ACHIEVEMENTS OF CONTEMPORARY BHARAT

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MINISTRY OF EDUCATION
Government of India

CHANDRAYAAN UTSAV

CODE 1.7S

SPECIAL MODULE

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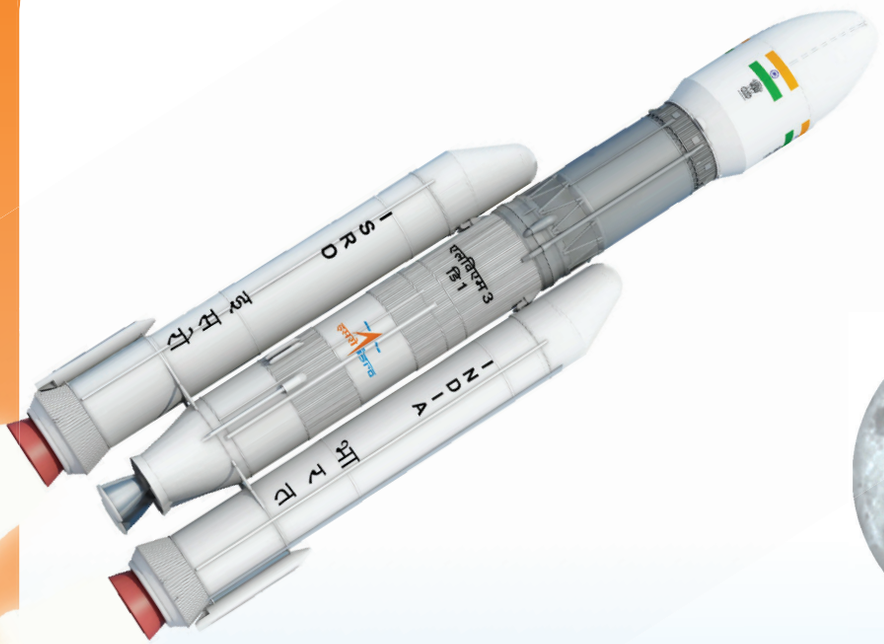


Exploring Chandrayaan-3
Bharat's Lunar Mission

Secondary Stage

What is Chandrayaan-3?

As the students eagerly await their science teacher's arrival; there was a palpable sense of expectation to learn something new. The moment she entered the class, she declared, "Today, we will embark on a captivating journey into space exploration!" With a twinkle in her eyes, she posed a question, "Which recent space initiative by Bharat has amazed the world?"

Ramesh promptly replied, "Mission Chandrayan-3".

Appreciating the reply given by Ramesh, the teacher instructed the students in the class to voluntarily create a narrative on the Mission contributing one or two facts about it and connecting the threads. Students were very excited!

Suman begun with her statement, "India created history on 23rd August 2023 when it landed on the Moon, making it the first country to land near the South Pole of the Moon, and the fourth country to join the group of countries to successfully land on the Moon."

Then one-by-one the following facts were contributed by the students about the mission-

Preet: "the other three countries which landed on the Moon's surface are US, Russia and China."

Aman: "Chandrayaan-3 was launched aboard from Launch Vehicle Mark – III (LVM3) rocket."

Shrija: "Chandrayan-3 landed near the South Pole of the Moon; the prospect of finding water on the Moon is the key reason behind choosing the South Pole of the Moon. The South Pole has a specific advantage with respect to being less illuminated by the sun. The frozen water untainted by the Sun's radiation might have accumulated in cold polar regions over millions of years, leading to the accumulation of ice on or near the surface."

Joseph recollected: "When Chandrayaan-2 couldn't make a successful landing, our Hon'ble Prime Minister encouraged the project team, emphasising that even in failure, there were lessons to be learned. This motivation fuelled our scientists' resolve, culminating in the monumental success of Chandrayaan-3."

Ratan, with a questioning look, inquired, "But why do we undertake such missions? What benefits do they bring?"

The students, brimming with curiosity, turned their attention to the teacher, awaiting her insights.

