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PRELIMS SAMPOORNA

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SCIENCE & TECHNOLOGY

SPACE PROGRAMS
INDIA & THE WORLD

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SPACE PROGRAMS (INDIA & THE WORLD)

Genesis of Indian Space Program

- The space research activities were initiated in India during the **early 1960's**, when applications using satellites were in experimental stages even in the United States.
- With the live transmission of Tokyo Olympic Games across the Pacific by the **American Satellite 'Syncom-3'** demonstrating the power of communication satellites, **Dr. Vikram Sarabhai, the founding father of Indian space Program**, quickly recognized the benefits of space technologies for India.
- As a first step, the **Department of Atomic Energy** formed the **INCOSPAR (Indian National Committee for Space Research) under the leadership of Dr. Sarabhai and Dr. Ramanathan** in 1962.
- **The Indian Space Research Organisation (ISRO)** was later formed on **August 15, 1969**.
- The prime objective of ISRO is to **develop space technology and its application to various national needs.** It is one of the **six largest space agencies in the world**. The Department of Space (DOS) and the Space Commission were set up in 1972 and ISRO was brought under DOS on June 1, 1972.
- Since inception, the Indian space Program has been orchestrated well and had **three distinct elements such as, satellites for communication and remote sensing, the space transportation system and application Programs.**
- Two major operational systems have been established – **the Indian National Satellite (INSAT)** for telecommunication, television broadcasting, and meteorological services and the **Indian Remote Sensing Satellite (IRS)** for monitoring and management of natural resources and Disaster Management Support.

Major milestones in Indian Space Program

- Indian Space Program began at **Thumba Equatorial Rocket Launching Station (TERLS) located at Thumba near Thiruvanathapuram.** Thumba was selected for being rocket launching station because **geomagnetic equator of the earth passes over Thumba**.
- **On November 21, 1963**, the first sounding rocket was launched **from TERLS.** The first rocket, **a Nike-Apache** was procured from the US. (A sounding rocket is a rocket, which is **intended for assessing the physical parameters of the upper atmosphere.**)
- **The Satellite Telecommunication Earth Station** was set up at Ahmadabad on January 1, 1967.
- **India's first indigenous sounding rocket, RH-75**, was launched on November 20, 1967.
- **Aryabhata - First Indian Satellite** was launched on **April 19, 1975**. It was launched from the **former Soviet Union**. It provided India with the **basis of learning satellite technology and designing.**
- During 1975-76, **ISRO along with NASA** developed means of using **space communications system for TV broadcasting.** This resulted in the creation of the **project Satellite Instructional Television Experiment (SITE)**. It was a **one-year program** covering Indian **villages and districts**.
  - The main purpose of SITE was to experiment **usage of satellite broadcasting to educate the masses**.
  - 0ewSITE, hailed **as 'the largest sociological experiment in the world'** benefited around 200,000 people, covering 2400 villages of six states and transmitted development oriented Programs using the **American Technology Satellite (ATS-6).**
- During January 1, 1977 — January 1, 1979, **Satellite Telecommunication Experiments Project (STEP), a joint project of ISRO-and Post and Telegraphs Department (P&T)** using the **Franco-German Symphonie satellite** was taken up. Conceived as a **sequel to SITE** which focused on Television, **STEP was for telecommunication experiments.**
- **Bhaskara-I -** an **experimental satellite for earth observations** was launched on June 7, 1979.
- **First Experimental launch of SLV-3 with Rohini Technology Payload** on board (August 10, 1979). Satellite could not be placed in orbit. **Satellite Launch Vehicle-3 (SLV-3) is the first launch vehicle of India.**
- **Second Experimental launch of SLV-3,** Rohini satellite successfully placed in orbit. (July 18, 1980).
- **Ariane Passenger Payload Experiment (APPLE), an experimental geo-stationary communication satellite was successfully launched** on June 19, 1981.
- **Indian National Satellite system (INSAT)-1A** was launched on April 10, 1982. This system was for the **communication, broadcasting and meteorology**.
- **On April 2, 1984,** the **first Indo-Soviet manned space mission** was launched. **Rakesh Sharma** became the **first Indian citizen to go into space**. He flew aboard in the Soviet **rocket Soyuz T-11,** as part of **a three member Soviet-Indian crew**.
- The **first operational Indian Remote Sensing Satellite, IRS-1A** was launched on March 17, 1988.
- On March 24, 1987, the **first developmental launch of Augmented Satellite Launch Vehicle** (ASLV) that supported a larger payload than the SLV-3 and was meant to be low-cost happened.
- Launch of **first operational Indian Remote Sensing Satellite, IRS-1A** happened on March 17, 1988.
- Second developmental launch of Polar Satellite Launch Vehicle (PSLV) with IRS-P2, on board took place on October 15, 1994. Satellite successfully placed in **Polar Sunsynchronous Orbit**.
- The first developmental launch of Geosynchronous Satellite Launch Vehicle (GSLV)-D1 with GSAT-1 on board took off from Sriharikota on April 18, 2001. It was developed keeping in mind the **heavier and more demanding geosynchronous communication satellites**.

