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CBSE Coaching Classes | Classes VIII - XII

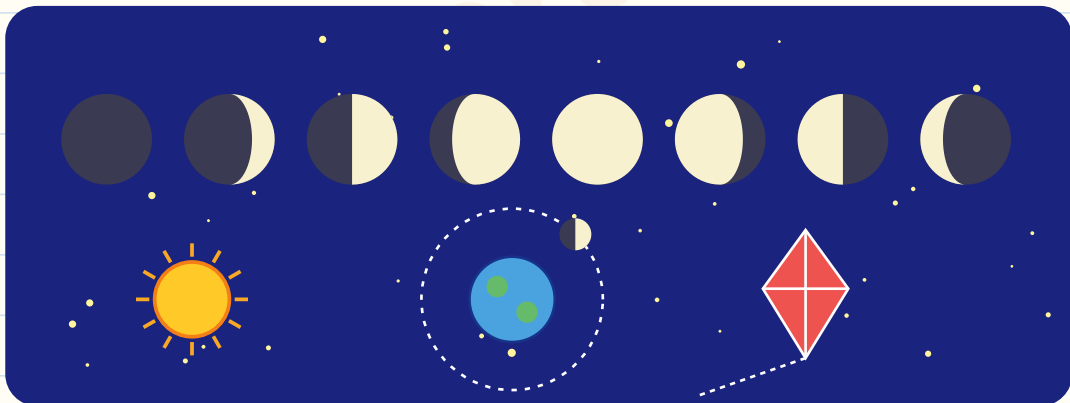
CLASS 8 | SCIENCE | CURIOSITY (NCERT)

Chapter 11

Keeping Time with the Skies

Detailed Handwritten-Style Notes

with moon-phase diagrams, calendars, festivals, fun Q&A and solved NCERT exercise



Inside:

- * Why the Moon changes shape: phases, waxing and waning
- * Where and when to look for the Moon; why it rises ~50 min later daily
- * Day, month, year: lunar, solar, luni-solar and Indian National calendars
- * Leap years, Adhika Maasa, festivals and the sky
- * Artificial satellites and ISRO
- * Fun Q&A after every topic + full NCERT exercise solved + practice sheet

Chapter at a Glance

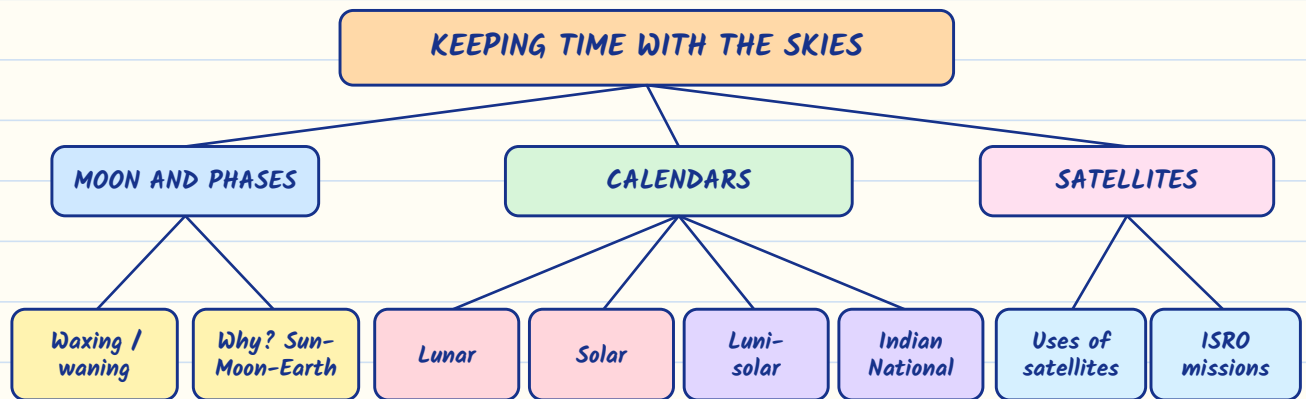


Fig. 1: Concept map of the chapter

Meera's puzzle at the Patang Mahotsav

On Makar Sankranti, Meera was at the International Kite Festival in Ahmedabad. She spotted the **Moon in the daytime** - and it was **not a full circle**. She knew the Moon is a sphere that shines by **reflecting sunlight**, so why isn't the whole Moon visible every night? It cannot be a lunar eclipse (eclipses are rare and brief).

So what makes the Moon's shape change? That is the big question of this chapter - and it leads us to calendars, festivals and satellites.

Probe and Ponder - quick answers

- **Moon during the day?** Yes! For a large part of the month the Moon is above the horizon in daytime. It is bright enough (it reflects sunlight) to be seen against the daytime sky, especially a waxing Moon in the afternoon and a waning Moon in the morning.
- **Living on the Moon - day, month, year?** A "day" (sunrise to sunrise) would last about **29.5 Earth days** because the Moon turns very slowly; the year would still be about one Earth year, as the Moon travels around the Sun with the Earth. (Think about it: what would the Earth look like in the Moon's sky - does it show phases too?)
- **Two moons?** The night sky would show **two sets of phases** with different cycle lengths, nights could be brighter, and calendars would be more complicated.
- **No clocks or calendars?** We could use natural cycles: the **Sun's shadow** length, day and night, the **phases of the Moon**, the **seasons**, and which **stars** rise at sunset.

11.1 How Does the Moon's Appearance Change and Why?

Activity 11.1 - watching the Moon for a month

Let us explore

- Begin at **sunrise on the first day after the full Moon**: spot the Moon in the **western** direction.
- Make a table (Table 11.1). Note the **date**, **when** you saw the Moon (sunrise or sunset), and **shade the circle** to show the bright part (Fig. 11.1).
- From day 2 note: is the bright part **increasing or decreasing**? Is the Moon **closer to or farther from the Sun** than the day before?
- After about 15 days the Moon is no longer seen at sunrise - for the next 15 days observe at **sunset**.

Tip from the book: start this a month before the chapter is taught!

Day	Seen at	Appearance	Bright part vs previous day	Moon-Sun separation
1	Sunrise (west)	Full circle	-	-
2	Sunrise	Almost full	Decreased	Closer
8	Sunrise	Half circle	Decreased	Closer
12	Sunrise	Thin crescent	Decreased	Closer
15-16	Not visible	New Moon	-	Very close to the Sun
18	Sunset	Thin crescent	Increased	Farther

(Sample entries - your own observations will differ slightly.) Analyse: the Moon looked different each day; it was not visible on all days; and its position in the sky shifted every day.