The teacher elaborated, "Lunar missions are pivotal for various reasons:

- They allow us to study the Moon's surface, geology, composition, and the distribution of key elements and minerals. Such explorations also augment our comprehension of the Moon's evolution.
- The Moon's geology offers clues about the formative years of the Earth-Moon system, shedding light on the evolutionary journey of planets and their satellites.
- Locating lunar resources, especially water ice, is vital for envisaging future lunar bases and ensuring the sustainability of space expeditions.
- Moreover, the Moon is an unparalleled platform for astronomical observations, unhindered by Earth's atmospheric disturbances. Instruments stationed on the Moon can offer unprecedented views of cosmic events."

Activity 1

Concluding her explanation, the teacher encouraged students to delve deeper into lunar missions. Distributing newspapers featuring articles about Chandrayaan-3, she divided the class into three groups, assigning each a theme to research and present.

Group 1- History of Lunar missions

Group 2- Brief history of India's Lunar missions

Group 3 -The Components of Chandrayaan-3 Mission

Students sat in groups, discussed the theme, distributed newspapers among them, and began reading newspapers. Some students obtained permission from the teacher to go to the computer lab and search the internet for information. Since science period had ended, mathematics teacher joined; seeing the students preoccupied with Chandrayaan Mission, the teacher permitted the students to continue their work in mathematics period as well, and placed some mathematical questions before them to be answered in the group work.

Question-1: If the average distance from the Earth to the Moon is about 384,400 km, how long would it take a spacecraft traveling at an average speed of 1,600 km/h to reach the Moon?

Question-2: A rocket's engine produces a thrust of 20,000 Newtons to lift a payload weighing 2,000 kg. If the gravitational force on Earth is approximately 9.81/29.81m/s2, will the rocket overcome Earth's gravity to ascend?

Students worked in Groups and made their group-wise presentations.

Group 1- History of Lunar Missions

Earth's Moon is the fifth largest moon in the solar system and the only astronomical object beyond Earth, where humans have set foot. More than 107 robotic spacecraft have been launched to explore the Moon. It is the only celestial body beyond the Earth, which, so far, is most explored and visited by human beings.

There have been different types of Moons Mission such as–

- **Flyby Missions**

These missions are designed to pass by the Moon without entering its orbit or landing on its surface. The spacecraft typically captures and sends back data during its closest approach. Flybys provide initial data about the Moon's surface, atmosphere (exosphere), and magnetic environment. Luna 1 (by USSR in 1959) was the first lunar flyby mission, which transmitted data back to Earth until it was too far away, continuing on into a heliocentric orbit.

- **Orbiter Missions**

These missions aim to insert a space into a stable orbit around Moon, the spacecraft can study the Moon from proximity over a prolonged period, mapping its surface, studying its composition, and understanding its gravitational effects. Lunar Orbiter series by NASA in the 1960s, which were key in mapping the Moon and identifying potential landing sites for the Apollo missions are few Orbiter Missions.

- **Impact Missions**

These missions intentionally crash a spacecraft onto the Moon's surface. The impact can help scientists study the composition of the lunar regolith by analysing the ejected debris. Impact Missions can also be used to search for the presence of materials like water. Luna 2 (by USSR in 1959) was the first human-made object to impact another celestial body.

- **Lander Missions**

These missions aim to make a controlled descent and landing on the Moon's surface. Unlike Impact Missions, the goal is a soft landing. Once landed, these missions can deploy instruments to study the lunar surface directly, and can sometimes serve as a precursor to crewed missions. Luna 9 (by USSR in 1966) was the first mission to achieve a soft landing on the Moon and transmit photographic data back to Earth.

- **Rover Missions**

These missions land on the Moon and deploy rovers that can move across the lunar surface. Rovers can carry a suite of instruments, allowing them to conduct in-situ analysis of multiple locations on the Lunar surface. They offer the advantage of exploring a larger area than Stationary Landers. Luna 17 (by USSR in 1970) deployed Lunokhod 1, the first Lunar Rover, which travelled across the Moon's surface and sent back data and images to Earth.

Each type of mission provides unique insights into our understanding of the Moon, and as technology advances, the capabilities and objectives of these missions continue to expand. NASA followed with a series of robotic Ranger and Surveyor spacecraft that performed increasingly complex tasks that made it possible for the first human being to walk on the Moon in 1969. In addition to the US and Russia, China and India have both successfully soft-landed unmanned probes, landers, and rovers on the moon.

