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India

A RISING SPACE POWER

India: A Rising Space Power | Secondary Stage

India: A Rising Space Power

(Secondary Stage)

August 2025

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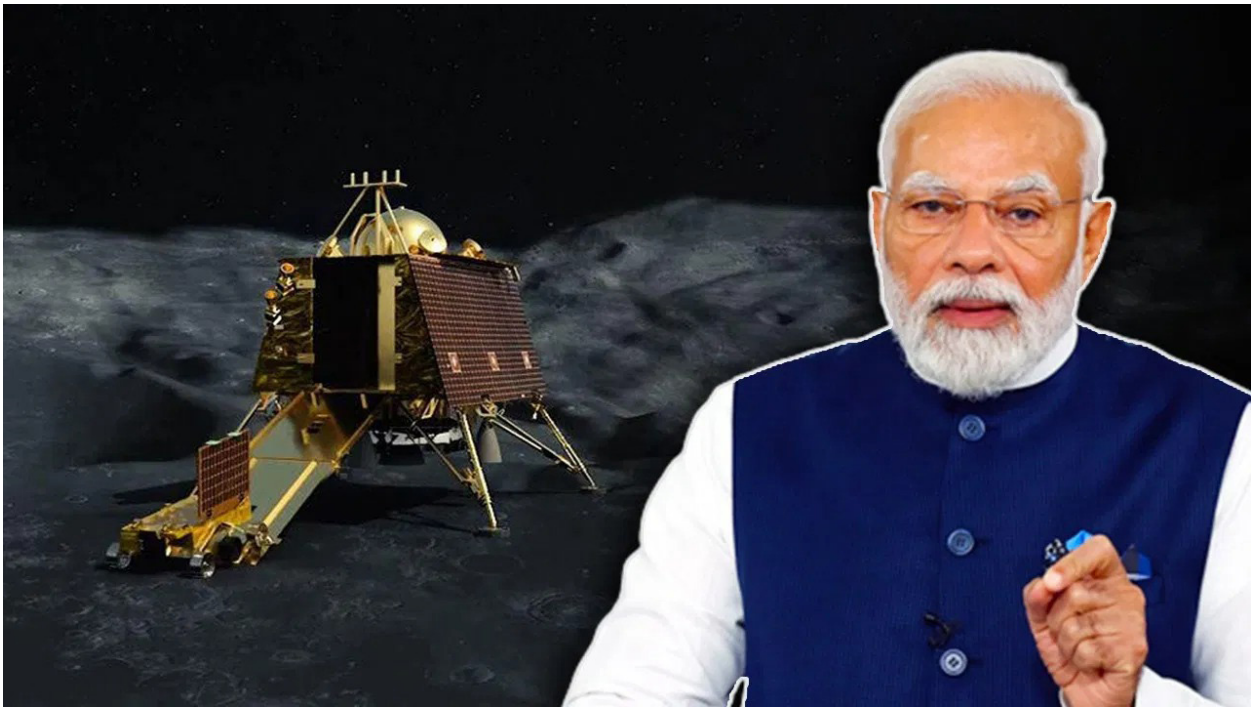
Published at the Publication Division, by the Secretary, National Council of Educational Research and Training, Sri Aurobindo Marg, New Delhi
110 016



Space may seem distant, but is an integral part of our daily life. It derives our modern communication and connects even the remotest family to the ordinary. India's space programme is a perfect example of our vision of Scale, Speed and Skill.

Hon'ble Prime Minister Shri Narendra Modi

INDIA: A RISING SPACE POWER

It was recess time in school. A group of students sat together under the shade of a big tree, chatting about different things India is doing. They started talking about India's space programmes and this topic caught everyone's attention.

The students grew more and more curious. They wanted to know how India had started this incredible journey and how it had come so far. Their excitement pushed them to seek answers. So, after recess, they went to their class.

The students nodded eagerly, ready to listen. And thus began a fascinating tale—the story of how India set out to reach the stars and became a rising space power.

