLUTION

Seasons on Earth are caused by two factors working together: (1) the tilt of the Earth's axis of rotation with respect to its orbital plane, and (2) the spherical shape of the Earth.

The textbook states: 'The tilt of the Earth's axis and the spherical shape of the Earth gives rise to seasons.'

If the Earth's axis were not tilted — that is, if it were perpendicular to the plane of its orbit — then as the Earth revolves around the Sun:

— Neither hemisphere would ever be tilted towards or away from the Sun at any point in the orbit.

— Every part of the Earth would receive sunlight at the same angle throughout the year.

— The length of daytime and night-time would remain equal (12 hours each) at every location throughout the year.

— There would be no variation in the intensity of sunlight falling on any hemisphere over the course of the year.

As a result, there would be no seasons. Every place on Earth would experience the same weather conditions throughout the year — neither the heat of summer nor the cold of winter would occur due to the revolution of the Earth.

(The spherical shape of the Earth would still cause some variation in sunlight intensity based on latitude — equatorial regions would always be warmer than polar regions — but there would be no seasonal change in any given location.)

Answer: If the Earth's axis were not tilted, neither hemisphere would ever be inclined towards or away from the Sun. All locations would receive sunlight at the same angle with equal day-length (12 hours) throughout the year. There would be no seasons — no summer or winter caused by Earth's revolution.