11.1.1 Phases of the Moon

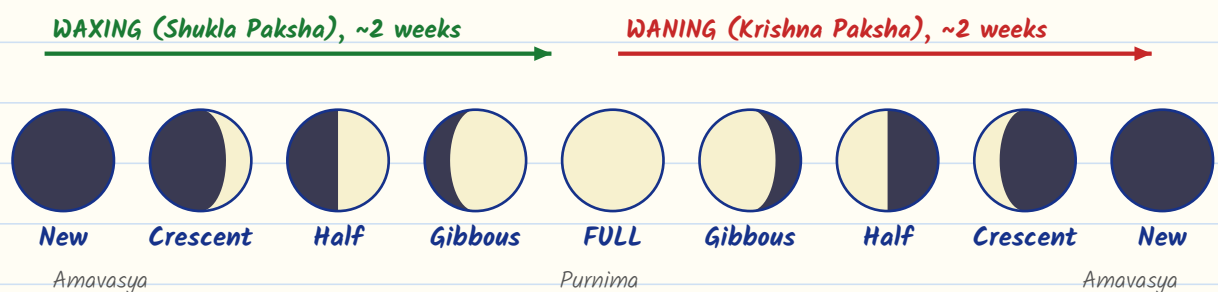


Fig. 2: One full cycle of phases (as seen from the Northern Hemisphere, e.g. India)

Key terms

- **Full Moon (Purnima)**: the Moon appears as a **full bright circle**.
- **New Moon (Amavasya)**: the Moon is **not visible**.
- **Waning**: the bright part **decreases** (full → half → nothing) over about 2 weeks. In India: **Krishna Paksha**.
- **Waxing**: the bright part **increases** (new → half → full) over about 2 weeks. In India: **Shukla Paksha**.
- **Phases of the Moon**: the changing shapes of the Moon's bright part from day to day, as seen from the Earth.
- One full Moon to the next takes about a **month** (about 29.5 days).

Phase	What we see	Remember
New Moon	Bright part not visible	Amavasya
Crescent	Less than half of the lit part is visible	Thin curved "banana" shape
Half	Half of the lit part is visible	About 1 week after new / full Moon
Gibbous	More than half of the lit part is visible	Fat, almost full
Full Moon	Entire lit part is visible	Purnima

Kuch Mazedaar Questions - Phases

Q1. How long does the Moon take to go from one full Moon to the next? What are the two halves of this cycle called in India?

Ans. About **one month (29.5 days)**. The waxing half is **Shukla Paksha** and the waning half is **Krishna Paksha**.

Q2. On which day is the Moon not visible at all? And on which day is the whole circle bright?

Ans. Not visible: **new Moon (Amavasya)**. Whole circle: **full Moon (Purnima)**.

Q3. A crescent Moon is shown in a picture with the bright side on the right. Is it waxing or waning?

Ans. From India (Northern Hemisphere) a crescent with the **right side bright** is a **waxing** crescent seen soon after sunset in the west. (Left side bright = waning.)

Q4. Does the Moon itself change shape?

Ans. No. The Moon is always a sphere; only the part of its lit half that we can see changes.

11.1.2 Locating the Moon

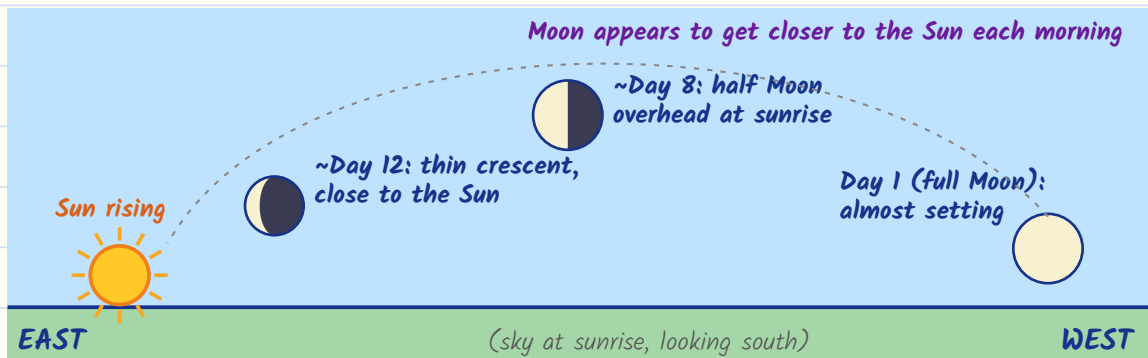


Fig. 3: Where the Moon is at sunrise on successive mornings after full Moon

Where and when to look for the Moon

- **Full Moon:** nearly **opposite** the Sun - when the Sun rises in the East, the Moon is almost **setting in the West**.
- Each following morning the bright part decreases and the Moon appears **closer to the Sun**. When it is a **half circle**, the Moon is **overhead at sunrise**; a few days later the **crescent** is even closer to the Sun.
- A **waxing Moon** is easiest to spot at **sunset**; a **waning Moon** at **sunrise**.
- Because of these shifts the Moon **always rises and sets at different times than the Sun**.

A step further - "Moon rises when the Sun sets"? Not always!

- Moonrise is about **50 minutes later** each day (check a newspaper or the Positional Astronomy Centre, IMD website).
- Sometimes moonrise is in the **afternoon (about 2-4 pm)**, so you can see the Moon in the **eastern sky in daylight** (wait ~30 min after the listed time for it to climb).
- Example in the book: 7 April 2025 moonrise 14:23; 8 April 2025 moonrise 15:17 (54 minutes later).

Phase	Rises	Highest in sky	Sets
New Moon	About sunrise	About noon	About sunset
Waxing crescent	Morning	Afternoon	Evening (soon after sunset)
Waxing half	About noon	About sunset	About midnight
Waxing gibbous	Afternoon	Evening / night	After midnight
Full Moon	About sunset	About midnight	About sunrise
Waning gibbous	Evening / night	Late night	Morning
Waning half	About midnight	About sunrise	About noon
Waning crescent	Before dawn	Morning	Afternoon

(Extra: the approximate timetable above is a standard guide, added for revision; exact times vary with place and season.)

11.1.3 Making sense of our observations

SUNRAYS

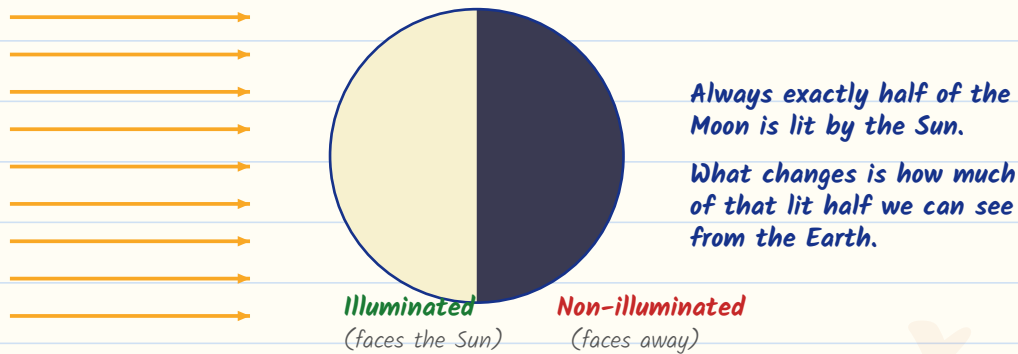


Fig. 4: Sunlight falls on only half of the Moon at a time

The big idea

- The Moon does **not** produce its own light - it **reflects sunlight**. The half facing the Sun is **illuminated**; the half facing away is **non-illuminated**.
- The Moon **revolves around the Earth**, and the **same half** of the Moon always faces the Earth.
- But the Earth-facing half is **not always the lit half**. We see only the **lit part of the Earth-facing half**.
- On **new Moon** day, only the dark half faces the Earth, so we see nothing bright.