To know more about the status of these missions worldwide, you can visit the following website:

(https://moon.nasa.gov/exploration/moon-missions/)

Interesting facts

Twenty-four humans have travelled from the Earth to the Moon as of 2023. Out of them only twelve walked on its surface (Moon Walkers). The last human visit to the lunar surface was in 1972.

Group -2 Brief History of India's Lunar Missions:

Chandrayaan-1 (2008)

Chandrayaan-1 was India's first lunar mission, launched by the Indian Space Research Organisation (ISRO). Launched on October 22 2008, using a Polar Satellite Launch Vehicle (PSLV). Objectives included mapping the Moon's surface, studying its mineral composition, and searching for water ice. It made significant discoveries, including confirming the presence of water molecules on the Moon's surface.

Chandrayaan-2 (2019)

Chandrayaan-2 was the second lunar mission by ISRO, aimed at further lunar exploration and technology demonstration. Launched on July 22 2019, with an Orbiter, a Lander (Vikram), and a Lunar Rover (Pragyan) using a GSLV Mk III rocket. The orbiter continues to study the Moon from the orbit, providing valuable scientific data. Unfortunately, the lander lost communication during the descent, and the rover's mission was cut short.

Chandrayaan-3 (2023)

Chandrayaan-3 is a follow-on mission to Chandrayaan-2 to demonstrate end-to-end capability in safe landing and roving on the lunar surface. It was launched from the Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota on 14th July 2023.

Group-3 Bharat's Chandrayaan-3 Mission-Major Components

Chandrayaan-3 comprises three main components: a propulsion module, a lander, and a rover.

1. The propulsion module: The propulsion module carried the Lander and the Rover configuration to a 100-kilometre (62 mi) lunar orbit. It was a box-like structure with a large solar panel mounted

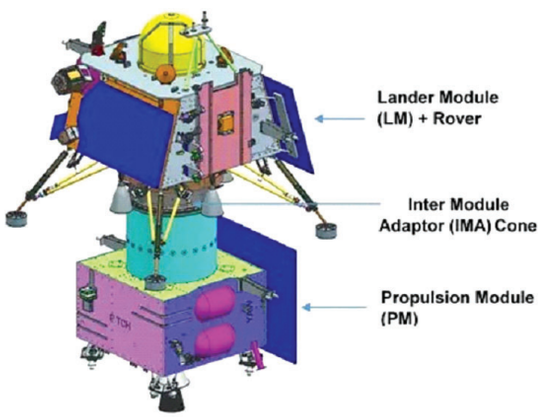


Figure 1: The overall anatomy of the Chandrayaan-3 rocket

on one side, and a cylindrical mounting structure for the lander (the Intermodular Adapter Cone) on top. The main function of Propulsion Module is to carry the Lander module (LM) from launch vehicle injection orbit to till Lander separation. It also carries a Spectro-polarimetry of Habitable Planetary Earth (SHAPE) payload/instrument to study the spectral and polarimetric measurements of earth from the lunar orbit.