India's Space Programme

The teacher said let us begin with India's Space Programme. It is a journey that began long ago, when India first dreamed of reaching the stars."

The students listened eagerly.

"It was the year 1962," she continued. "India set up the Indian National Committee for Space Research, or INCOSPAR." And do you know where the first rockets were launched from?

"The story to the stars began from a small building near the sea in Thiruvananthapuram! That place became the Thumba Equatorial Rocket Launching Station, or TERLS."

"Wow!" gasped the students. "So, India's space story began in a very small place in Kerala?"

"And in 1969, INCOSPAR grew into what we proudly call ISRO, that is Indian Space Research Organisation, today."

"Now, can anyone guess what India's very first satellite was called?" she asked with a smile.

"Aryabhatta!" All the students together.

"Exactly!" the teacher clapped her hands. "In 1975, Aryabhatta was launched for scientific researches. That same year, another amazing project began—the Satellite Instructional Television Experiment, or SITE. Through SITE, television programmes reached villages, teaching and connecting people across the nation."

"From this simple start, ISRO has grown into one of the most respected space agencies in the world. Today, it is a global leader in cost-effective space exploration—proving that big dreams can start small, but with determination, they can reach the stars."

The teacher asked, do you know how far India has come in space exploration?"

The teacher continued and told that till August 2025, ISRO has launched 160 satellites into different Earth orbits. Not only that—India has completed 131 spacecraft missions, 101 launch missions, and even nine re-entry missions! And here's something exciting—India has helped launch more than 433 foreign satellites from 35 different countries.

Can you imagine? Other nations now trust India to carry their dreams into space."

That is a proud moment for all of us. "India has also reached beyond Earth—to Mars and the Moon. On July 14, 2023, India has successfully launched its Chandrayaan–3 and has become fourth in reaching to Moon and first in landing the Vikram lander and Pragyan rover on the south pole of the Moon."

"Correct!" said the teacher proudly.

"on September 02, 2023, ISRO launched Aditya-L1, India's very first mission to study the Sun. It is now watching solar storms and learning how the Sun affects Earth."

"Very recently, in June 2025, India has also marked a historic milestone when Group Captain Shubhanshu Shukla became the first Indian astronaut to reach the International Space Station. India also plans to send Indian citizens to space and to establish its own Antariksh Station.

The class clapped in excitement, their voices buzzing with thrill.

The students said, "We are overwhelmed with India's success stories in space missions, and therefore we are eager to know more about the ISRO – the Indian Space Agency and its functioning."

Teacher extended the conversation by saying: "Good. ISRO has its headquarters in Bengaluru. ISRO was blessed to be led by many stalwarts since its inception in 1969."

Fig. 1: ISRO Chairpersons

The teacher further said: "Students, you can search internet for detailed information on its functioning."

Now the students are anxious and equally enthusiastic to discuss about the ISRO's achievements.

Teacher replied: "Excellent, students. Let us first ponder a little on main objectives and goals of the ISRO."

The teacher said, India's space programme is deeply rooted in nationalism, entrepreneurship, and national security. Since inception, successive governments have

prioritized space development as a tool for nation building, scientific advancement, and global status. Under Prime Minister Narendra Modi's leadership, space reforms have accelerated, with a strong push toward commercial innovation and low-cost missions like Chandrayaan, Aditya-L1, Gaganyaan, Mangalyaan, Antariksh Station, and other planetary missions. National security remains a key pillar, with growing reliance on satellite-based surveillance, navigation, and strategic intelligence. The development of "eye in the sky" capabilities strengthen India's border monitoring and military preparedness.

Students asked, "What is the vision now?"

The teacher further added, "2047 vision includes expanding satellite communication for rural and mobile services, enhancing imaging for climate and resource management, advancing space science missions, building heavy-lift and reusable launch vehicles, and launching India's human spaceflight programme. Together, these goals reflect a dynamic blend of scientific ambition, commercial strategy, and strategic foresight.