- **INSAT-4CR weighing 2130 kg** and **launched by GSLV-F04** on September 2, 2007 is the **heaviest satellite launched from India**.
- **PSLV-C11 successfully launches CHANDRAYAAN-1** from Sriharikota on October 22, 2008. Chandrayaan-1 is a **scientific investigation – by spacecraft – of the Moon**. Chandrayaan-1 is the **first Indian planetary science and exploration mission.** Chandrayaan-1 was operational for **312 days till August 28, 2009.**
- **November 5, 2013** - **PSLV - C25 successfully launches Mars Orbiter Mission** (Mangalyaan) Spacecraft from Sriharikota.
- On February 15, 2017**, PSLV-C37**, the 39th mission of the workhorse launch vehicle of ISRO, **injected ISRO's Cartosat-2 Series Satellite** weighing 714 kg and two **ISRO Nano-satellites namely INS-1A (8.4 kg) & INS-1B (9.7 kg) and 101 Nano-satellites**, from **six foreign countries into a Sun-Synchronous Orbit** (SSO) at an orbit of 506 km above earth, with an inclination of 97.46°. The mass of nano-satellites varied from 1 to 10 kg. The total weight of all the 104 satellites carried on-board PSLV-C37 was 1378 kg.
- **PSLV-C38/Cartosat-2 Series Satellite Mission** was launched on June 23, 2017 from SDSC SHAR, Sriharikota. India's Polar Satellite Launch Vehicle, in its 40th flight (PSLV-C38), launched the 712 kg Cartosat-2 series satellite for earth observation and 30 co-passenger satellites together weighing about 243 kg at lift-off into a 505 km polar Sun Synchronous Orbit (SSO).
- **India's latest communication satellite, GSAT-17** was inducted into the **INSAT/GSAT system** on June 29, 2017 **from Kourou, French Guiana by Ariane-5 VA-238**. Weighing 3477 kg at lift-off, GSAT-17 carries Payloads in Normal C-band, Extended C-band and S-band to provide various communication services. GSAT-17 also carries **equipment for meteorological data relay and satellite based search and rescue services being provided by earlier INSAT satellites.**
- **India's Polar Satellite Launch Vehicle,** in its **forty second flight (PSLV-C40),** successfully launched the **710 kg Cartosat-2 Series Satellite** for earth observation and 30 co-passenger satellites together weighing about 613 kg at lift-off. PSLV-C40/Cartosat-2 Series Satellite Mission was launched on Friday, Jan 12, 2018.
- **GSLV-F08 is the 12th flight of Geosynchronous Satellite Launch Vehicle** (GSLV) and Sixth flight with **indigenous Cryogenic Stage**. GSLV -F08 / GSAT-6A Mission was launched on Thursday, March 29, 2018.
- India's Polar Satellite Launch Vehicle, in its forty-third flight (PSLV-C41) in XL configuration **launched IRNSS-1I Satellite**.. **The IRNSS-1I is the eighth satellite to join the NavIC navigation satellite constellation and was launched on April 12, 2018.**
- PSLV-C42 Successfully Launches **two foreign satellites** from Satish Dhawan Space Centre (SDSC), SHAR, Sriharikota on September 16, 2018. This mission was designed to launch two **earth observation satellites, NovaSAR and S1-4** (together weighing nearly 889 kg).
- PSLV-C43 lifted off on November 29, 2018 from the **First Launch Pad (FLP) of Satish Dhawan Space Centre SHAR**, Sriharikota and successfully launched **India's Hyper spectral Imaging Satellite (HysIS)** and 30 international co-passenger satellites.
- India's next generation high throughput communication satellite, GSAT-11 was successfully launched on December 05, 2018 from Kourou launch base, French Guiana by Ariane-5 VA-246. Weighing about 5854 kg**, GSAT-11 is the heaviest satellite built by ISRO.**
- GSLV-F11 successfully launched GSAT-7A, ISRO's 39th communication satellite, on December 19, 2018 from Satish Dhawan Space Centre SHAR, Sriharikota. GSLV-F11 is the 13th flight of India's Geosynchronous Satellite Launch Vehicle (GSLV) and its 7th flight with indigenous Cryogenic Upper Stage (CUS). GSLV – F11 is ISRO's fourth generation launch vehicle with three stages.
  - ▶ It is a geostationary satellite carrying communication transponders in Ku-band. The Satellite is built to provide communication capability to the users over the Indian region.
- **Gaganyaan Program** - Cabinet has approved **Indian Human Spaceflight Initiative - Gaganyaan Program. Two unmanned & one manned flight has been planned**.
- India's telecommunication satellite, GSAT-31 was successfully launched on February 06, 2019 from Kourou launch base, French Guiana by Ariane-5 VA-247.