Activity 11.2 - ball and lamp model

Let us explore (do it at night with a torch or lamp)

- A soft ball on a stick = Moon; a torch/lamp ~3 m away = Sun; your head = Earth.
- Hold the ball at arm's length, slightly above your head, at position E (towards the lamp): you see the **dark side** - like **new Moon**.
- Turn **anti-clockwise** slowly. The lit part you see changes and the line separating lit and dark parts is **curved**.
- At position A (opposite the lamp) you see the **entire lit half** - like **full Moon**.

Top view of Activity 11.2

Ball (= Moon) is held at arm's length and you turn around anti-clockwise.

A: ball opposite the lamp
→ you see all of the lit half

E: ball towards the lamp
→ you see only the dark half

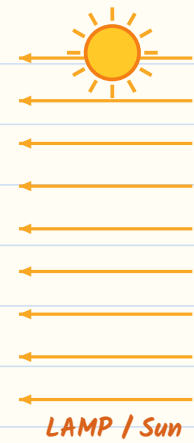
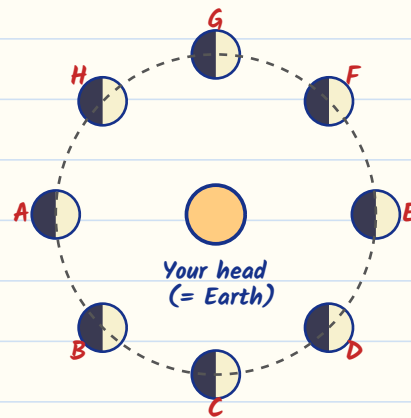
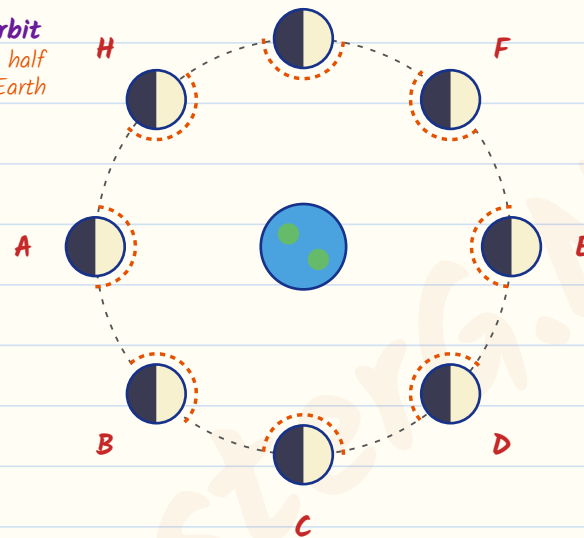


Fig. 5: Top view of the ball-and-lamp model

(a) Moon in its orbit

Orange dashes = the half of the Moon facing Earth



SUNRAYS

**(b) As seen from the Earth**

waning (A to E) waxing (E to A)

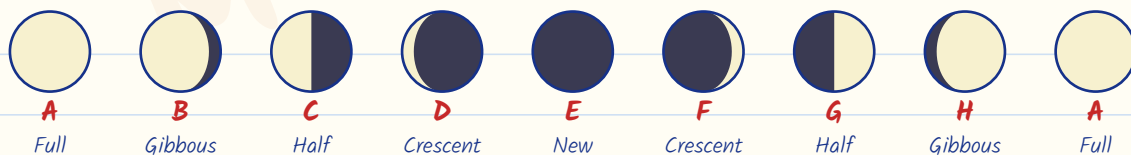
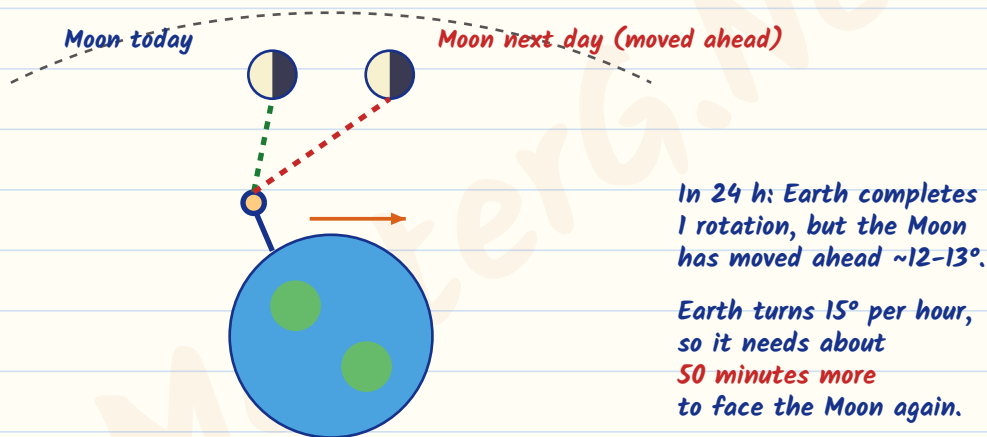


Fig. 6: The Moon at different positions in its orbit (A to H) and the phases seen from Earth (sizes and distances not to scale)

Reading the orbit diagram

- **A (Day 1): full Moon** - the Moon is opposite the Sun; the whole lit half faces us.
- **B and H: gibbous** - more than half of the lit portion visible. **D and F: crescent** - less than half visible.
- **C and G: half** of the lit portion visible. **E (Day 15): new Moon** - Moon is between Earth and Sun; no lit part visible.
- **A → C → E: waning**. **E → G → A: waxing**. One complete trip A to H and back to A takes about **one month**.
- The Moon appears **closest to the Sun on new Moon day** and **farthest on full Moon day** - exactly what we noticed in Activity 11.1!
- Earth rotates once a day but the Moon takes about a month to revolve, so on a given day **people in different parts of the Earth see nearly the same phase**.

Why does the Moon rise ~50 minutes later every day?

Result: Moon rises, crosses overhead and sets ~50 min later every day

Fig. 7: The Moon moves ahead in its orbit while the Earth rotates once

A step further - phases are NOT caused by Earth's shadow!

- A common wrong idea: "Earth's shadow falls on the Moon and makes phases." **Wrong**. Phases come from the **changing positions of Sun, Moon and Earth**.
- Earth's shadow on the Moon causes a **lunar eclipse** (only on a **full Moon day**). A **solar eclipse** can happen only on a **new Moon day**.
- Eclipses do not occur every month because the **Moon's orbit is slightly tilted** with respect to the Earth's orbit around the Sun.

Moon's orbit is slightly tilted (about 5° , drawn exaggerated) w.r.t. Earth's orbit around the Sun
 Eclipse needs: New/Full Moon exactly where the two orbits cross

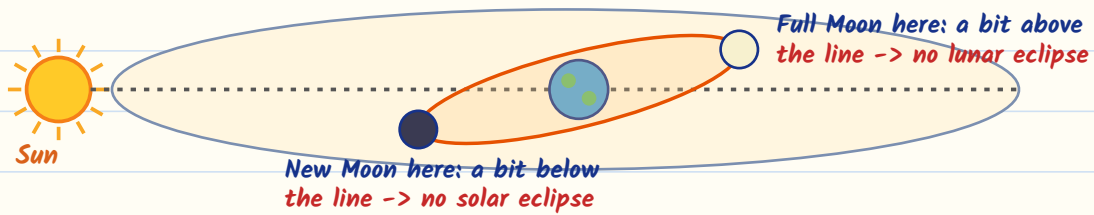


Fig. 8: Why there is no eclipse every month (tilt exaggerated)

Dekhe Kya Seekha Tumne? - Why the Moon changes shape

Q1. Why do we never see the dark half of the Moon on a new Moon day?