With this, another student raised her hand and said, "Learning about the ISRO and its functioning was an eye opener. We also hear and read about the kind of rockets that are used to launch satellites and spacecrafts such as SLV, PSLV, GSLV, LVM etc. Please tell us more about this."

The teacher replied, "Yes. It is important to learn about the launch vehicles in use."

India's Launch Vehicles

The teacher told that initially, India launched rockets to study the upper atmosphere from 40 km altitude to 150 km altitude. For this Rohini series of sounding rockets were used from Thumba Equatorial Rocket Launching Station.

The teacher said, "students, India's first satellite-launch rocket was SLV-3. It could carry small satellites weighing around 40 kg!"

The class had a good laugh.

"Later, scientists made it stronger by adding boosters, and called it ASLV. Now it could carry 150 kg," the teacher explained.

"But the real superhero arrived in 1993—PSLV. Strong, reliable, and versatile, it has flown over 60 missions, launching satellites for Earth, the Moon, and even Mars. That's why PSLV is called the workhorse—and the superhero—of Indian rockets."

One student asked, "How does India launch all of its satellites?"

The teacher appreciated the question and showed them the pictures ISRO's launch vehicles.

Fig. 2: ISRO's Launch Vehicles

The students were amazed to see these pictures.

The teacher explained that in order to meet the growing demand of launching big communication satellites into special orbits called Geo-Synchronous Orbits, ISRO built the GSLV.

It could carry satellites weighing up to 2500 kg into space!

One of the students, from commerce background asked: "Madam, I am interested in building my own business. Is it possible to be associated with the space programmes?"

The teacher responded: "Yes. Entrepreneurship in space has flourished through ISRO's commercial arm, Antrix Corporation, and the creation of New Space India Limited, which fosters public-private partnerships and global outreach. The government envisions itself as an enabler, promoting private sector innovation while leveraging space for improved mapping, connectivity, disaster forecasting, and logistics."

She added: "ISRO has raised so far 18 satellites developed by private players and students. Moreover nearly 200 start-ups from private players are set-up in space economy."

To launch even heavier satellites, ISRO created a stronger version LVM3 (also called GSLV Mk-III). These rockets can carry up to 4000 kg. All these rockets have been used for launching Chandrayaan, Mangalyaan, Aditya L1 spacecrafts etc. For small satellites, ISRO made the SSLV, which can take up to 500 kg into orbits up to 500 km.

Well, after having learnt about space missions, the space agency of our country, ISRO and its constituent units, and its journey so far, let us now focus on India's present endeavours in space research.

Would you like to recapitulate?

"We have learnt that ISRO has developed a variety of satellites and launch vehicles. Together, they make India's space programme strong, versatile, and ready for future missions.

Students asked in chorus, "Please tell us about the kind of applications satellites are being used."

The teacher answered, "Well. There are a variety of applications. Major Earth observation application of satellites include: Television; Satellite Radio Networking; Telecommunications; Telemedicine; Tele-education; Satellite Aided Search and Rescue (SAS&R); Data Relay Transponders (DRT); Real-time Train Information System (RTIS); Vessel Communication and Support System in Marine Fishing Vessels for Monitoring, Control and Surveillance (MCS)."

Now, let us read about different applications in detail.

The teacher asks a student to read aloud. One student reads.

Earth Observation Satellites

India's space programme keeps an eye on our own planet Earth! Placing various satellites in different orbits has led to applications in the remote sensing of the Earth surface. The Indian Remote Sensing (IRS) series of satellites has enabled us to observe the Earth in regular intervals, such as natural resources like water bodies, snow and glaciers, forests, soils, crops, groundwater and mining information, minerals, oceans, as well as human settlements and structures in a continuous manner as distinct land cover. These observations allow to study climate patterns, urban growth, and disaster zones. These efforts have resulted in making India a global leader in using remote sensing and GIS (Geographic Information Systems) to make smart decisions about nature, development, and society. Yet again the use of the internet etc. has made the

data more accessible than ever.

The teacher said, "With such progress, India has emerged as a key player in space exploration, gaining respect globally and opening doors to new collaborations."

The teacher asks another student to read.