- India's PSLV-C46 successfully launched RISAT-2B satellite from Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota on May 22, 2019. The satellite is intended to provide services to Agriculture, Forestry and Disaster Management domains.
- **Geosynchronous Satellite Launch Vehicle, GSLV MkIII-M1 rocket, carrying Chandrayaan-2 spacecraft** was launched from the Satish Dhawan Space Centre, Sriharikota in Andhra Pradesh on July 22, 2019.

Chandrayaan-2

- Chandrayaan-2 mission is a **highly complex mission**, which represents a significant technological leap compared to the previous missions of ISRO, which brought together an **Orbiter, Lander and Rover** with the **goal of exploring South Pole of the Moon**.
- This is a unique mission aims at **studying not just one area of the Moon but all the areas combining the exosphere, the surface as well as the sub-surface of the moon in a single mission.**

Why did we go to the Moon?

- The Moon is the **closest cosmic body** at which space discovery can be attempted and documented.
- It is also a **promising test bed to demonstrate technologies required for deep-space missions.**
- Chandrayaan-2 aims for enhancing our **understanding of the Moon**, **stimulate the advancement of technology**, **promote global alliances and inspire a future generation of explorers and scientists.**

About Chandrayaan-2 India's second Moon mission

- The Chandrayaan-2 mission comes nearly 11 years after India's first expedition to the moon in October 2008.
- Chandrayaan-2 moon mission is **totally an indigenous mission.** It was launched on 22 July, 2019 via GSLV-Mk-III rocket from **Satish Dhawan Space Centre, Sriharikota**.
- The journey of Chandrayaan-2 is around **3.84 lakh km to Moon**.
- The weight of Chandrayaan-2 spacecraft is approximately 3840 kilograms.
- It will **collect data on water, minerals and formations of rock**.
- Chandrayaan-2 spacecraft have three modules a **Lander (Vikram), an Orbiter and Rover (Pragyan).**
- Scientific goals are to **study lunar topography, mineralogy, elemental abundance, the lunar exosphere and signatures of hydroxyl and water ice.**
- The primary objective of ISRO to launch Chandrayaan-2 was to **demonstrate the ability to soft-land on the lunar surface** (South Pole) **and operate a robotic rover on the surface.**

What is soft landing?