Ans. On new Moon day the Moon is between the Earth and the Sun, so the **non-illuminated half faces the Earth**. The lit half faces away from us.

Q2. Why is the Moon sometimes seen in the daytime?

Ans. The Moon is above the horizon for part of the day for most of the month. Its reflected sunlight is bright enough to be visible in daylight, e.g. waxing Moon in the afternoon.

Q3. In the ball and lamp activity, what do the ball, the lamp and your head represent?

Ans. Ball = Moon, lamp/torch = Sun, your head = Earth.

Q4. Why do people in Delhi and Chennai see almost the same Moon phase on the same night?

Ans. The Moon takes about a month to go round the Earth while the Earth's rotation takes only a day; the phase changes very slowly, so all places see nearly the same phase on a given day.

Q5. Is a lunar eclipse the same as the Moon's phase change? When does it happen?

Ans. No. A lunar eclipse is caused by the Earth's shadow falling on the Moon and happens only on a full Moon day (and rarely). Phases happen every month due to relative positions.

Q6. Why does a half Moon in the evening sky mean it is waxing?

Ans. A waxing Moon is easiest to see at sunset; the half Moon overhead at sunset is on its way to full, i.e. waxing.

11.2 How Did Calendars Come into Existence?

Natural events that **repeat in a regular way** (periodic events) helped people to measure time: the **rising and setting of the Sun**, the **phases of the Moon** and the **cycle of seasons**.

The Day

- The Sun appears to rise in the East and set in the West every day. This apparent motion is mainly due to the **rotation of the Earth on its own axis** - the foundation of the **day**.
- The average time the Sun takes to go from its **highest position** one day to its highest position the next day is **24 hours** = the **mean solar day**.
- The Sun is highest when the shadow of an object is **shortest**.

Activity 11.3 - Let us measure a day!

- Fix a **1 m stick vertically** in a flat, sunny place. From **11:00 a.m.** mark a dot at the tip of the shadow **every minute** until about **1:10 p.m.**
- Find the time of the **shortest shadow** (count the dots). Repeat on the next days and find the difference in time between consecutive days.

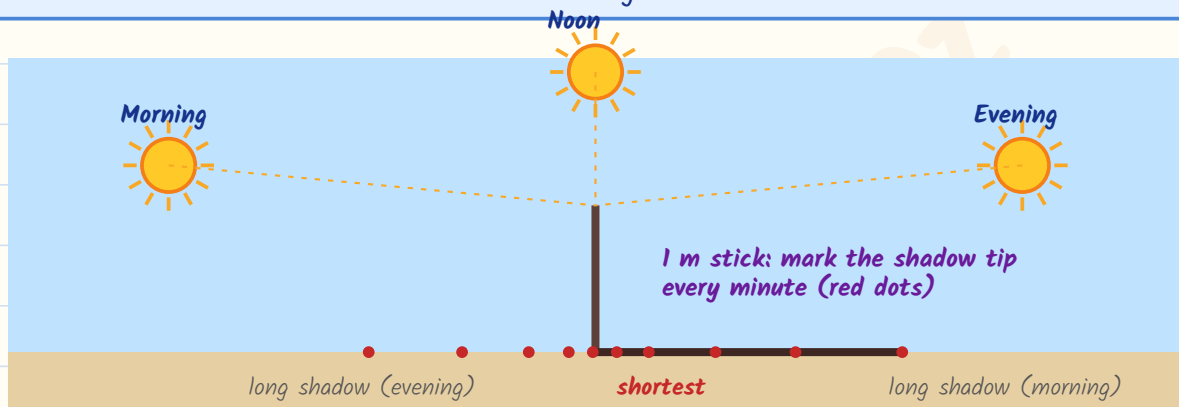
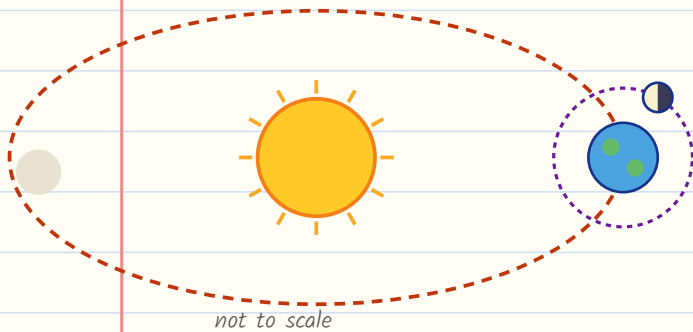


Fig. 9: Shadow of a stick during the day

Date	Time of shortest shadow	Duration of day
22 March 2025	12:20	-
23 March 2025	12:20	24:00
24 March 2025	12:19	23:59

Average of 24:00 and 23:59 = about **23 h 59.5 min** - almost exactly **24 hours**. This is why the Sun's cycle is used to define a mean solar day.

The Month and the Year



DAY

Earth spins once on its axis (24 h);
Sun returns to its highest position.

MONTH

Moon goes around the Earth;
cycle of phases ~29.5 days.

YEAR

Earth goes around the Sun (~365¼ days);
cycle of seasons repeats.

Fig. 10: The three natural cycles used for time units

Unit	Natural cycle behind it	Duration
Day	Earth's rotation on its axis (Sun back at its highest point)	24 hours (mean solar day)
Month	Moon's revolution around the Earth (cycle of phases)	About 29.5 days
Year	Earth's revolution around the Sun (cycle of seasons)	About 365¼ days (solar year)

Kuch Mazedaar Questions - Day, month, year

Q1. Why is the shadow of a stick shortest around noon?

Ans. At that time the Sun is at its highest position in the sky, so the shadow is the shortest.

Q2. Which phenomenon is used to define (i) day (ii) month (iii) year?

Ans. (i) Earth's rotation (Sun returning to its highest position); (ii) Moon's phases cycle due to its revolution around the Earth; (iii) cycle of seasons due to Earth's revolution around the Sun.

Q3. The shortest shadow came at 12:20 on Monday and 12:19 on Tuesday. How long was that solar day?

Ans. 23 hours 59 minutes - very close to 24 hours.

Q4. Which is longer - a month or a solar year? By roughly how many times?

Ans. A year is longer: $365\frac{1}{4} \div 29.5$ is about 12.4, so a year has about 12 lunar months plus a few days.

11.2.1 Lunar calendars



- People noticed that in **one cycle of seasons** there are nearly 12 cycles of Moon phases - nearly 12 lunar months.
- **Lunar calendar:** day = shortest unit; month = about 29.5 days; lunar year = 12 lunar months = 354 days.
- **Problem:** seasons repeat in about 365 days but the lunar year is only 354 days, so the lunar months slip against the seasons every year (by about 11 days).

11.2.2 Solar calendars

- Farmers needed to know the arrival of **seasons**, so the year was synchronised with the seasons: **solar calendars**. The **Gregorian calendar** (used today) is a solar calendar.
- Months are adjusted to add up to **365 days** - some months have 30 days, some 31 and February has 28.
- The Earth takes about **an extra quarter of a day**, which adds up to about **one day every 4 years**. So an extra day is added: a **leap year** (366 days; February has 29 days).