Navigation with Indian Constellation (NavIC)

NavIC is designed with a constellation of 7 satellites and a network of ground stations operating 24×7. Its main objective is to meet the positioning and navigation of the nation. The ground network consists of a control center, a precise timing facility, range and integrity monitoring stations, two-way ranging stations, etc. NavIC coverage area includes India and a region up to 1500 km beyond the Indian boundary. NavIC signals can provide user position accuracy better than 20 m. Its applications include areas in transportation (terrestrial, aerial and marine); location-based services; personal mobility; resource monitoring; surveying and geodesy; scientific research; time dissemination; and safety-of-life alert dissemination, etc. The International Maritime Organisation (IMO) has recognized NavIC as a component of the worldwide radio navigation system (WWRNS) for maritime applications.

Let us discuss

- Why do you think NavIC is important for India's independence in navigation technology?
- Compare NavIC with GPS—why do you think India developed its own system?

Then the students enthusiastically asked, "Do we also aim for planetary missions?"

- The teacher said, "Yes, Chandrayaan is one of them along with other missions for planetary research.

Teacher asked another student to read aloud about mission Chandrayaan-1"

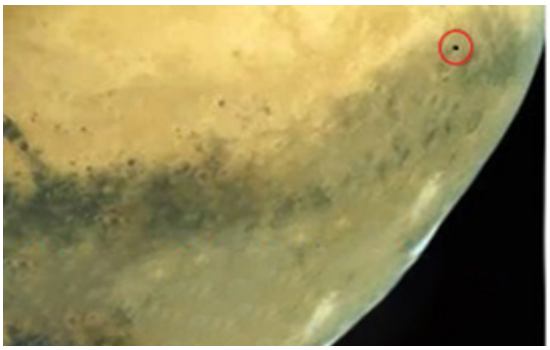


Fig.5: The image of the shadow of the Phobos (circled in red, a satellite of Mars) on the surface of mars. Image taken by Mangalyaan.

Chandrayaan-1: India's First Lunar Mission Launched on 22 October 2008

Using the Polar Satellite Launch Vehicle (PSLV) rocket, Chandrayaan-1 was successfully launched from the Satish Dhawan Space Centre, Sriharikota. It entered the lunar orbit on November 10. This spacecraft orbited the moon in an orbit at an altitude of 100 km.

Chandrayaan-1 carefully mapped the Moon—studying its chemicals, minerals, and surface features. Then came a historic moment. On November 14, 2008, the moon impact probe impacted near the Shackleton crater on the Moon's surface. With this, India became the fifth country to reach the lunar surface. But the biggest triumph was still to come—Chandrayaan-1 confirmed the presence of water on the Moon, a discovery that amazed the entire world.

Fig. 3: The NavIC

The teacher asked the students, "What is Chandrayaan-1 mainly credited for?"

Fig. 4: Chandrayaan-1 is credited for reviving interest about presence of water on Moon.

Now, let us learn about the next mission.

Mars Orbiter Mission: Launched on November 5, 2013

Mangalyaan, India's first interplanetary mission, was launched by a PSLV rocket from Sriharikota. Weighing about 1350 kg, it entered Mars' orbit on September 24, 2014, making India the first Asian nation and the first in the world to succeed in its maiden attempt.

Its orbiter worked for over seven years, studying Mars' surface, atmosphere, minerals,

and seasonal changes. It also showed India's strength in deep space navigation and cost-effective mission planning. Now, ISRO is preparing for MOM-2, which may even carry a Martian helicopter drone called MARBLE.

The teacher asked a few questions to the students:

- What world record did India achieve with Mangalyaan?
- What is ISRO preparing now and how will it be useful?

The teacher asked the students to read about Chandrayaan-2.

