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Chandrayaan-3: India’s South-Pole Landing and Its Systems

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Chandrayaan-3: India’s South-Pole Landing and Its Systems

This lesson explains Chandrayaan-3, India’s 2023 mission that landed near the Moon’s south pole. It covers the landing, the instruments, the findings and what came next. This update follows ISRO’s figures: the hop was on 2 September 2023, about 50 cm.

MissionChandrayaan-3 launched on 14 July 2023. Its Vikram lander soft-landed near the south pole on 23 August 2023.

AimIt had to show a safe soft landing, a rover on the move and experiments on the surface.

PlaceThe Prime Minister called India the fourth country to touch the Moon. The landing point is Shiv Shakti.

NextCabinet approved Chandrayaan-4 in September 2024. It is a mission to bring samples back.

What must I know about Chandrayaan-3?

1 What was Chandrayaan-3 meant to do, and why?

Chandrayaan-2 reached the Moon in 2019 but its lander did not land safely. Chandrayaan-3 was the second try at the hard part.

What were the three goals?

- **Landing:** show a safe and soft landing on the Moon.
- **Roving:** show a rover moving on the surface.
- **Science:** run experiments on the spot.

ISRO planned for one lunar day of work. That is about 14 Earth days.

What went wrong with Chandrayaan-2?

NASA says ISRO lost contact with the Chandrayaan-2 lander shortly before touchdown. That was on 7 September 2019, India time. It aimed at a site about 600 km from the pole.

Why a landing near the south pole?

The main reason is possible water ice. Scientists suspect it hides in permanently shadowed areas near the poles. The Sun never reaches the floors of such areas, so they stay extremely cold.

- **The ice:** NASA says a team saw definite evidence of water ice on the Moon's surface in 2018. At the south pole, most of that ice sits in craters.
- **What the site is:** the prime site lay near 69.4 degrees south. That is a high southern latitude, but not the pole itself.
- **What was new:** the lander gave a first on-the-spot soil temperature profile for this region. The rover's laser tool confirmed sulphur there. Neither result is about ice.

How did the journey go in dates?

The rocket lifted off on 14 July 2023 at 14:35 IST (Indian Standard Time). It flew from the second launch pad at Sriharikota. The lander touched down on 23 August 2023. The rover rolled out on 24 August.

14 Jul 2023
Launch at 14:35 IST

5 Aug 2023
Enters lunar orbit

17 Aug 2023
Vikram separates

23 Aug 2023
Soft landing

24 Aug 2023
Rover rolls out

Illustration: Dates from the ISRO update log.



The LVM3-M4 rocket, ISRO's Launch Vehicle Mark 3, lifts off from the second launch pad at Sriharikota on 14 July 2023. Photo: ISRO, via Wikimedia Commons (licence: GODL-India). Resized from the original.

> **Quick check 1.** Chandrayaan-3 lifted off from Sriharikota on 14 July 2023. *(True or False?)* See answer ↓

Sources: isro.gov.in; nasa.gov; science.nasa.gov

2 Which countries have soft-landed on the Moon?

Five countries have done it: the Soviet Union, the United States, China, India and Japan. A soft landing means the craft touches down in one piece. A crash landing does not count.

Who was first?

- **Soviet Union:** Luna 9 made the first survivable landing, on 3 February 1966.
- **United States:** Surveyor 1 made the first true soft landing, on 2 June 1966.
- **China:** Chang'e-3 made China's first soft landing, on 14 December 2013. Chang'e-4 followed on 3 January 2019. It was the first soft landing on the Moon's far side, in the Von Karman crater.
- **India:** Chandrayaan-3 landed on 23 August 2023. India was the fourth country to do it.
- **Japan:** SLIM landed on 20 January 2024 JST (19 January UTC). Japan was the fifth country to do it.

NASA gives the first two dates. It also dates the Chang'e-4 landing and names Japan as the fifth nation to soft-land (NASA on SLIM). The China Lunar Exploration Programme data centre dates Chang'e-3 (NSSDC, Chang'e-3).