Leap year rule

- In the Gregorian calendar a year divisible by **4** is a leap year.
- **A step further:** adding a day every 4 years adds slightly too much, so **century years are skipped** (1700, 1800, 1900 are NOT leap years) - but every **400 years** the leap year is put back (1600 and 2000 ARE leap years).

Year	Leap year?	Why
2024	Yes	Divisible by 4
2026	No	Not divisible by 4
1900	No	Century year, not divisible by 400
2000	Yes	Divisible by 400
2100	No	Century year, not divisible by 400

A step further - tropical and sidereal years

- **Tropical year:** time between two successive **spring equinoxes**. The Gregorian calendar is based on it.
- **Sidereal year:** time for the **same stars** to rise again at sunset. It is longer than the tropical year by only about **20 minutes**, so it takes a very long time for the two calendars to differ noticeably.
- Astronomers use the sidereal year to track the Earth's position in its orbit around the Sun.

Our scientific heritage - watching the Sun rise

- Ancient people (including in India) had no modern instruments and did not know the Earth goes around the Sun, yet they worked out that the year is about **365 days** by careful sky observation.
- The Sun does **not** always rise exactly in the East: in summer it rises a little **north** of East and in winter a little **south** of East. The extremes are on the **solstices** (about June 21 and December 21).
- **Uttarayan**: apparent northward movement of the Sun, December to June. **Dakshinayan**: apparent southward movement, June to December.
- The Taittiriya Samhita (6.5.3) records that the Sun moves southwards for six months and northwards for six months. The Surya Siddhanta notes the stars of **Makar (Capricorn)** in the background of the Sun around the winter solstice in ancient times.
- Equinoxes and solstices were also tracked using the **stars that rise at sunset**.

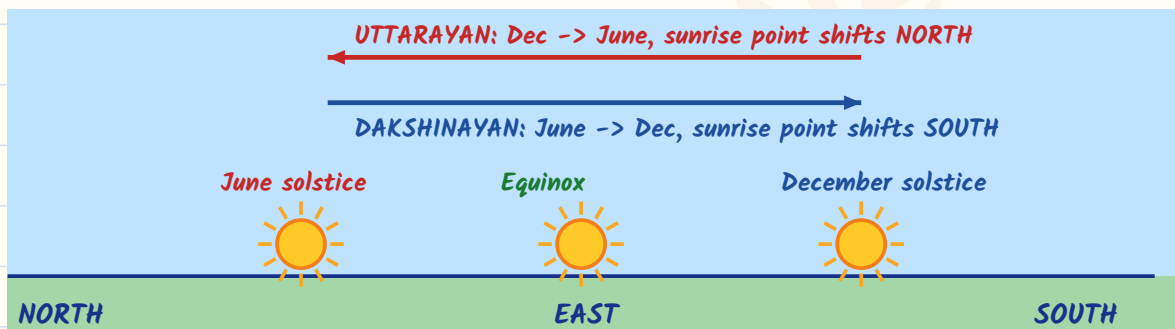


Fig. 11: Sunrise point shifts north and south of East through the year

11.2.3 Luni-solar calendars

- These calendars **primarily use the Moon's phases** for days and months but also **adjust to stay in step with seasons**.
- 12 lunar months = **354 days**, about **11 days** short of the solar year. After **2-3 years** the difference is close to a full month ($11 \times 3 = 33$ days).
- So every few years an **extra month - Adhika Maasa** (intercalary month) - is added. Such calendars are called **luni-solar calendars**; many parts of India use them.

Ever heard of... month names and Amant / Purnimant

Months of Indian luni-solar calendars: Chaitra, Vaisakha, Jyeshtha, Ashadha, Shravana, Bhadrapada, Ashwin, Kartika, Margashirsha (Agrahayan), Pausha, Magha, Phalgun.

- **Amant**: month starts the day after the **new Moon** and ends on the next new Moon day.
- **Purnimant**: month starts the day after the **full Moon** and ends on the full Moon day.

Calendar type	Based on	Year length	Needs correction?	Examples
Lunar	Moon's phases only	354 days (12 months)	No - drifts ~11 days/yr vs seasons	Islamic (Hijri) calendar
Solar	Earth around Sun (seasons)	365 days (+1 in leap year)	Leap years	Gregorian, Indian National
Luni-solar	Moon's phases + seasons	Lunar months with an extra month every 2-3 years	Adhika Maasa	Many Indian regional calendars

11.2.4 The Indian National Calendar

Facts

- A **solar calendar** by the Government of India, used along with the Gregorian calendar for official purposes. Fig. 11.9 shows **Shaka Era 1947** (Chaitra, Vaisakha, Jyestha).
- **365 days** in a year; the year **begins on 22 March** (day after the spring equinox). Months have **30 or 31 days**.
- In a regular year the **2nd to 6th months have 31 days**, the rest 30. In a **leap year** one day is added to **Chaitra** (first month); then the new year begins on **21 March**.
- Month names are taken from traditional Indian calendars.

No.	Month	Days	Starts on (Gregorian, regular year)
1	Chaitra	30 (31 in leap year)	22 March
2	Vaisakha	31	21 April
3	Jyaistha	31	22 May
4	Ashadha	31	22 June
5	Shravana	31	23 July
6	Bhadra	31	23 August
7	Ashwina	30	23 September
8	Kartika	30	23 October
9	Agrahayana	30	22 November
10	Pausha	30	22 December
11	Magha	30	21 January
12	Phalgun	30	20 February

(The first three months' dates are in Fig. 11.9 of the book; the rest are standard dates added for revision. 5 months of 31 + 7 months of 30 = 365.)

Ever heard of... the Calendar Reform Committee

In 1952 the Government of India set up the **Calendar Reform Committee (CRC)** to study all calendars followed in the country and recommend an accurate, uniform calendar. The **Unified National Calendar** it recommended was adopted from **21 March 1956 CE (1 Chaitra 1878 Saka)**. It follows the general principles of the *Surya Siddhanta*.

Be a scientist - Meghnad Saha (1893-1956)

A pioneering Indian **astrophysicist** who studied stars and their temperatures and developed the famous **Saha equation**. The **Saha Institute of Nuclear Physics**, Kolkata, is named after him. He was also the **chairperson of the Calendar Reform Committee**.

Dekhe Kya Seekha Tumne? - Calendars

Q1. Why does a lunar calendar not stay in step with the seasons?

Ans. A lunar year has 354 days but seasons repeat in about 365 days, so lunar months shift by about 11 days every year against the seasons.

Q2. What is Adhika Maasa? Why is it added?

Ans. It is an extra (intercalary) month added every 2-3 years in luni-solar calendars. The 11-day yearly gap adds up to about a month in 2-3 years, and adding a month brings the calendar back in step with the seasons.

Q3. Why do we need leap years?

Ans. Earth takes about $365\frac{1}{4}$ days to go around the Sun. The extra quarter day adds up to about one day in 4 years; a leap day (29 February) keeps the calendar synchronised with the seasons.

Q4. Is 1900 a leap year? Is 2000?

Ans. 1900 is not (century year not divisible by 400). 2000 is (divisible by 400).

Q5. What are the main differences between the Gregorian and the Indian National Calendar?