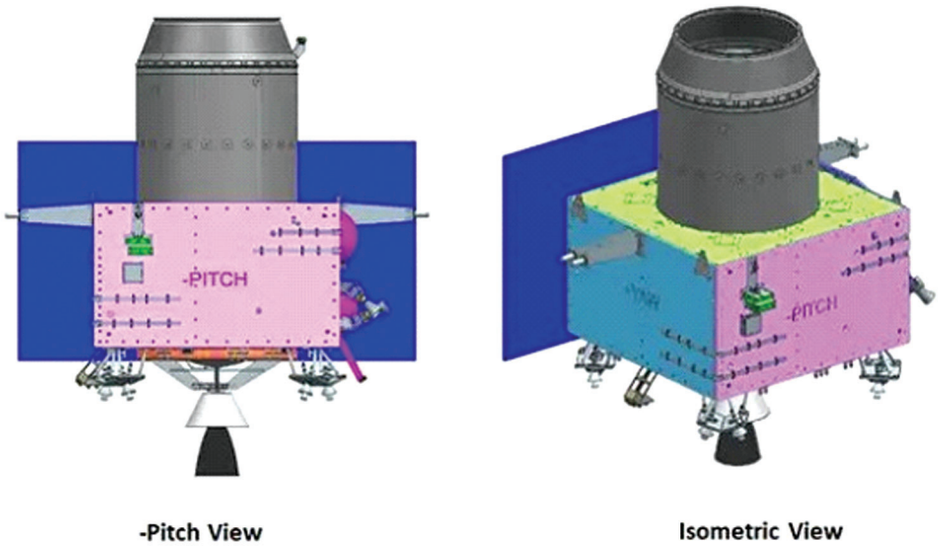


Figure 2: Different view of the propulsion module

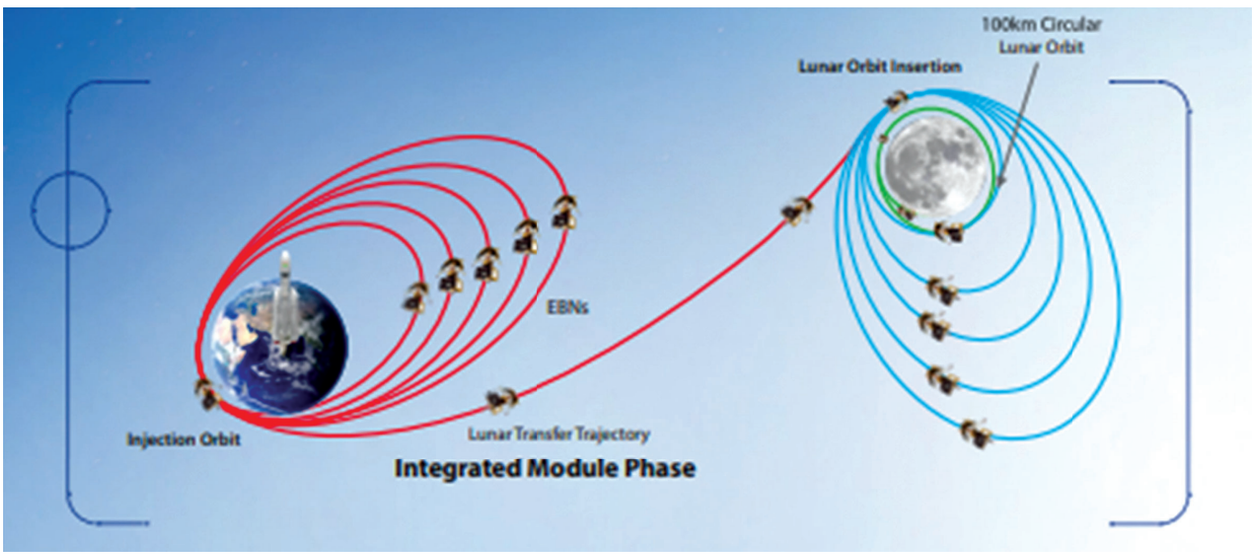


Figure 3: The trajectory of Chandrayaan-3 spacecraft

2. Lander (Vikram): The Vikram lander was named after the first chairman of ISRO, and the father of India's space program Dr. Vikram Sarabhai.

The lander was responsible for the soft landing on the Moon. It is also box-shaped, with four landing legs, and four landing thrusters capable of producing 800 Newton of thrust each. It carried the rover and had various scientific instruments to perform on-site analysis. The lander has four variable-thrust engines with capabilities to slow down the rates of descent during landing.

Figure 4: The Vikram lander carrying Rover and payloads

The lander Mission life is 1 Lunar Day (14 Earth days), and mass is 1749.86 kg including the Rover. The landing site is 69.373°S and 32.319°E. The landing site has been named Shiva Shakti Point by the Indian Prime Minister, Shri Narendra Modi.

3. Rover (Pragyan): Rover *Pragyaan* is named after the Sanskrit word *pragyan* (meaning wisdom or knowledge). Some lunar missions include rovers that can move across the lunar surface. These rovers are equipped with scientific instruments to study surface features up close. They are often solar-powered and controlled remotely from the Earth. The *Pragyan* Rover is a six-wheeled vehicle with a mass of 26 kilograms (57 pounds). It is (36.1 in × 29.5 in × 15.6 in) in size. The rover is expected to take multiple measurements to support research into the composition of the lunar surface, the presence of water ice in the lunar soil, the history of lunar impacts, and the evolution of the Moon's atmosphere.