Apollo 11 put humans on the Moon on 20 July 1969, US time. That crewed landing is a separate story.

What did the Prime Minister say?

On 26 August 2023 he told the ISRO team that India had become the fourth country to touch the Moon's surface.

3 Feb 1966
Soviet Union: Luna 9

2 Jun 1966
United States: Surveyor 1

14 Dec 2013
China: Chang'e-3

23 Aug 2023
India: Chandrayaan-3

20 Jan 2024
Japan: SLIM

Illustration: Dates from NASA and ISRO.

Does Japan’s SLIM count as a landing?

Yes. SLIM landed on 20 January 2024 JST, which was 19 January UTC. It ended tilted and its solar cells could not make power at first. That does not undo the landing. NASA names Japan as the fifth nation to soft-land, and JAXA says the pinpoint-landing demonstration was achieved. India’s place as the fourth country, in 2023, is unchanged.

Was India first at the south pole?

Not clearly. ISRO's wording is that the soft landing was near the south polar region. This lesson says no more than that.

> **Quick check 2.** The Prime Minister called India the fourth country in the world to touch the Moon's surface. *(True or False?)* See answer ↓

Sources: science.nasa.gov; nasa.gov; nssdc.ac.cn; pib.gov.in; global.jaxa.jp

3 How did Chandrayaan-3 reach the Moon?

It flew up on a rocket, raised its orbit step by step, and then sent the lander down. The craft was made of three parts that worked as a team.

What were the three modules?

- **Propulsion module:** 2,148 kg. It carried the lander to a 100 km circular polar orbit.
- **Lander module:** 1,752 kg, including the 26 kg rover. Its name is Vikram.
- **Rover:** 26 kg. Its name is Pragyan.
- **Total:** about 3,900 kg.

The propulsion module also carried one science payload, SHAPE (Spectro-polarimetry of HAbitable Planet Earth). It studies Earth in near-infrared light.

How did the orbit grow?

It grew in steps, like a slow spiral outward. ISRO raised the orbit again and again.

- **15 July:** 41,762 by 173 km.
- **1 August:** the craft left Earth for the Moon, at 288 by 369,328 km.
- **5 August:** it entered lunar orbit at 164 by 18,074 km.
- **16 August:** a near-circle of 153 by 163 km.

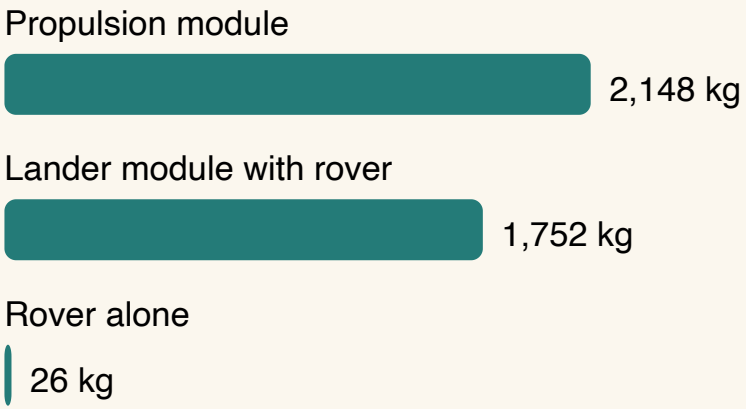


Illustration: Masses from the ISRO details page. Total about 3,900 kg.

When did the lander split off?

Vikram separated from the propulsion module on 17 August 2023. On 20 August the orbit was 25 by 134 km. ISRO then expected powered descent around 17:45 IST on 23 August.