- A soft-landing protects the **object from impact while a hard landing doesn't**.
- Soft-landing ensures that the **object is able to carry out further experimentation on the target planet or satellite, mostly with the help of a rover vehicle.**
- **Soft-landing on any planetary surface is complicated**.
- Vikram was to **use five thrusters — four at the corners and one at the centre to make its final descent.**

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- **Maintaining the required velocity with such thrusters is difficult as a fine balance among them needs to be maintained.**
- Then there is the issue **of moon dust which could wreck the engines of the thrusters.**

The Orbiter:

- The orbiter is safe in the intended orbit around the moon. And with **the "precise launch and mission management",** its life span will extend to **almost seven years**.
- Carrying **eight of the 13 payloads**, the orbiter will spend the next **nearly seven years making high-resolution maps of the lunar surface, mapping the minerals, understanding the moon's evolution, and most importantly looking for water molecules in the polar regions.**
- Some of the impact craters in the South Pole are permanently shadowed from sunlight and could be ideal candidate sites to harbour water.
- **Water** on the moon would, in principle, be **used for life support and manufacturing rocket fuel.**
- With the U.S. wanting to send astronauts to the South Pole by 2024, **the National Aeronautics and Space Administration (NASA), in particular is keen on data from the Chandrayaan 2 orbiter.**

The Launcher:

- The **GSLV Mk-III** carried Chandrayaan 2 to its designated orbit. **This three-stage vehicle** is India's most powerful launcher to date, and is capable of **launching 4-ton class of satellites to the Geosynchronous Transfer Orbit (GTO).**
- Its components are:
  - S200 solid rocket boosters
  - L110 liquid stage
  - C25 upper stage

The Lander

- The Lander of Chandrayaan-2 **was named Vikram after Dr Vikram A Sarabhai, the Father of the Indian Space Program.**
- It was designed to function for **one lunar day**, which is equivalent to **about 14 Earth days.**

The Rover

- Chandrayaan-2's Rover was a **6-wheeled robotic vehicle named as Pragyan**, which translates to **'wisdom' in Sanskrit.**

Chandrayaan -3

- Chandrayaan-3, India's third mission to Moon, is likely to be launched in 2022.
- Chandrayaan-2, aimed at landing a rover on unchartered Lunar South Pole Aitken Basin, was launched on July 22, 2019 on board the country's most powerful geosynchronous launch vehicle.

- However, the lander Vikram hard-landed on September 7, 2019, crashing India's dream to become the first nation to successfully land on the lunar surface in its maiden attempt.
- Chandrayaan-3 is critical for ISRO as it will demonstrate India's capabilities to make landing for further interplanetary missions. It's of particular interest as it is thought to host numerous deposits of subsurface water ice – a vital component for any future sustainable lunar habitation.

Astrosat

- AstroSat is the first dedicated Indian astronomy mission aimed at studying celestial sources in X-ray, optical and UV spectral bands simultaneously.
- One of the unique features of AstroSat mission is that it enables the simultaneous multi-wavelength observations of various astronomical objects with a single satellite.
- AstroSat with a lift-off mass of 1515 kg was launched on September 28, 2015 into a 650 km orbit inclined at an angle of 6 deg to the equator by PSLV-C30 from Satish Dhawan Space Centre, Sriharikota. The minimum useful life of the AstroSat mission is expected to be 5 years.

The scientific objectives of AstroSat mission are:

(a) To understand high energy processes in binary star systems containing neutron stars and black holes;

(b) Estimate magnetic fields of neutron stars;

(c) Study star birth regions and high energy processes in star systems lying beyond our galaxy;

(d) Detect new briefly bright X-ray sources in the sky;

(e) Perform a limited deep field survey of the Universe in the Ultraviolet region.

Gaganyaan

- In the 2018 edition of Indian defence expo, ISRO released the **astronaut's space suit Gaganyaan** ("Skycraft") is (planned) India's autonomous **3.7-tonne spacecraft** designed to carry a **3-member crew** to orbit and safely return to the Earth after mission duration of few orbits and up to **seven days.**
- The space vehicle is planned to be launched **on ISRO's GSLV Mk III in 2022**.
- It is planned currently, **an Indian astronaut**, who is yet to be chosen, would be stationed at an **altitude of 400 km from earth for 5-7 days**.
- To maintain this altitude (which is very low compared to orbits which are parallel to equatorial plane which is 36000 km) one needs to orbit only in **plane perpendicular to equatorial plane.**
- The payload consists of a **crew module and a service module**.
- Based on the payload capability of the GSLV-III booster, the service module would have a mass of about 3 tonnes which being heavier needs **cryogenic technology.**
- The flight would take 16 minutes to reach its orbit and during the period of stay, the astronaut would carry out a series of experiments, particularly microgravity experiments.
- The descent would take 36 minutes as care would be taken to avoid heating up while heading back to earth.
- If successful, it would make India only the **fourth member (after Russia, the US, and China) of an elite club of nations with indigenous manned space Programs.**

