इसरो ISRO

CHANDRAYAAN 3

India's Historic Moon Landing

HANDOUT

ENGLISH EDITION

Chandrayaan- 3: India Lands First in Southern Polar Region

India has made history as its Moon mission becomes the first to land in the lunar south pole region. With this, India joins an elite club of countries to achieve a soft landing on the Moon, after the US, the former Soviet Union and China. The Vikram lander from Chandrayaan-3 successfully touched down as planned at 18:04 local time (12:34 GMT). Two visitors from India — a lander named Vikram and a rover named Pragyan — landed in the southern polar region of the moon on 23 Aug 2023. The two robots, from a mission named Chandrayaan-3, make India the first country to ever reach this part of the lunar surface in one piece — and only the fourth country ever to land on the moon. The Indian mission launched in July, taking a slower, fuel-conscious route toward the moon. Vikram out-endured its Russian counterpart, Luna-25, which launched 13 days ago for the moon. It was scheduled to land on 21 Aug 2023 in the same general vicinity as the Indian craft but crashed on 19 Aug 2023 following an engine malfunction. The Aug. 23 landing was selected because it is the day when the sun will rise at the landing site. The mission is to conclude two weeks later when the sun sets. While on the surface, the solar-powered lander and rover will use a range of instruments to make thermal, seismic and mineralogical measurements.

The Deep Space Network, a NASA network of large dish antennas, is assisting ISRO in communicating with the ground. Right now, it shows Chandrayaan-3 sending signals.

Beginning

Chandrayaan-3's development phase commenced in January 2020, with scientists and engineers working on the spacecraft's design and assembly. Learning from the previous mission's setbacks, ISRO has made enhancements, including stronger impact legs for the lander.

Timeline

Chandrayaan-3 was launched aboard the Launch Vehicle Mark 3 (LVM 3) rocket. Unlike its predecessor, the orbiter was not included in this mission. The spacecraft reached the moon's South Pole and operate for one lunar day, approximately 14 earth days. The trajectory will follow a similar

path as Chandrayaan-2, with the propulsion module orbiting the Earth several times before heading towards the moon. Once within the moon's gravitational pull, the module will adjust its orbit to a circular path of about 100 x 100 km. Subsequently, the lander will separate and descend to the lunar surface.

Objectives

The journey from Earth to the moon is estimated to take around a month. The landing is currently scheduled for August 23-24, with potential adjustments depending on the sunrise over the moon. If necessary, ISRO will reschedule the landing for September. Upon landing, the lander named 'Vikram' will deploy its four scientific payloads to study the moon's surface temperature and subterranean characteristics. Additionally, the lander carries an instrument called 'Spectro-polarimetry of HAbitable Planet Earth' (SHAPE), designed to collect data on light emission and reflection from Earth. The rover, 'Pragyan,' will explore the lunar surface using chemical tests as it moves across the terrain.

Why explore Moon?

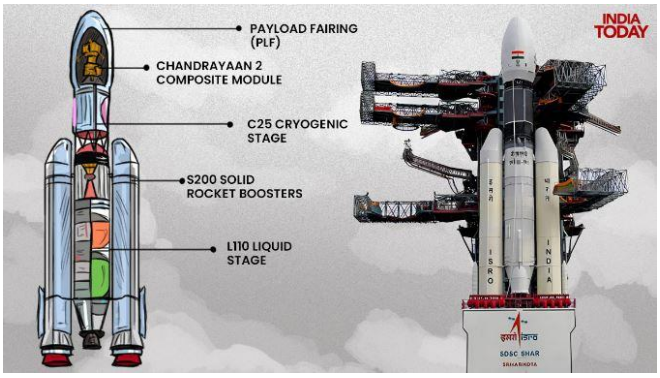
The Moon offers a multitude of answers and opportunities across various domains, comparable to the countless craters dotting its surface. As the Moon formed from Earth, it serves as a repository of Earth's early history, preserving records that have been erased on our dynamic planet due to geological processes. Exploring the Moon provides scientists with invaluable insights into Earth's origins, the formation and evolution of the Earth-Moon system, and the influence of asteroid impacts on Earth's past and potentially its future.