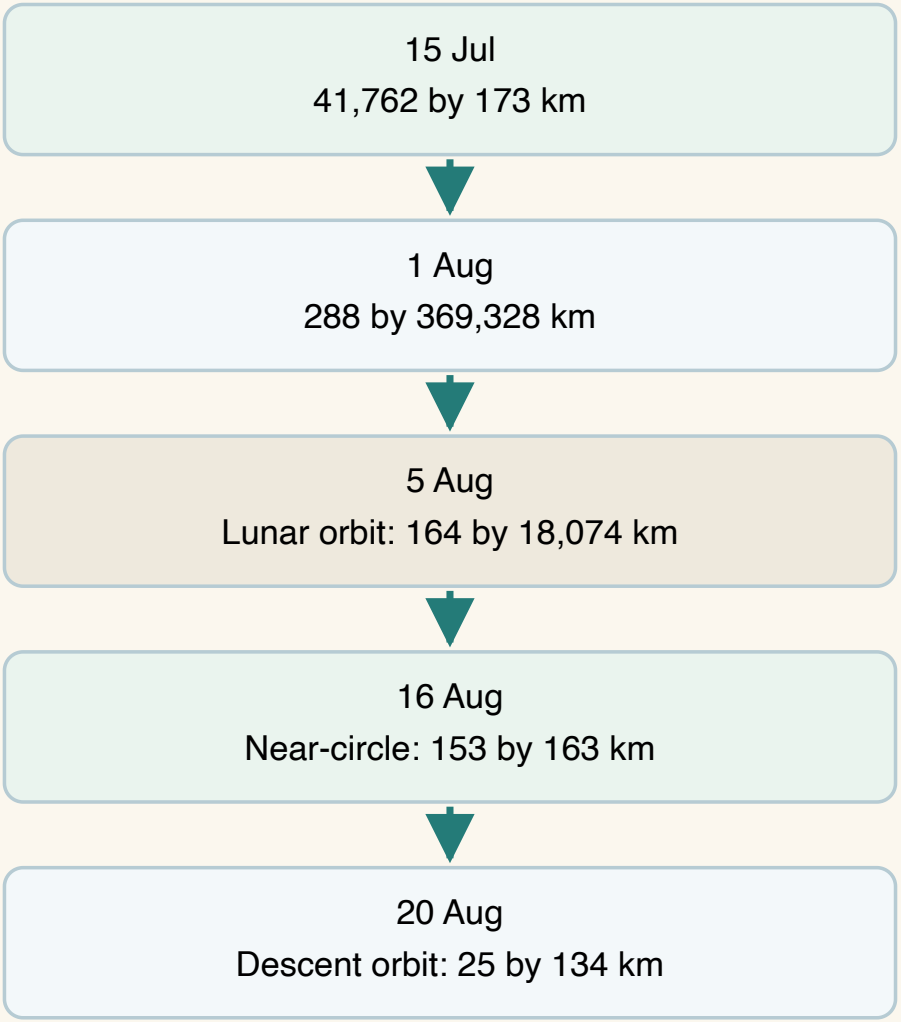


Illustration: Figures from the ISRO update log.

Sources: isro.gov.in

4 How did Vikram land safely?

It slowed with throttleable engines and used sensors and cameras to pick a safe spot. The final minutes are the hard part. Vikram had to slow from orbital speed to almost nothing.

What hardware did it have?

- **Engines:** four throttleable engines of 800 N each.
- **Thrusters:** eight of 58 N each.
- **Sensors:** laser and radio altimeters and a laser Doppler velocimeter.
- **Cameras:** cameras that spot hazards and steer around them.

Throttleable means the thrust can be turned up or down in flight. That lets the lander slow gently.

What were the touchdown limits?

- **Vertical speed:** 2 m/s or less.
- **Sideways speed:** 0.5 m/s or less.
- **Slope:** 12 degrees or less.

ISRO tested the system on a helicopter for the cold run. It used a tower crane for the hot run.

Where was the target?

The prime site was a box of 4 km by 2.4 km. Its centre was at 69.367621 S and 32.348126 E. That is about 69.37 S and 32.35 E. The lander touched down on the evening of 23 August 2023.

Did the rover talk to Earth?

No. The rover talked only to the lander. Chandrayaan-2's orbiter stood by as a backup link.

Vikram: the landing kit

Four 800 N throttle engines

Eight 58 N thrusters

Laser and radio altimeters

Laser Doppler velocimeter

Hazard cameras

Illustration: Hardware from the ISRO details page.