Ans. Both are solar. In the Indian National Calendar the year starts on 22 March (21 March in leap years), months have 30 or 31 days, and a leap day is added to Chaitra; the Gregorian year starts on 1 January with February as the short month.

Q6. Name the type of calendar in which month names Chaitra, Vaisakha... are used.

Ans. Indian luni-solar calendars (names are also used in the Indian National Calendar).

11.3 Are Festivals Related to Astronomical Phenomena?

Many Indian festivals are tied to the **phases of the Moon** and so are based on **lunar or luni-solar** calendars. That is why they fall on **different Gregorian dates** in different years.

Festival	When it is celebrated	Calendar basis
Diwali	New Moon (Amavasya) of Kartika	Luni-solar
Holi	Full Moon (Purnima) of Phalguna	Luni-solar
Buddha Purnima	Full Moon of Vaisakha	Luni-solar

Festival	When it is celebrated	Calendar basis
Dussehra	10th day of the month of Ashwina	Luni-solar
Eid-ul-Fitr	After sighting the crescent Moon at the end of Ramazan	Lunar
Makar Sankranti, Pongal, Bihu, Vaisakhi, Poila Baisakh, Puthandu	Nearly the same Gregorian date every year	Solar (sidereal)

Why do the dates shift?

- **Luni-solar festivals** (Diwali, Holi...): Gregorian dates shift but **typically by less than a month**, because the extra Adhika Maasa corrects the lunar-solar difference.
- **Purely lunar festivals** (Eid-ul-Fitr): no correction, so the date moves about **11 days earlier each year** and the festival passes through **different months/seasons** over the years.
- **Solar sidereal festivals** (Makar Sankranti etc.): happen on **almost the same date** in the Gregorian calendar.

A step further - why Makar Sankranti slowly moves

- Long ago these festivals were tied to a solstice or an equinox. The **sidereal** and **tropical** years differ slightly, so festival dates **slowly shift away** from the solstices/equinoxes.
- The cause is the slow **wobble of the Earth's axis** (like the wobble of a spinning top).
- **Makar Sankranti moves ahead by one day every 71 years.**

Ever heard of... Rashtriya Panchang

- Many festival dates depend on the **exact lunar phase at sunrise**. Sunrise is earlier in **Eastern India** and later in **Western India**, so dates can differ by a day between regions.
- For uniformity the **Positional Astronomy Centre** (Government of India) publishes the **Rashtriya Panchang** every year, with positions of the Sun, Moon and other objects for a central location in India; it helps in declaring festival holidays.

Ever heard of... the Moon in art and music

- **Ragas** inspired by the Moon: Chandrakauns, Chandranandan, Shubhapantuvarali (auspicious moon).
- **Mudras** relating to the Moon: Chandrakala, Ardhachandran (Bharatanatyam); similar in Kathak, Odissi, Kuchipudi.
- **Art:** Madhubani, Warli paintings; Dhokra brass sculpture; pottery and sculpture of Saura, Gond and other tribes show the Sun and Moon prominently.

Kuch Mazedaar Questions - Festivals

Q1. Why does Diwali fall on a different Gregorian date every year?

Ans. It is fixed by the Moon (new Moon of Kartika) in a luni-solar calendar, not by a fixed Gregorian date.

Q2. Why does Makar Sankranti usually fall on the same date (about 14-15 January) every year?

Ans. It follows a solar (sidereal) calendar, linked to the Sun's position, not to the Moon's phase.

Q3. Why can Eid-ul-Fitr fall in any season over the years while Diwali always falls in autumn?

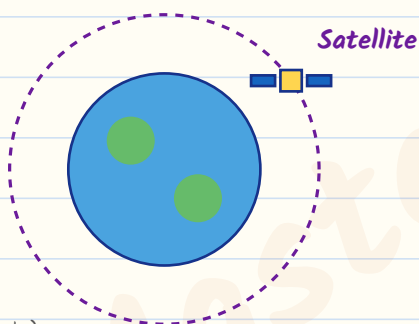
Ans. Eid follows a purely lunar calendar (354-day year, no correction), so it keeps moving earlier by ~11 days each year. Diwali follows a luni-solar calendar that adds Adhika Maasa, keeping it within the same season.

Q4. Why might the same festival fall one day apart in Kolkata and Mumbai?

Ans. It depends on the lunar phase at sunrise; sunrise is earlier in the East than in the West, so the date can differ by a day.

11.4 Why Do We Launch Artificial Satellites in Space?

- The **Moon** is Earth's **natural satellite**. Human-made **artificial satellites** also orbit the Earth - they look like **tiny moving specks** in the night sky.



Most artificial satellites orbit
~800 km above the Earth
and take ~100 minutes
for one orbit.

Appear as a fast-moving tiny
point of light in the early
evening / early morning sky.

Fig. 12: An artificial satellite orbiting the Earth

What do satellites do?

- Communication** (TV, phone, internet), **navigation** (like GPS), **weather monitoring**, **disaster management** and **scientific research**.
- Their motion is **periodic** too: roughly one orbit every ~100 minutes.

Our scientific heritage - ISRO

- Cartosat** series: high-quality images of the Earth for maps, city planning and disaster handling. **Bhuvan** (mapping platform) uses these images to show terrain, soil, land use, vegetation.
- AstroSat**: scientific observations of stars and other celestial objects.
- Other missions: **Chandrayaan 1, 2, 3** (Moon), **Aditya L1** (Sun), **Mangalyaan** (Mars).
- ISRO also lets Indian students build and launch small satellites: **AzaadiSat**, **InspireSat-1**, **Jugnu**.

Activity 11.4 - spot a satellite (with an adult!)

- Just before sunrise or after sunset go to a place with a **clear view of the sky**, away from trees and tall buildings.
- Look for a **point of light** with steady or flickering brightness moving **very fast** across the sky - visible to the naked eye or with binoculars.
- Mobile apps/websites can tell you when satellites pass over your location.

A step further - space debris

After their useful life many satellites and rocket parts become **space junk (debris)**. It crowds space and may **collide with working satellites**. Small debris burns up in the atmosphere; larger pieces can crash on the ground. Countries are working together to remove it.

Be a scientist - Vikram Ambalal Sarabhai (1919-1971)

A researcher in space science and nuclear physics, known as the **Father of the Indian Space Programme**. He pioneered the effort to launch the first artificial satellites. The **Vikram Sarabhai Space Centre (VSSC)**, Thiruvananthapuram - the ISRO centre that develops rockets and launch vehicle technology - is named after him.

Dekhe Kya Seekha Tumne? - Satellites

Q1. What is the difference between a natural and an artificial satellite? Give one example of each.

Ans. A natural satellite is formed in nature (the Moon). An artificial satellite is built by humans and launched (Cartosat, AstroSat).

Q2. How do you recognise a satellite in the night sky?

Ans. It looks like a star-like point of light moving fast and steadily across the sky.

Q3. Why is space debris a problem?

Ans. It can collide with working satellites and larger pieces can crash on the ground.

Q4. Name two uses of satellites that you benefit from in daily life.

Ans. Weather forecasts and mobile/TV communication (also navigation/maps).

Snapshots – Quick Revision Sheet

Learn these by heart!