First to land on Moon's South Pole

The Chandrayaan-3 will the first to land on Moon's South Pole. No human missions so far, including the human Moon missions of the United States, have taken any spacecraft to the South Pole. Therefore, the successful landing of Chandrayaan-3 on Moon's South Pole will be a demonstration of technical prowess and bold spacefaring ambitions. The lunar south pole is of special interest because parts of it remain permanently in shadow, raising the possibility of sampling Moon ice for the first time. Moreover, the large craters near the lunar south pole might contain clues to the composition of the early Solar System. This will be the first time any tests would be conducted on the South Pole, so data and conclusions drawn are set to be studied keenly across the world.

Note: Notably, this is India's second mission to South Pole. The Chandrayaan-1 (2008) was intentionally crashed into the South Pole that confirmed the presence of water ice in a major discovery.

LVM-3 aka Bahubali of Rockets

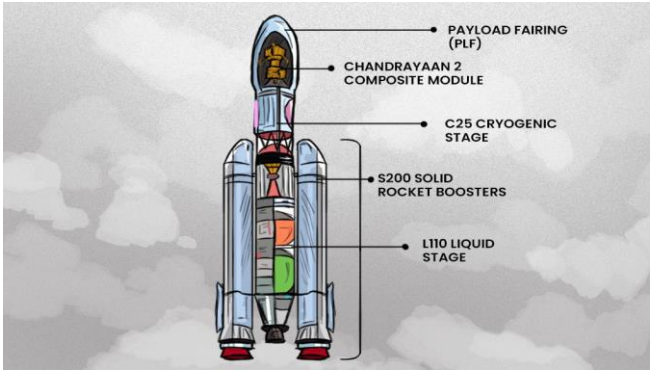


The LVM-3 is a heavy-lift launch vehicle, which means that it can carry a large payload into space. It is the most powerful rocket that ISRO has ever developed, and it is unmatched in its class. Christened as the 'Bahubali' of rockets, LVM-3 is a three-stage rocket, consisting of two solid-fuel boosters and a liquid-fuel core stage powering it. The solid-fuel boosters provide the initial thrust, while the liquid-fuel core stage provides the sustained thrust to propel the rocket into orbit. The rocket is powered by two solid strap-on motors (S200), one liquid core stage (L110), and a high-

thrust cryogenic upper stage (C25) with a propellant loading of 28 tons. The LVM-3 has a lift-off mass of 640 tonnes, and it can carry a payload of up to 4,000 kilograms into geosynchronous transfer orbit (GTO). LVM-3 has been used to launch a number of different satellites in the past, including the GSAT-19 communication satellite, the Astrosat astronomy satellite, and the Chandrayaan-2 lunar mission. It is also scheduled to be used to launch the Gaganyaan crewed mission, which will be India's first human spaceflight.

How does it work?

The rocket operates using a staged combustion cycle, employing liquid-fueled engines for its core and strap-on boosters. The core stage of the rocket is powered by two Vikas engines, each generating an impressive thrust of 720 kN. Meanwhile, two solid propellant boosters provide additional thrust during the initial phase of the launch. The upper stage of the LVM-3 utilizes the CE-20 engine, an indigenously developed cryogenic engine, which provides the necessary thrust to reach the desired orbit.



The 43.5 m tall three-stage launch vehicle gives India full self-reliance in launching heavier communication satellites that weigh up to 4000 kg in GTO.

The rocket was previously known as the GSLV-MkIII, however, the Indian space agency has rebranded it as LVM-3 and has so far flown three successful missions.

The Chandrayaan-3 launch will be its fourth mission to propel a payload beyond the orbit of Earth.