Safe touchdown

Up and down: 2 m/s or less

Sideways: 0.5 m/s or less

Slope: 12 degrees or less

Illustration: Limits from the ISRO details page.



The Vikram lander on the Moon, imaged by the Pragyan rover. Photo: ISRO, via Wikimedia Commons, under the Government Open Data License. Resized for this page.

> **Quick check 3.** Vikram was designed to touch down on slopes steeper than 30 degrees. *(True or False?)* See answer ↓

Sources: isro.gov.in

What is good to know about the instruments?

5 What instruments did Chandrayaan-3 carry?

Each module had its own tools. Together they studied the surface, the plasma above it and Earth.

What did the lander carry?

- **RAMBHA-LP (Radio Anatomy of Moon Bound Hypersensitive ionosphere and Atmosphere, Langmuir Probe):** a probe that studies the plasma near the surface.
- **ChaSTE (Chandra's Surface Thermophysical Experiment):** a probe that measures how heat moves through the top soil.
- **ILSA (Instrument for Lunar Seismic Activity):** a tool that senses ground shaking.
- **LRA (Laser Retroreflector Array):** a NASA reflector for laser ranging.

What did the rover carry?

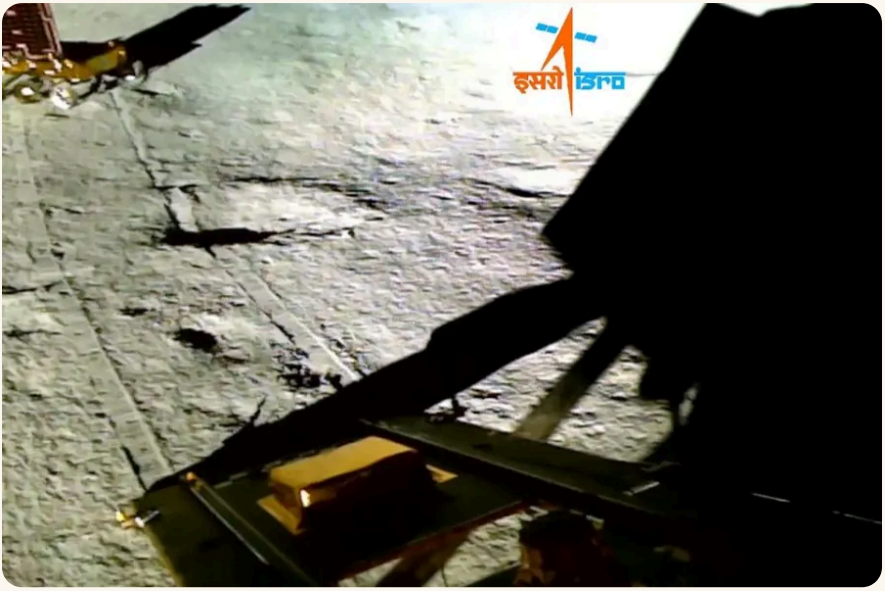
- **LIBS (Laser Induced Breakdown Spectroscope):** a laser tool that finds which elements a rock holds.
- **APXS (Alpha Particle X-ray Spectrometer):** an X-ray tool that looks for magnesium, aluminium, silicon, potassium, calcium, titanium and iron.

How does ChaSTE work?

Its probe can reach 10 cm below the surface. It has 10 temperature sensors along its length. That gives a vertical profile of heat.

Why did the rover matter?

The rover could test ground that the lander could not reach.



A dim frame from the lander’s camera shows the ramp and surface after the Pragyan rover rolled out on 24 August 2023. Credit: ISRO, via Wikimedia Commons (India’s open data licence, GODL-India). The frame is dim.

Chandrayaan-3 payloads

Lander: RAMBHA-LP, ChaSTE, ILSA, LRA

Rover: LIBS and APXS

Propulsion module: SHAPE

Illustration: Payloads from the ISRO details page.

> **Quick check 4.** The rover's LIBS instrument confirmed sulphur in the soil near the south pole. *(True or False?)* See answer ↓

Sources: isro.gov.in

6 What did Chandrayaan-3 find?

It found sulphur and other elements, and it recorded soil temperatures near the pole. The results arrived in the days after landing. Later studies added more.