Chandrayaan-2: A Technological Leap Launched on July 22, 2019

Using the Geosynchronous Satellite Launch Vehicle (GSLV) rocket, the Chandrayaan-2 spacecraft was successfully launched on July 22, 2019 from the Satish Dhawan Space Centre, Sriharikota. After successive maneuvers, it attained the lunar orbit on 20 August. It then circled the Moon at an altitude of 100 km. In preparation for its lunar soft-landing, on September 02, 2019, the Vikram lander was detached from the orbiter. On September 06, 2019, during the descent to the surface, unfortunately the communication with the lander was lost at an altitude of 2.1 km. And a hard-landing of the Vikram lander was assumed. Meanwhile, the Orbiter, which had been placed in its intended lunar orbit, played a crucial role in expanding our knowledge of the Moon's history and mapping the distribution of minerals and water molecules in the polar regions of Moon.

The teacher suggested students to discuss the following with their peers:

- What happened to the Vikram lander?
- What role did the Orbiter play?

The teacher then asked the students to read about mission Chandrayaan–3.

Teacher suggested students to scan the following QR codes to watch the videos:

(i) (ii) (iii)

i. Chandrayaan-3 lander descend to moon's surface in amazing time-lapse

ii. Chandrayaan 3: Vikram rover soft landing on Moon

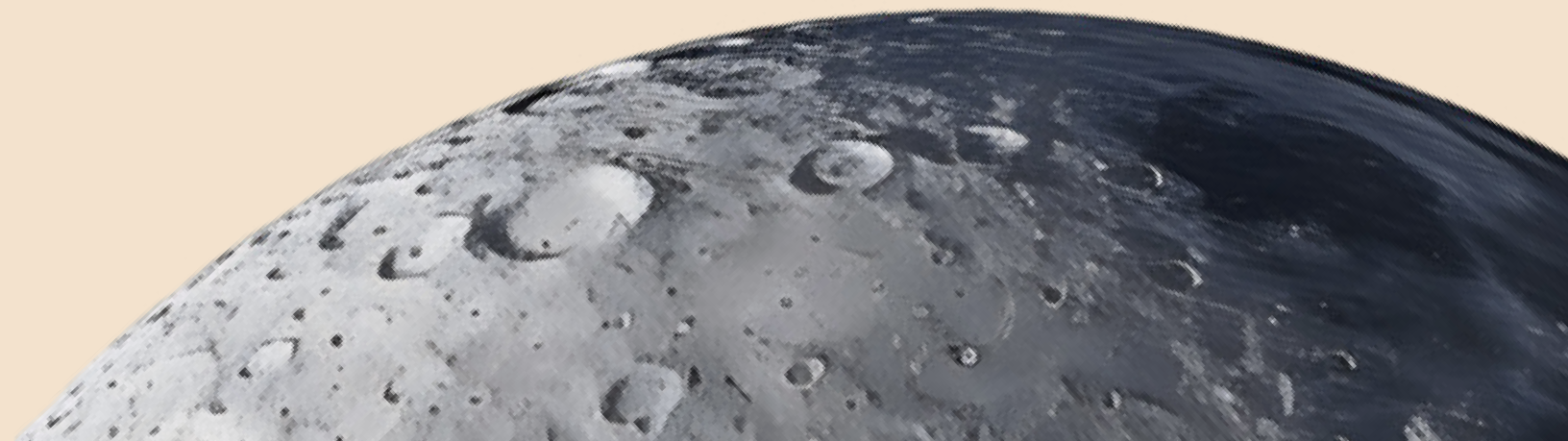
iii. Chandrayaan 3: Vikram rover soft landing on Moon

Chandrayaan-3: Advancing Lunar Exploration Launched on 14 July 2023

Chandrayaan-3 was successfully launched on July 14, 2023 from Sriharikota. This time the 630-ton LVM3 (also known as Launch Vehicle Mark-III – M4) rocket was used. The spacecraft inserted in the gravitational field of Moon on 5 August 2023. This mission did not have any orbiter to place in the Moon's orbit; it rather used the data received from the predecessor's orbiter of Chandrayaan-2.

(a) (b) (c) (d)

Fig. 6: (a) Landing of the Vikram and (b) Rolling out of the Pragyan (artistic illustrations); (c) Pragyan receding away from the Vikram; (d) The path retraced by the Chandrayaan-3 Pragyan Rover on the Moon.