Here are the different kinds of moon missions that have been launched so far:

1. Flybys: These are the missions in which the spacecraft passed near the Moon but did not get into an orbit around it. These were either designed to study the Moon from a distance or were on their way to some other planetary body or deep space exploration and happened to pass by the celestial body. Some early examples of flyby missions were Pioneer 3 and 4 by the United States and Luna 3 of the then USSR.

2. Orbiters: These were spacecraft that were designed to get into a lunar orbit and carry out prolonged studies of the Moon's surface and atmosphere. India's Chandrayaan-1 was an Orbiter, as were 46 other Moon missions from various countries. Orbiter missions are the most common way to study a planetary body. So far, landings have been possible only on the Moon, Mars and Venus. All other planetary bodies have been studied through orbiter or flyby missions. Chandrayaan-2 mission also consisted of an orbiter, which is still operational and orbiting the Moon at an altitude of around 100 km.

3. Impact Mission: These are an extension of Orbiter missions. While the main spacecraft keeps going around the Moon, one or more instruments on board make an uncontrolled landing on the lunar surface. They get destroyed after the impact, but still send some useful information about the Moon while on their way. One of the instruments on Chandrayaan-1, called Moon Impact Probe, or MIP, was also made to crash land on the Moon's surface in a similar way. ISRO claimed that the data sent by the MIP had presented additional evidence of the presence of water on the Moon, but these findings could not be published because of calibration errors.

4. Landers: These missions involve the soft landing of the spacecraft on the Moon. These are more complicated than the Orbiter missions. In fact, the first 11 attempted lander missions had all

ended in failure. The first landing on the moon was accomplished on January 31, 1966, by the Luna 9 spacecraft of the then USSR. It also relayed the first picture from the Moon's surface.

5. Rovers: These are an extension of the lander missions. The lander spacecraft, because they are bulky and have to stand on legs, remain stationary after landing. The instruments on board can carry out observations and collect data from close quarters but cannot come in contact with the Moon's surface or move around. Rovers are designed to overcome this difficulty. Rovers are special wheeled payloads on the lander that can detach themselves from the spacecraft and move around on the moon's surface, collecting very useful information that instruments within the lander would not be able to obtain. The rover onboard Vikram lander in the Chandrayaan-2 mission was called Pragyaan.

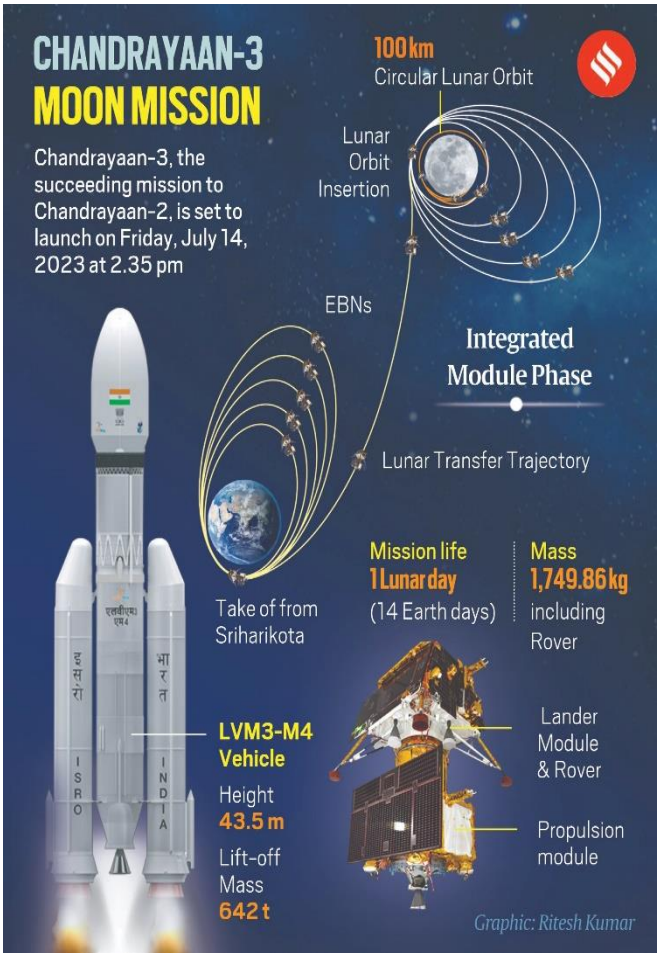
6. Human missions: These involve the landing of astronauts on the moon's surface. So far only NASA of the United States has been able to land human beings on the moon. So far, six teams of two astronauts each have landed on the moon, all between 1969 and 1972. After that, no attempt has been made to land on the Moon. But with NASA's Artemis III, currently planned for 2025, humanity is set to once again to the lunar surface in more than 50 years.