- India announced that human spaceflight module of Gaganyaan will be launched after the second unmanned mission planned in 2022-23. First unmanned mission is planned in December 2021.
- In June 2019, the Human Space Flight Centre of the ISRO and the Russian government-owned Glavkosmos signed a contract for the training, which includes Russian support in the selection of candidates, their medical examination, and space training.
- The candidates will study in detail the systems of the Soyuz manned spaceship, as well as be trained in short-term weightlessness mode aboard the Il-76MDK aircraft.

Navigational Satellites

IRNSS: India's Navigation system

- IRNSS is an **Independent regional navigation satellite system** being developed by India.
- The **NAVIC (Navigation in Indian Constellation)** system consist of a **constellation of 3 satellites in Geostationary orbit (GEO), 4 satellites in Geosynchronous orbit (GSO),** approximately 36,000 kilometres (22,000 mi) altitude above earth surface, and **two satellites on the ground as stand-by, in addition to ground stations.**
- It is designed to provide accurate position information service to users in India as well as the **region extending up to 1500 Km from its boundary**, which is its primary service area.
- IRNSS provide **two types of services**, namely **Standard Positioning Service** (SPS) which is provided to all the users and **Restricted Service (RS)** which is an **encrypted service provided only to the authorized users.**

- **Satellite navigation** means using **a portable radio receiver (like a cell phone)** to pick up speed-of-light signals from orbiting satellites so that one can figure out precise position, speed, and local time.
- To pinpoint location accurately, **the receiver** (here cellphone) needs to receive signals from at **least four navigational satellites**
- The receiver determines your distance from each of the satellites by measuring the time taken by the signal to travel from the satellite to your receiver antenna

GPS Satellite Systems around the World

- **United States (GPS)**
  - The United States is the **first country to introduce satellite technology with the global positioning system (GPS).**
  - This satellite navigation system, operated by the United States government offers **navigation and tracking technology, including location, time and other data throughout the planet. Individuals, corporations, and military personnel utilize GPS devices and GPS trackers.**
- **Japan (QZSS)**
  - The **Quazi-Zenith Satellite System (QZSS)** is Japan's satellite system which is similar to GPS satellites with some slight variations.
  - The QZSS is a system using **three satellites.**

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- The satellites in this constellation are expected to **orbit Japan and other areas of Asia**, which will further increase the accuracy of GPS signals in the US.

Russia (GLONASS)

- Russia also has its own satellite system called the **Russian Global Navigation Satellite System (GLONASS).**
- In the last 10 years new satellites have been introduced into the system and it now has **optimal signal coverage**.
- GLONASS is similar to GPS and includes **24 satellites located in 3 orbit places**.

China Peoples Republic of China (BeiDou Navigation Satellite System)

- BeiDou Navigation Satellite System (formerly referred to as Compass) is the **navigational system of China.**
- It will consist of more than **30 satellites**.
- This satellite system intends to have **two levels of signals** to be used for **military and civilians.**
- Chinese government has reported that the satellite constellation is expected for **global availability by 2020.**

European Union (Galileo)

- Galileo system of Europe is a Global Navigation Satellite System (GSNN).
- The development for Galileo **began in 2003 and is expected to be fully completed by 2019.**
- Galileo will have **30 satellites** (27 active with 3 spares) with **signals reaching throughout the globe.**
- Galileo is funded by **public and private sectors**, as opposed to the public only funding of the US GPS system.

GAGAN- Geo Augmented Navigation System

- **GPS Aided Geo Augmented Navigation "GAGAN"** is an augmentation system to enhance the accuracy and integrity of GPS signals to meet precision approach requirements in Civil Aviation and is being implemented jointly by **AAI and ISRO**.
- It will augment **GPS signals over the Indian land mass, the Bay of Bengal, South East Asia, the Middle East and the Arabian Sea widening its reach up to Africa.**
- At present **radio navigation** (through reflections of Ionosphere) is used for **precision landing and approaches at Indian airports.**

Studying the Sun

Parker Solar Probe

- Sent by **NASA** in order to **understand Sun's corona and to protect a society** that is increasingly dependent on technology from the threats of space weather.
- The primary science goals for the mission are:
  - To trace the **flow of energy** that heats and accelerates the solar corona and solar wind.