What did the first week show?

- **27 August:** ChaSTE sent the first temperature profile for the lunar south pole.
- **28 August:** the rover’s LIBS confirmed sulphur.
- **30 August:** APXS found minor elements in the soil.

ISRO credits the sulphur result to the rover's LIBS tool.

How far did the rover travel?

ISRO's release of 23 August 2024 says the rover covered about 101 m. The data are open to researchers on ISRO's portal.

Did it land inside a crater?

Yes, a buried one. A study by PRL and ISRO scientists found the site sits inside an old crater. It is about 160 km wide and 4.4 km deep. Layers of debris have worn it down.

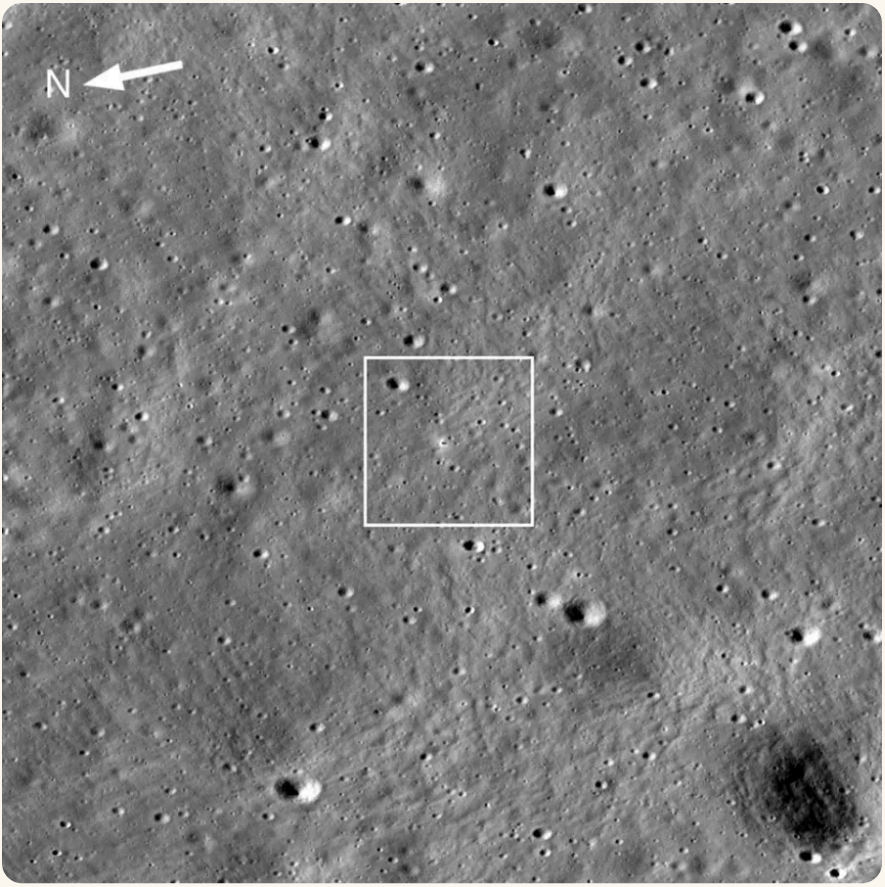
Where is the site compared with the big basin?

It sits about 350 km from the rim of the South Pole-Aitken basin.

- **South Pole-Aitken basin:** the largest and oldest basin on the Moon.
- **Distance:** the site lies about 350 km from the basin rim.
- **Ejecta:** the basin added about 1,400 m of material. Eleven other basins added about 580 m.

Is the site near the pole?

Fairly near, but not at it. NASA says it is about 600 km from the pole. Its Lunar Reconnaissance Orbiter imaged the site four days after landing. The bright halo is where the rocket plume hit the regolith.



NASA's Lunar Reconnaissance Orbiter imaged the landing site four days after touchdown. The white box marks the site. Credit: NASA/GSFC/Arizona State University, via Wikimedia Commons, public domain. Cropped and resized from the original.