India's Chandrayaan-3 and its benefits for the US

The data from Chandrayaan-3 could prove useful for future Artemis human landings. India has signed the Artemis Accords, which advance a common vision of space exploration for the benefit of all humankind. Chandrayaan-3's major goal is to land safely on the lunar surface, undertake rover operations, and conduct critical scientific investigations. This project has enormous promise for the future of space travel, with data from it likely to benefit NASA's Artemis program, which intends to establish a long-term human presence on the moon.

Indian Space Research Organisation (ISRO)

- ✓ Headquarters: Bengaluru
- ✓ Founded: 15 August 1969
- ✓ Founder: Vikram Sarabhai
- ✓ Chairperson: S. Somanath
- ✓ Owner: Government of India



Chandrayaan-3

Chandrayaan-3 consists of a lander module (LM), a propulsion module (PM) and a rover. It was launched by the LVM3-M4 on July 14. The integrated module (comprising LM, PM and rover) was placed in an elliptical parking orbit (EPO) of size ~170 x 36500 km

LAUNCH VEHICLE

LMV3-M4

Height: 43.5 m

Lift-off mass: 642 t

PROPULSION MODULE (PM)

Mission life: PM will carry the lander and the rover from the injection orbit to a circular lunar orbit. Its payload will be operational for 3 to 6 months

Mass: 2,145 kg

Power: 738 W, summer solstice and with bias

Payload: 1

LANDER

Mission life: 1 lunar day (14 earth days)

Mass: 1,749.86 kg including rover

Power: 738 W (winter solstice)

Payloads: 4

Chandrayaan-3 spacecraft

ROVER

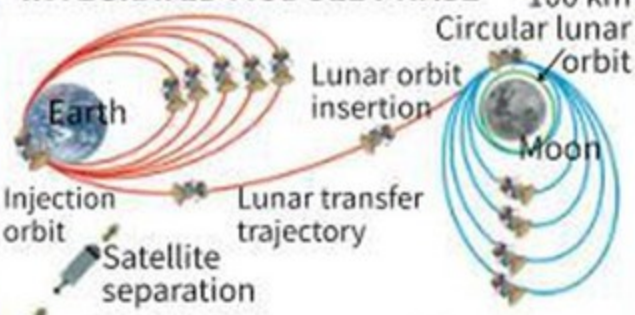
Mission life: 1 lunar day.

Mass: 26 kg

Power: 50 W

Payloads: 2

INTEGRATED MODULE PHASE



Chandrayaan-3 will follow the same trajectory as its predecessor. The Propulsion Module will orbit the Earth several times before slingshotting towards the Moon. Once within the Moon's gravitational pull, the module will lower itself to a 100 x 100 km circular orbit. Subsequently, the Lander will detach and descend to the surface

Distance between earth and moon

3,84,400 km

When the lander will land on the moon

The landing is scheduled for August 23-24

Where will the lander land?

It is likely to land near the moon's south pole and operate for one lunar day, equivalent to 14 earth days