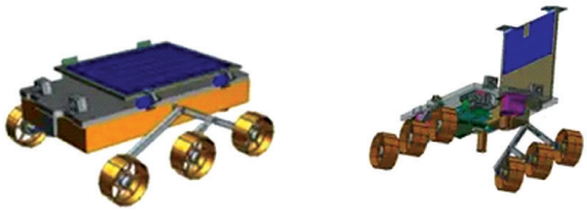


Figure 5: Rover powered by solar panels

4. Payloads: Different scientific instruments that have been sent along with the Orbiter, Lander and Rover of Chandrayaan-3 for elemental, chemical and physical analysis of the lunar surface and atmosphere are given below:

- Chandra's Surface Thermo Physical Experiment (ChaSTE) to measure the thermal conductivity and temperature.
- Radio Anatomy of Moon Bound Hypersensitive Ionosphere and Atmosphere (RAMBHA).
- Instrument for Lunar Seismic Activity (ILSA) for measuring the seismicity around the landing site.
- Langmuir Probe (LP) to estimate the plasma density and its variations.

Do you know why the landers and rover's mission life is only 1 lunar day?

The Moon always keeps the same face towards Earth because it takes the same amount of time to rotate on its axis as it does to orbit our planet. The Moon takes about one month to orbit Earth (27.3 days to complete a revolution, but 29.5 days (lunar cycle) to change from New Moon to New Moon?). Partly due to its eccentric orbit, partly due to the inclination of its orbit, we see the Moon from slightly different angles over the course of a month or a total of 59 per cent of the Moon's surface at one time or another. In simple terms, only one side of the Moon is always facing the Earth, while the other can never be visible. On Earth, it takes about 24 hours for the planet to make one rotation on its own axis. Of which, we remain exposed to the sun for 12 hours and plunged to darkness for another 12 hours. This completes a full-day cycle on Earth. Similarly, one face of the moon remains exposed to sunlight for one lunar day which equals approximately 14 days on Earth.

Since, Chandrayaan-3's lander and rover are solar-powered, it is likely they will be devoid of power after 14 days.

Other Planetary Missions of ISRO

Gaganyaan-1: Gaganyaan is an Indian crewed orbital spacecraft. It is intended to be the basis of the Indian Human Spaceflight Programme. This spacecraft is being built for three people only. It will be most probably launched in 2025. Similarly, the agency has one more lunar mission on the cards, in collaboration with the Japanese space agency, JAXA. This mission, called LUPEX, or Lunar Polar Exploration, is scheduled for 2024-25. Moreover, India has also developed its observatory class solar mission. The first Indian solar mission Aditya L-1 was successfully launched on 2nd September 2023, days after the soft landing of Chandrayaan-3 on the Moon. It would study the solar corona using a solar coronagraph. X-Ray spectroscopic instruments would be providing flare spectra while in situ payloads would observe solar events. Not only Moon, but ISRO is also on the race to explore more planetary objects like Venus, Mars, etc., in the next decade to come.

All three groups of students made presentations before the whole class, followed by interesting interaction among students about sincere efforts of our scientists that led to the success of Chandrayan Mission, expectations about exploration of other planets, nature of celestial bodies, design of rovers and landers, etc.

Teachers teaching them science, mathematics, social science and languages also witnessed these presentations, and discussed with them mathematical and social aspects of this mission.

Students also provided solutions to the given mathematical questions.

Answer 1: Time = Distance/Speed = 384,400 km÷1,600 km/h=240.25 hours or 10 days and 0.25 hours (i.e., 10 days and 6 hours).

Answer2: Gravitational force = Mass × Gravity = 2,000kg×9.81m/s2=19,620 Newtons. Since 20,000 Newtons > 19,620 Newtons, the rocket will overcome Earth's gravity.