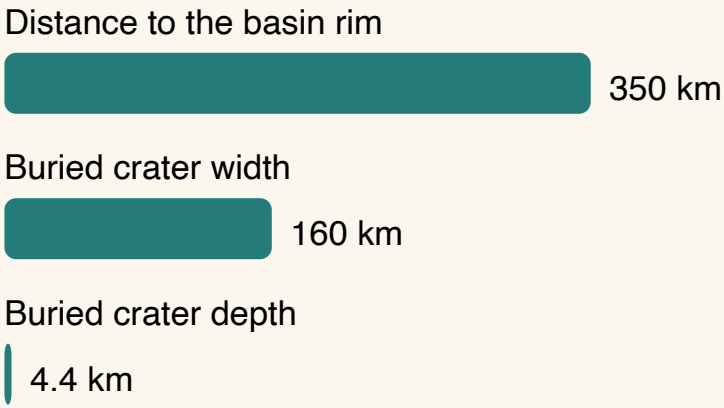


Illustration: Figures from the ISRO news of 30 September 2024.

> **Quick check 5.** Chandrayaan-3 landed inside a buried impact crater about 160 km wide. *(True or False?)* See answer ↓

Sources: isro.gov.in; nasa.gov

7 What happened after the landing?

The lander and rover worked about one lunar day. Then came a hop, a long sleep and a quiet second career.

What was the hop?

On 2 September 2023 Vikram fired its engines again. It rose about 50 cm and landed nearby. It used its leftover fuel. ISRO calls this a key skill for future sample-return missions.

What did the hop teach?

The engine blast stripped the top few centimetres of loose dust. ChaSTE measured that change. The top 2 to 6 cm of soil is sticky and full of holes. It can act like a thermal blanket.

Did the craft wake up again?

No wake-up has been reported.

- **4 September 2023:** ISRO put the lander and rover in sleep mode.
- **About 22 September:** the Sun was due to return. ISRO said it was trying to reach them.
- **Outcome:** the ISRO pages read give no sign of a reply.

What did the lander's mirror do?

It is meant to serve as a fixed laser marker near the pole for decades. The LRA has eight small corner reflectors and weighs about 20 g. NASA's Lunar Reconnaissance Orbiter (LRO) bounced a laser off it on 12 December 2023. ### What happened to the propulsion module?

It moved from lunar orbit back to Earth orbit. The first move was on 9 October 2023. It left the Moon's pull in November 2023. SHAPE carries on watching Earth.

2 Sep 2023
Hop of about 50 cm

4 Sep 2023
Lander and rover in sleep mode

9 Oct 2023
Module leaves lunar orbit

12 Dec 2023
LRO ranges the reflector

Illustration: Dates from ISRO updates.

Quick check 6. The Chandrayaan-3 propulsion module crashed on the Moon after the lander separated. *(True or False?)* See answer ↓

Sources: isro.gov.in

8 What names, days and missions followed?

Success brought names, a new national day and a bigger plan.

What is the Shiv Shakti point?

On 26 August 2023 the Prime Minister named the lander's spot Shiv Shakti Point. He named the Chandrayaan-2 spot Tiranga Point. A Cabinet resolution also lists both names. The US names gazetteer lists the landing site as Statio Shiv Shakti.

What is National Space Day?

The Government named 23 August as National Space Day to honour the landing. The first one was held on 23 August 2024. The theme was "Touching Lives while Touching the Moon: India's Space Saga".

What is Chandrayaan-4?

On 18 September 2024 the Union Cabinet approved it. It is a technology demonstration mission. The craft must land, collect samples and return to Earth.

- **Cost:** Rs 2,104.06 crore.
- **Time:** 36 months from approval.
- **Rockets:** two launches of the LVM3 rocket.
- **Bigger plan:** an Indian landing on the Moon by 2040.

18 Sep 2024
Cabinet approval

Rs 2,104.06 crore
Cost

36 months
Time from approval

Two LVM3 launches
Rockets planned

Illustration: Plan from the PIB release.