- The lit part of the Moon we see changes day to day: phases like new Moon, crescent, half, gibbous and full Moon.
- Phases happen because we see different parts of the illuminated half of the Moon as it moves around the Earth.
- A full cycle of phases takes about a month (29.5 days).
- Natural cycles led to calendars: day (Earth's rotation), month (Moon's phases), year (Earth's revolution - seasons).
- Lunar calendars follow the Moon; solar calendars follow the seasons; luni-solar calendars adapt to both (Adhika Maasa).
- Artificial satellites are human-made and launched from Earth; they give important information for well-being and space science.

Topic	Key facts
Moon's cycle	~29.5 days; waxing = Shukla Paksha, waning = Krishna Paksha
Moonrise	~50 minutes later every day
Lunar year	$12 \times 29.5 = 354$ days (11 days short of solar year)
Solar year	~365¼ days; leap year = extra day every 4 years
Leap rule	Divisible by 4; century years only if divisible by 400
Indian National Calendar	Starts 22 March (21 March in leap years); 365 days; Chaitra gets the leap day
Makar Sankranti drift	1 day every 71 years
Satellite orbit	~800 km up, ~100 minutes per orbit

Memory tricks

- Waxing = Wow it's growing; Waning = Wasting away. Waxing Moon: seen at sunset; waning Moon: seen at sunrise.
- Crescent faces the Sun - the bright side always points towards the Sun.
- Lunar = 354, Solar = 365: 11 days gap → Adhika Maasa after 2-3 years.
- Leap year: 4, skip 100, but 400 saves it. (1900 no, 2000 yes)
- Moon: 50 minutes later - the Earth has to spin a bit extra to catch the Moon again.

Discover, Design and Debate - Ideas and Hints

- **Finger activity:** point towards the Sun, then slide your finger to the crescent Moon by the shortest path: you cross the **bright part first** - the Moon's bright side faces the Sun. The line joining the tips of the crescent represents the Moon's diameter.

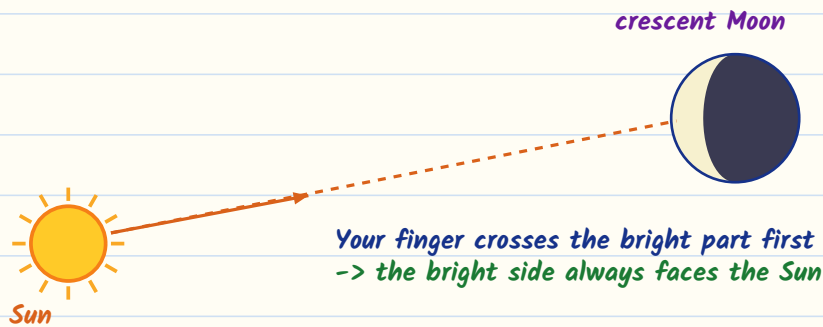


Fig. 13: The Moon's crescent always faces the Sun

- **Indian National Calendar vs Gregorian:** most dates map to the same Gregorian dates; the difference is in **leap years** - Chaitra 1 falls on 21 March (not 22) and Chaitra has 31 days.

State / region	New Year festival	Calendar type
Maharashtra	Gudi Padwa	Luni-solar
Karnataka	Ugadi	Luni-solar
Andhra Pradesh / Telangana	Ugadi	Luni-solar
Gujarat	Bestu Varas (day after Diwali)	Luni-solar
Tamil Nadu	Puthandu	Solar
Kerala	Vishu	Solar
West Bengal	Poila Baisakh	Solar
Assam	Bohag (Rongali) Bihu	Solar
Punjab	Vaisakhi	Solar
Odisha	Maha Vishuva / Pana Sankranti	Solar

(Starter list added for the project - verify and extend it with your teacher or family.)

- **Eid-ul-Fitr vs Diwali table:** you will see Eid moving about **11 days earlier** every year (same lunar date), whereas Diwali moves earlier for a few years and then **jumps ahead by about a month** - the year with a jump had an **Adhika Maasa**.
- **Sunrise sketch for a year:** the sunrise point moves **north** of East from December to June (**Uttarayan**) and **south** from June to December (**Dakshinayan**).

A step further - tides

At the sea, water levels rise and fall: **tides**. A high or low tide comes about **50 minutes later** each day - the same shift as moonrise. Tide levels are closely related to the **Moon's position and phase**.

NCERT Exercise – Keep the Curiosity Alive (Solved)**Q1. True or False?**

(i) We can only see that part of the Moon which reflects sunlight towards us.

Ans. True.

(ii) The shadow of Earth blocks sunlight from reaching the Moon causing phases.

Ans. False. Phases are due to the changing relative positions of the Sun, Moon and Earth. Earth's shadow on the Moon causes a lunar eclipse.

(iii) Calendars are based on various astronomical cycles which repeat in a predictable manner.

Ans. True.

(iv) The Moon can only be seen at night.

Ans. False. The Moon can also be seen in the daytime (e.g. waxing Moon in the afternoon, waning Moon in the morning).

Q2. Amol was born on 6 May on a full Moon day. Does his birthday fall on a full Moon day every year?

Ans. No. Moon phases follow a lunar cycle of about 29.5 days (12 lunar months = 354 days) while the Gregorian date follows the 365-day solar year. So the full Moon comes about **11 days earlier** (in Gregorian dates) each year and will not fall on 6 May every year. It may coincide again only after a number of years.

Q3. Name two things that are incorrect in Fig. 11.10.

Ans. Fig. 11.10 shows a Moon with stars and clouds. Likely errors (check them against your figure):

(1) **Stars are shown on/inside the Moon's dark part** – the Moon is opaque and nearer than the stars, so stars cannot be seen "on" the Moon; (2) **the clouds are drawn behind/around the Moon** – clouds are in Earth's atmosphere, much closer than the Moon, so they would pass **in front of** the Moon; (3) **the dark part of the Moon is shown as a clear circle** – the non-illuminated part is not normally visible.

Q4. Match the pictures of Fig. 11.11 with the phases. List the phases never seen from Earth.

Ans. Approach: **B** (completely dark) = **new Moon**; **E** (fully bright) = **full Moon**. Use Fig. 11.2 for the rest: a **crescent** with the bright side on the right is "three days after new Moon"; a **gibbous** Moon with the bright side on the left is "three days after full Moon"; a **half Moon** with the left half bright is "a week after full Moon". For (ii): the phases never seen from Earth are the ones whose **bright part is on the wrong side of the sequence** (for example a crescent/gibbous with the dark and bright regions arranged in a way that does not appear in Fig. 11.2). Please match the letters with your textbook picture, as the small images need to be checked.

Q5. Malini saw the Moon overhead at sunset. (i) Draw the phase. (ii) Waxing or waning?

Ans. (i) A **half Moon** (right half bright, left half dark – bright side towards the Sun that has just set in the west). (ii) **Waxing**: a waxing Moon is easiest to see at sunset; a half Moon overhead at sunset is about 7–8 days after new Moon.

Q6. Ravi: "I saw a crescent Moon rising in the East when the Sun was setting." Kaushalya: "I saw the gibbous Moon during the afternoon in the East." Who is telling the truth?

Ans. Kaushalya. A crescent Moon is always close to the Sun in the sky, so it cannot be rising in the East while the Sun sets in the West. A waxing gibbous Moon rises in the afternoon and is seen in the eastern sky before sunset.

Q7. The Moon is getting farther from the Earth and slower in its revolution. Will luni-solar calendars need an intercalary month more often or less often?