Quiz

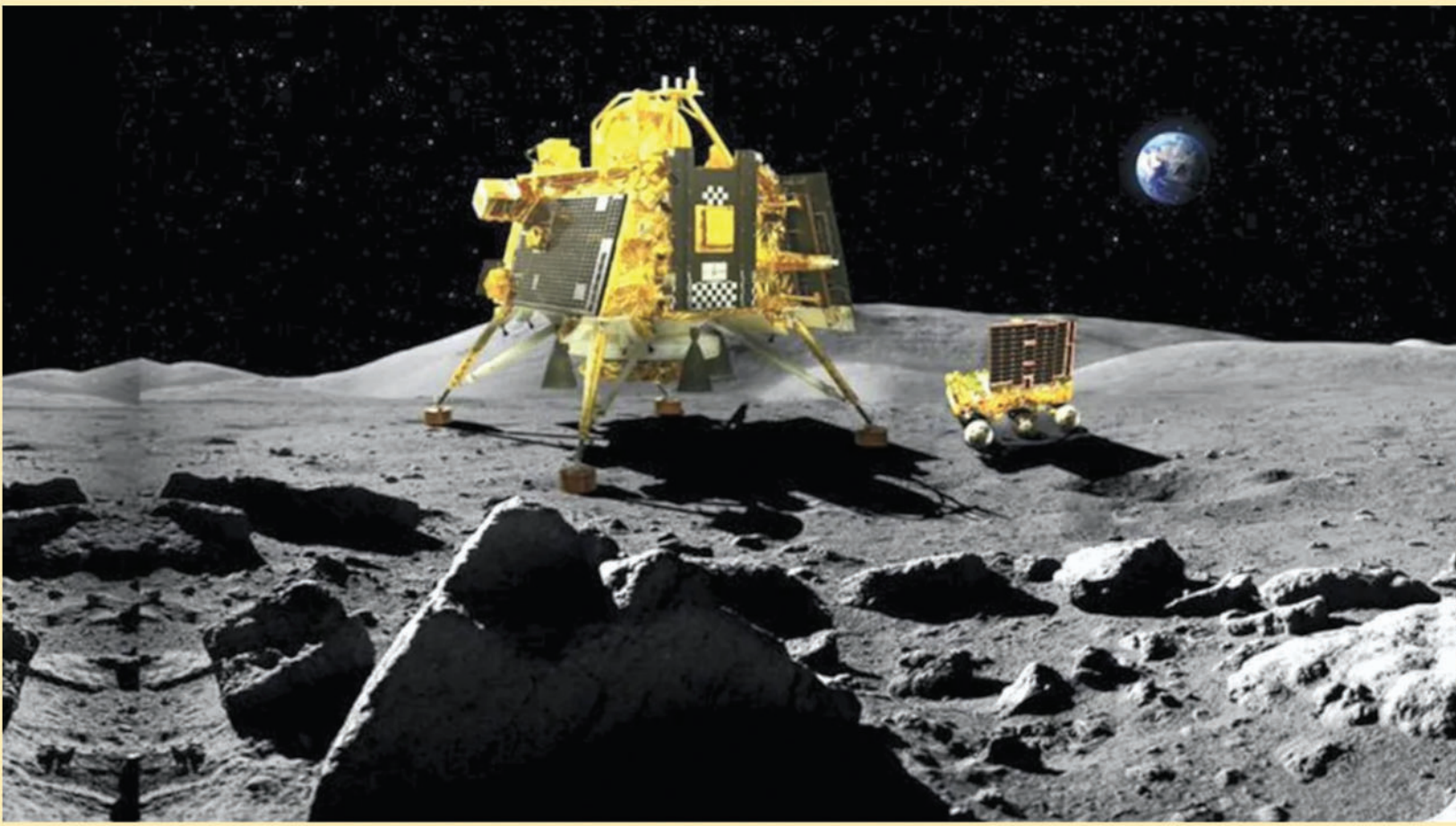
At the end of presentations, the science teacher conducted a simple quiz of the students and teachers and everyone participated with enthusiasm.

Theme 1.0 Chandrayaan Utsav

1.1	F	हमारा चंद्रयान Our Chandrayaan
1.2	P	*Mera Pyara Chanda: Rani ki Khoj*
1.3	M	Chandrayaan Mission: Bharat's Expedition to the Moon
1.4	S	Chandrayaan: Journey Towards the Moon
1.5	S	Exploring the Moon Mission of Bharat
1.6	S	Towards Moon and Beyond
1.7	S	Exploring Chandrayaan-3: Bharat's Lunar Mission
1.8	HS	Bharat on the Moon
1.9	HS	Bharat Space Mission: The Chandrayaan Mission
1.10	HS	Physics of Chandrayaan-3

For participation in the activities related to Apna Chandrayaan:
Visit : www.bharatonthemoon.ncert.gov.in

For more information:
Email: dceta.ncert@nic.in
PMeVIDYA IVRS: 8800440559



An image of Rover *Pragyan* with Lander *Vikram*

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