National Space Day

Recognising ISRO's achievements in Chandrayaan-3 mission, Prime Minister Shri Modi announced August 23 as the 'National Space Day'. During his visit to ISRO, he named the sites where Vikram lander (Chandrayaan-3 mission) touched the lunar surface after its soft-landing as "Shiv Shakti Point". He explained that the selection of "Shiva Shakti" was based on concept of "Shiva" as humanity's determination and "Shakti" as the capability to actualize these humanitarian ambitions, while further noting that "Shakti" is also a tribute to the women scientists. He also mentioned that the area where the Chandrayaan-2 lander unfortunately hard-landed on September 06, 2019 to be referred as "Tiranga Point".

The National Space Day is celebrated every year on August 23 to commemorate the successful soft-landing of the Vikram lander on the south pole of the Moon and all successive programmes of the India's contribution in space science and technology.

The students then asked, "we want to know about Aditya L1: India's Solar Observatory."

The teacher said, "our next session is on it."

Aditya L1: India's Solar Observatory Launched on September 02, 2023

The first Indian mission dedicated to observe the Sun, Aditya-L1 was designed to study the Sun's outer atmosphere. It was successfully launched from Sriharikota. It is now orbiting at about 15 lakh km from earth in a halo orbit around the Lagrange point 1 (L1) between the Earth and the Sun to view the Sun continuously without any eclipse. The data collected by it is to study the solar atmosphere, solar magnetic storms, and their impact on the environment around the Earth. There are seven payloads on board, where four are for remote sensing of the Sun and three for in-situ observation in L1 range.

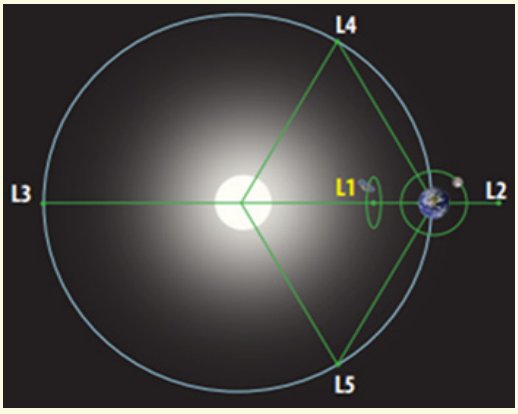


Fig. 7: The Lagrange points L1, L2, L3, L4 and L5 in the Sun-Earth system. The orbit shown in green is the halo orbit around L1.

On 23 August 2023, the Vikram lander successfully soft-landed in the lunar south pole region, achieving humanity's first soft landing in the south polar region of the Moon. This made India the fourth country to achieve soft landing on the Moon after Russia, USA, and China. Soon after the touchdown, the Pragyan rover moved down of the ramp over the dust of the lunar surface. With this, India became making India only the third country to operate a robotic rover on the moon after Russia and China.

Chandrayaan-3 consisted of a Propulsion Module; Vikram lander module; and Pragyan Rover. The Propulsion module carried the lander and rover to lunar orbit. It also included the SHAPE payload to study Earth's spectral and polarimetric properties from lunar orbit. The Vikram lander module performed the soft landing. It also carried instruments like ChaSTE to measure thermal conductivity and temperature; ILSA to detect moonquakes; and a Langmuir probe to study the plasma density on lunar surface. The third part Pragyan rover conducted in-situ chemical analysis using Alpha Particle X-ray Spectrometer and Laser-Induced Breakdown Spectroscope.

"Aha! Our Chandrayaan-3 mission has been so successful that we are the first country to reach in the south polar region of the Moon." Students exclaimed.

They further curiously asked the teacher: "We heard that on this occasion, our Hon'ble Prime Minister Shri Narendra Modi made some important announcements. What are these."

The students exclaimed in surprise after hearing about Aditya L1's distance from the Earth. They asked, "how far it is from the Sun then?"