Sources: pib.gov.in; pmindia.gov.in; planetarynames.wr.usgs.gov

What is great to know about the launch centre?

9 What is the Virtual Launch Control Centre?

One news report describes it as a remote testing centre at VSSC in Thiruvananthapuram. UPSC asked about this centre. The ISRO pages read say little about it.

What does the report say it is?

A news report quotes S. Somanath, then director of the Vikram Sarabhai Space Centre (VSSC). He said ISRO built a Virtual Launch Control Centre there, in Thiruvananthapuram. It lets teams test rocket systems at Sriharikota from far away.

Why was it built?

To cut travel during the Covid-19 pandemic. ISRO wanted fewer people to travel to Sriharikota. The real launch control centre stays in the Mission Control building at Sriharikota. Its systems are copied at VSSC.

Did it launch Chandrayaan-3?

Not as far as the sources show. No ISRO page read describes its role in the Chandrayaan-3 launch. The report does not mention that mission. It supports only a role in remote testing.

What do we know about nearby events?

PSLV-C49 lifted off on 7 November 2020. Business Standard called it ISRO's first launch since the lockdown. ISRO's page gives a lift-off time of 1511 IST.

Sources: keralakaumudi.com; business-standard.com; isro.gov.in

How do I answer an exam question on Chandrayaan-3? Exam practice

10 What did UPSC ask, and what are the traps?

UPSC asked about Chandrayaan-3 in the 2023 Mains. This card gives the wording, an outline and the traps.

What did the past paper ask?

How could you answer it?

- **Task:** a safe, soft landing on the Moon.
- **Countries:** the Soviet Union, the United States, China, India and Japan.
- **Subsystems:** propulsion module, lander module and rover, with their payloads.
- **Centre:** remote testing of rocket systems from VSSC.

What are the traps?

1. **Dates.** Launch 14 July 2023. Landing 23 August 2023.
2. **Hop.** 2 September 2023, about 50 cm.
3. **Masses.** 2,148 kg, 1,752 kg and 26 kg. The total is about 3,900 kg.
4. **Names.** Shiv Shakti is Chandrayaan-3. Tiranga is Chandrayaan-2.

5. **Rank.** Fourth country to touch the Moon, per the Prime Minister.
6. **Crater.** About 160 km wide, 4.4 km deep.
7. **Sleep.** Sleep mode began by 4 September, not 2 September.

Sources: mcqquestion.com; isro.gov.in; pib.gov.in

Review your 6 understanding checks

Review the feedback after each answer. The understanding-check score lasts for this page session.

Reset the checks when you want another attempt. This score is separate from the practice score below.

Questions to think through

Why did ISRO test the landing system on a helicopter and a crane?

Those tests checked the cold and hot runs of the sensors and engines before the real descent.

Why is the soft landing the key skill?

Every later step needs it, from rovers to sample return. A crash ends the mission at once.

Why does the hop matter for Chandrayaan-4?

Sample return needs a craft that can lift off again. The hop showed Vikram could relight its engines.

Why is the Virtual Launch Control Centre answer kept short?

Only one news report was found. ISRO pages read do not say more.

Sources: isro.gov.in; keralakaumudi.com

Practice MCQs

1. What was the main task of Chandrayaan-3 that Chandrayaan-2 had failed to achieve?

A. Placing a rover inside the lander

B. Entering an orbit around the Moon

C. Carrying a separate orbiter to lunar orbit

D. Making a safe and soft landing on the lunar surface

See answer ↓

2. Which Chandrayaan-3 instrument used laser-induced breakdown spectroscopy to confirm sulphur in the lunar soil near the south pole?