Ans. Less often. A slower revolution makes the lunar month longer, so 12 lunar months add up to more than 354 days. The gap with the 365-day solar year becomes smaller, so it takes longer to build up a full month.

Q8. 37 full Moons happen in 3 years in a solar calendar. Show that at least two must happen in the same month.

Ans. 3 years = 36 months of the solar calendar. 37 full Moons are to be placed in 36 months. If every month had at most one full Moon, there could be only 36 full Moons. Since there are 37, at least one month must have **two or more** full Moons (pigeonhole principle).

Q9. Vaishali saw the Moon from sunset to sunrise. What phase?

Ans. Full Moon: it rises at sunset (opposite the Sun) and sets at sunrise.

Q10. If we stopped having leap years, in approximately how many years would Independence Day (15 August) happen in winter?

Ans. Without leap years the calendar loses about **1 day every 4 years** against the seasons (about 0.24 day per year). To slip by about **6 to 8 months** (180–240 days) from mid-August (monsoon) to winter would take roughly $180 \times 4 = 720$ to $240 \times 4 = 960$, i.e. **about 700–1000 years**.

Q11. What is the purpose of launching artificial satellites?

Ans. Communication, navigation, weather monitoring, disaster management, mapping/remote sensing and scientific research (stars, Earth, space).

Q12. On which periodic phenomenon are (i) day (ii) month (iii) year based?

Ans. (i) **Day:** rotation of the Earth on its axis (Sun returning to its highest position). (ii) **Month:** the cycle of Moon's phases due to its revolution around the Earth. (iii) **Year:** the cycle of seasons due to the Earth's revolution around the Sun.

Practice Time – Thoda Aur Practice!**A. Multiple choice questions**

1. The Moon shines because: (a) it produces light (b) it reflects sunlight (c) it reflects Earth's light only (d) it is hot
2. The period when the bright part of the Moon increases is called: (a) waning (b) waxing (c) eclipse (d) Krishna Paksha
3. The day when the Moon is not visible is: (a) Purnima (b) Amavasya (c) Sankranti (d) Ekadashi
4. The Moon rises about _____ later each day: (a) 5 minutes (b) 50 minutes (c) 2 hours (d) 24 hours
5. A lunar year consists of: (a) 354 days (b) 365 days (c) 360 days (d) 400 days
6. Which of these is a leap year? (a) 1900 (b) 2100 (c) 2000 (d) 2026
7. An extra month added in luni-solar calendars is called: (a) Purnimant (b) Amant (c) Adhika Maasa (d) Uttarayan
8. The Indian National Calendar year begins on: (a) 1 January (b) 21 March / 22 March (c) 14 April (d) 1 April
9. Which festival is based on a purely lunar calendar? (a) Diwali (b) Holi (c) Makar Sankranti (d) Eid-ul-Fitr
10. Most artificial satellites orbit at about: (a) 8 km (b) 80 km (c) 800 km (d) 80,000 km
11. A waning Moon is best seen at: (a) sunrise (b) noon (c) sunset (d) midnight
12. The Moon's phases are caused by: (a) Earth's shadow (b) clouds (c) changing positions of the Sun, Moon and Earth (d) Moon's rotation only

B. Fill in the blanks

1. The waxing period of the Moon is called _____ in India.
2. The mean solar day is _____ hours.
3. The Moon takes about _____ days to go through all its phases.
4. The 12 lunar months fall short of the solar year by about _____ days.
5. A "Moon" that is more than half lit is in the _____ phase.
6. In a leap year of the Indian National Calendar an extra day is added to _____.

C. True or False

1. The same half of the Moon always faces the Earth.
2. On new Moon day the Moon is far from the Sun in the sky.
3. Solar eclipses can occur on a full Moon day.
4. Diwali always falls on the same Gregorian date.
5. The Gregorian calendar is a solar calendar.

D. Assertion - Reason

Options: (A) both true, R explains A; (B) both true, R does not explain A; (C) A true, R false; (D) A false, R true.

1. **A:** A lunar calendar does not stay in step with the seasons. **R:** A lunar year (354 days) is shorter than the solar year (about 365 days).
2. **A:** Moon phases are caused by the Earth's shadow on the Moon. **R:** A lunar eclipse happens on a full Moon day.
3. **A:** Moonrise happens about 50 minutes later every day. **R:** The Moon moves ahead in its orbit while Earth completes one rotation.

E. Numericals and reasoning

1. If the Moon rises at 6:00 p.m. today, at about what time will it rise after 4 days?
2. Show with a calculation why a lunar calendar needs an extra month every 2-3 years.
3. Which of these years are leap years: 1600, 1800, 2012, 2023, 2400?
4. A full Moon was on 1 March. About when will the next full Moon and the one after that be?
5. Makar Sankranti moves ahead by 1 day every 71 years. By how many days will it have moved in 284 years?

F. Short and long answers

1. Explain, with the ball-and-lamp activity, why the Moon shows phases.
2. Differentiate between lunar, solar and luni-solar calendars with an example each.
3. Why is the Moon sometimes visible during the day? When is a waning Moon best seen?
4. Why do not eclipses happen every month?
5. Explain why some festivals fall on different dates every year while others do not.
6. Describe the Indian National Calendar.

G. Zara Dimaag Lagao (HOTS)

1. You see a thin crescent Moon low in the western sky just after sunset. Is it waxing or waning? Which side of the Moon is bright?
2. If the Earth rotated twice as fast, how would the length of the solar day change? Would the number of days in a year change?
3. Why would a calendar based only on 12 lunar months be difficult for farmers?
4. A satellite takes 100 minutes for one orbit. How many orbits does it complete in one day?

Answer Key - Practice Time

Section	Answers
A. MCQ	1-(b); 2-(b); 3-(b); 4-(b); 5-(a); 6-(c); 7-(c); 8-(b); 9-(d); 10-(c); 11-(a); 12-(c)
B. Blanks	1. Shukla Paksha; 2. 24; 3. 29.5 (about a month); 4. 11; 5. gibbous; 6. Chaitra
C. True/False	1-True; 2-False (it is closest to the Sun on new Moon); 3-False (solar eclipse on new Moon day, lunar on full Moon); 4-False; 5-True

Section	Answers
D. Assertion-Reason	1-(A); 2-(D) [phases are not caused by Earth's shadow]; 3-(A)
E. Numericals	1. about 6:00 p.m. + 4×50 min = about 9:20 p.m.; 2. $365 - 354 = 11$ days a year; $11 \times 3 = 33$ days (about a month); 3. 1600, 2012, 2400 are leap years; 1800 and 2023 are not; 4. About 29-30 days later (30-31 March) and about 59 days later (late April); 5. $284 \div 71 = 4$ days

Hints for Sections F and G

- **G1:** Just after sunset in the west = **waxing crescent**; the bright side faces the Sun, i.e. the lower-right side (towards the setting Sun).
- **G2:** Faster rotation = **shorter day** (about 12 hours); the Earth's revolution does not change, so the year length stays the same but it would contain about twice as many days.
- **G3:** Lunar year is 11 days shorter than the seasons' cycle, so months would shift through seasons - sowing/harvest times would not match the calendar months.
- **G4:** $24 \times 60 = 1440$ minutes; $1440 \div 100 =$ about **14 orbits**.

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