> *Teacher replied: "Aditya-L1 may seem close to the Sun. The average distance from the Earth to the Sun is about 15 crore km, and Aditya-L1 sits at roughly 15 lakh km from the Earth—just about 1% of the total distance."*

The students are now very much involved in the conversation. They mentioned about the recent mass media coverage about India's marking a historic milestone in June 2025 when Group Captain Shubhanshu Shukla became the first Indian astronaut to reach International Space Station.

Teacher said: "Yes. Very true. Let us now learn about the International Space Station (ISS) and Indian in space. In addition, we will also learn about the India's Gaganyaan programme—Our own human spaceflight."

ISS and Indian in Space

The International Space Station (ISS) is a large space station in low earth orbit at about 400 km from the earth surface. This peaceful international cooperation and the pursuit of knowledge beyond our planet. First launched in 1998, it serves as a unique laboratory for scientific researches. ISS presently sizes around a football ground and weighs about 450 ton. It however has a habitable volume of nearly 400 cubic meter and the surface area of about 1500 square feet. This area serves as laboratories, living quarters, docking ports, and storage areas. With continuous human presence on board the ISS since year 2000, astronauts carry out a wide range of activities—from conducting scientific experiments in microgravity across disciplines such as biology, physics, and Earth observation, to testing advanced technologies for life support and deep space missions. The station also facilitates medical research, technology demonstrations, educational outreach, and Earth-monitoring operations.

India achieved another historic milestone when Group Captain Shubhanshu Shukla became the first Indian astronaut to reach the International Space Station (ISS). His remarkable journey is a matter of national pride and brought back memories of Wing Commander Rakesh Sharma, who made history as India's first astronaut in space in 1984.

Fig. 8: The International Space Station.

Fig. 9: Group Captain Shubhanshu Shukla at the International Space Station.

> "Namaskar, my dear countrymen! What a ride! We are back in the space once again after 41 years. It's an amazing ride. We are revolving around the earth at a speed of 7.5 km per second. The Tiranga embossed on my shoulders tells me that I am with all of you. This journey of mine is not a beginning to the International Space Station but to India's Human Space Programme. I want all of you to be part of this journey. Your chest, too, should swell with pride... Together, let's initiate India's Human Space Programme. Jai Hind! Jai Bharat!"
>
> *— Shubhanshu Shukla's first message from the outer space addressing the nation*

The teacher told that Gr. Cap. Shubhanshu Shukla successfully conducted pioneering microgravity experiments developed through a collaboration between ISRO, the Department of Biotechnology, and NASA. His presence aboard the ISS also led to the hoisting of the Indian flag on the station—a symbolic moment celebrated across the country.

Fig. 10: Prime Minister Narendra Modi in conversation with Gr. Cap. Shubhanshu Shukla at ISS on 28 June 2025.

The teacher then suggested students to know more about the NISAR mission and how important it is for Earth monitoring.

NISAR Mission: Launched on July 30, 2025

Fig.11: The orbiting NISAR with unfolded radar antenna.

A truly unique Earth imaging satellite jointly made by India and United States of America named the NASA-ISRO Synthetic Aperture Radar (NISAR) satellite is a technological marvel. It lifted off on July 30 from the Satish Dhawan Space Centre, Sriharikota, opening a new era of radar Earth observation. NISAR has a potential to revolutionize our understanding of earth's dynamic systems. By employing advanced dual-frequency radar imaging, NISAR will provide unprecedented insights into natural processes, climate change, and disaster management. It would make it one of the most significant Earth-observation missions to date. This satellite is designed to map the entire planet—from land and oceans to icy polar regions—every 12 days. It is envisaged to changes as small as a cm, in any weather and in both darkness and light. It does this by flying over in two directions: ascending (going north) and descending (going south). Thus, we get fresh data about Earth about every 6 days on average! This satellite would thus be a game changer in saving lives from impending natural disasters.

The teacher said, "I will now tell you about Chandrayaan-4, and you all note down its unique features for discussion."