A. LIBS on the rover

B. RAMBHA-LP on the lander

C. APXS on the rover

D. ChaSTE on the lander

See answer ↓

3. On which date did the Vikram lander separate from the Chandrayaan-3 propulsion module?

A. 17 August 2023

B. 5 August 2023

C. 14 August 2023

D. 23 August 2023

See answer ↓

4. National Space Day is observed on which date, chosen to honour the Chandrayaan-3 landing?

A. 7 September

B. 5 August

C. 14 July

D. 23 August

See answer ↓

5. A study by PRL and ISRO scientists found that Chandrayaan-3 landed inside a buried impact crater of about what width?

A. 600 km

B. 350 km

C. 4.4 km

D. 160 km

See answer ↓

6. What was the approximate total mass of the Chandrayaan-3 spacecraft at launch, including the propulsion module, lander and rover?

A. 2,148 kg

B. 1,752 kg

C. 3,900 kg

D. 26 kg

See answer ↓

Answer Key

1. **D.** The correct answer is **making a safe and soft landing on the lunar surface**. ISRO lists a safe soft landing as the first goal of Chandrayaan-3. NASA says ISRO lost contact with the Chandrayaan-2 lander shortly before touchdown in September 2019. Vikram then landed on 23 August 2023. Entering an orbit around the Moon is wrong because that is not the step Chandrayaan-2 failed at. Placing a rover inside the lander is wrong because that is how the rover travelled, not the failed task. Carrying a separate orbiter is wrong because Chandrayaan-3 carried a propulsion module and used the old orbiter only as a backup link. Memory hook: the lander is what failed in 2019, so the landing is what had to work in 2023. ↑ Q1
2. **A.** The correct answer is **LIBS on the rover**. ISRO's update log of 28 August 2023 credits LIBS with confirming sulphur. APXS is wrong because it uses X-ray emission, not a laser, and ISRO reported its results later, on 30 August. ChaSTE is wrong because it measures temperature below the surface. RAMBHA-LP is wrong because it is a Langmuir probe for the plasma near the surface. Memory hook: L for laser and L for LIBS. ↑ Q2
3. **A.** The correct answer is **17 August 2023**. ISRO's update log records the separation on that date. 5 August is wrong because that is when the craft entered lunar orbit. 14 August is wrong because that was a lunar orbit reduction to 151 by 179 km. 23 August is wrong because that is the landing date. Memory hook: orbit on the 5th, separate on the 17th, land on the 23rd. ↑ Q3
4. **D.** The correct answer is **23 August**. The Prime Minister announced it on 26 August 2023, and PIB says the first National Space Day was held on 23 August 2024. 14 July is wrong because that is the launch date. 7 September is wrong because that is the date Chandrayaan-2 lost contact, in India time. 5 August is wrong because that is when Chandrayaan-3 entered lunar orbit. Memory hook: the day India landed is the day India celebrates space. ↑ Q4
5. **D.** The correct answer is **160 km**. ISRO's news of 30 September 2024 says the buried crater is about 160 km wide and about 4.4 km deep. 350 km is wrong because that is the distance from the site to the South Pole-Aitken basin rim. 600 km is wrong because NASA gives that as the approximate distance of the site from the pole. 4.4 km is wrong because that is the depth. Memory hook: 160 wide, 4.4 deep, 350 to the big basin. ↑ Q5

6. **C.** The correct answer is **about 3,900 kg**. ISRO's details page gives the three parts that add up to it. 1,752 kg is wrong because that is the lander module with the rover inside. 2,148 kg is wrong because that is the propulsion module alone. 26 kg is wrong because that is the Pragyan rover alone. Memory hook: 2,148 plus 1,752 makes 3,900. ↑ Q6

Quick-check answers

1. **True.** ISRO's update log gives 14 July 2023 at 14:35 IST, from the second launch pad. ↑ 1
2. **True.** He said so on 26 August 2023 in his address to the ISRO team. ↑ 2
3. **False.** ISRO's details page sets the slope limit at 12 degrees or less. The vertical speed limit is 2 m/s. ↑ 3
4. **True.** ISRO's update log of 28 August 2023 credits LIBS with confirming sulphur. ↑ 4
5. **True.** A PRL and ISRO study found the site lies within a buried crater of about 160 km, roughly 4.4 km deep. ↑ 5
6. **False.** ISRO moved it from lunar orbit back to Earth orbit in October and November 2023. SHAPE kept watching Earth. ↑ 6

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