Chandrayaan-4:

Chandrayaan-4 is going to be India's most ambitious lunar mission with a capability of lunar sample return to Earth. With an aim to bring about 2-3 kg of moon rocks and soil back to Earth, it will place India among the elite few nations including USA, Russia, and China. This challenging mission would have two separate LVM3 rockets with five spacecraft modules, which will dock in earth's orbit before heading to the Moon. There shall be a robotic arm and a drilling mechanism to collect samples, along with a re-entry technology to return samples safely to the Earth.

All the students are making notes and take part in the class discussion.

One of the student's asked, "We have been hearing a lot about Gaganyaan. What are the main features of Gaganyaan Programme?"

Gaganyaan Programme

The teacher told that Gaganyaan project envisages demonstration of human spaceflight capability by launching crew of three members to a Low Earth Orbit of 400 km for a 3-days mission and bring them back safely to Earth. The programme thereby fulfils the aspirations of the established space–faring nation. It is a national effort led by ISRO in collaboration with industry, academia and other national & international agencies as stake holders. Key development features of Gaganyaan programme includes:

Fig.12: Gaganyaan

i. A modified version of ISRO's LVM3 will launch the orbital module (crew module and service module);

ii. A habitable capsule with life-support systems and safety features (crew module);

iii. Crew Escape System; and

iv. Training of crews and associated technologies.

With accomplishment of this mission, India will become the fourth country to have indigenous capability to send human in to space and bring back safely, after the US, Russia, and China. Before carrying out the actual Human Space Flight mission, ISRO plans to demonstrate the technology preparedness through various test flights and three uncrewed Gaganyaan flight to validate and ensure safety and reliability in the end-to-end mission operations.

The teacher suggested students to discuss the following queries in group.

- What is the main goal of the Gaganyaan project?
- At what altitude will the crew orbit Earth?
- Which rocket will be used to launch the Gaganyaan orbital module?

The teacher then told the students about India's own space station – Bharatiya Antariksh Station (BAS).

Bharatiya Antariksh Station: India's Own Space Station

In 2024, the Government of India approved the Bharatiya Antariksh Station (BAS) program, marking a significant milestone in the nation's human spaceflight ambitions. BAS is envisioned as a permanent Indian platform in Low Earth Orbit, designed to support medium- to long-duration missions as part of a sustained human spaceflight initiative.

BAS will consist of modules equipped with state-of-the-art technologies to facilitate advanced scientific research and technological innovation in a space environment. These activities will be aligned with national priorities and geared toward societal applications. BAS would also facilitate medical research, agricultural yield, Earth-monitoring operations etc. This programme will also provide a unique opportunity, especially for the youth of the country to take up careers in the field of science and technology as well as pursue opportunities in microgravity based scientific research & technology development activities. The resulting innovations and technological spin-offs will be benefitting the society at large. It is also to provide a platform for startups and academia to test space technologies.

These achievements reflect India's growing stature in space exploration. Further to these upcoming missions of NISAR, Gaganyaan, Bharatiya Antariksh Station etc., India is ambitious to soar higher.

In conclusion, we can say that India's Unique Strengths are cost-effective innovation; global collaboration; expanding private sector (over 200 start-ups and increasing foreign investment are taking part in India's space economy); and ambitious roadmap (India aims to capture 8% of the global space market by 2035, up from 2% today). Thus, India's strategic collaborations, frugal engineering, and scientific ambition are positioning it as a rising global space power.

All the students said, "This was awesome and we are proud of our nation."

The teacher smiled warmly and replied, "Yes, students, India's space journey teaches us that with courage, curiosity, and determination, we can achieve everything.

"From the Earth to the Moon and beyond, our space journey has begun with flying colours."

Jai Hind.

… "Had a great interaction with Shubhanshu Shukla. We discussed a wide range of subjects including his experiences in space, progress in science & technology as well as India's ambitious Gaganyaan mission. India is proud of his feat."

Hon'ble Prime Minister Shri Narendra Modi on meeting with Gr. Cap. Shubhanshu Shukla, 2nd Indian To Go To Space
18 August 2025

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