- Understand the **heating of the solar corona; determine the structure and dynamics of the plasma and magnetic fields at the sources of the solar wind.**
- Explore mechanisms that **accelerate and transport energetic particles**.
- Parker Solar Probe provides a **Statistical Survey of the Outer Corona.**

ADITYA-1

- It is the **1st Indian space based Solar Coronagraph** intended to study the outermost region of the sun called **'Corona'**.
- The project will increase our understanding about the Sun. The Temperature of the solar corona goes beyond million degrees.
- From the ground, the Corona **could be seen only during total solar eclipses** mainly due to the **bright solar disc and the scattering of the sunlight by the Earth's atmosphere**.
- One has to go beyond the atmosphere to be able to mask the bright solar disc and study the Corona.
- ARIES facility (Aryabhata Research Institute for Observational Sciences) will host the support centre for Aditya-L1 mission, which is due to be launched next year 2022
- **Objectives of the Mission:** The major scientific objectives of Aditya-1 are to achieve a fundamental understanding of the physical processes that:
  - Heat the solar corona
  - Accelerate the Solar Wind
  - Produce Coronal Mass Ejections (CMEs)

Gadanki Ionospheric Radar Interferometer (GIRI)

- The Indian Space Research Organisation (ISRO) has installed the Gadanki Ionospheric Radar Interferometer (GIRI) Radar System near **Tirupati, Andhra Pradesh.**
- **Primary objective:**
  - Carry out unattended observations for studying the forces from the sun like variation in solar flare, solar flux and magnetic storm on the ionospheric irregularities.
  - Studies unattended observations from the underneath atmosphere on the ionospheric irregularities (for e.g. waves generated by weather phenomena).
  - Provide important information about the angular location of plasma irregularities during the onset phase. Also establish its relationship to background ionospheric state parameters and sunset terminator.

India's space diplomacy: South Asia Satellite

- The South Asia Satellite, also known as **GSAT-9**, is a **geostationary communications** and **meteorology satellite** operated by the **Indian Space Research Organisation (ISRO) for the South Asian Association for Regional Cooperation (SAARC) region**.
- Geostationary Satellite are heavier satellites weighting more than 3 tonnes hence require Cryogenic engines. The 2,230-kg satellite has been fabricated in three years and is purely a communications satellite costing ₹235 crore.

- The uniqueness of this satellite is that it will have a **footprint that extends all over South Asia**.
- Its **applications touch everyday life and the neighbours use its applications free of charge.**
- The satellite will enable a range of applications and services to our neighbours only in the areas of **telecommunication and broadcasting applications viz. television, direct-to-home (DTH), very small aperture terminals (VSATs), tele-education, telemedicine and disaster management support**. **Each country** has to develop its **own ground infrastructure**.
- The South Asia Satellite has **12 Ku band transponders** which our neighbours can utilise to increase communications.
- The satellite also provides **secure hot lines among the participating nations in addition since the region is highly prone to earthquakes, cyclones, floods and tsunamis**.
- **Pakistan has fully opted out of the project.**
- Rest of the seven nation's part of the South Asian Association for Regional Co-operation (SAARC) are on-board.

Drones and Governance issues: Digital Sky Platform

- **Remotely Piloted Aerial Systems (RPAS),** popularly referred to as **drones**, are a technology platform with wide-ranging applications.
- India announced the release of **Civil Aviation Regulations** (CAR) to enable **safe flying of RPAS in India.**
- Digital Sky Platform is a first of its kind that implements '**no permission, no take-off' (NPNT) – a novel system of software-based self-enforcement to minimize deviations from the CAR.**
- The regulations were to come in effect from **December 1, 2018** allowing the industry time to ready them for the launch.

Significance for Drone users:

- Existing drone operators and potential drone owners are required to buy **No Permission-No-Takeoff (NPNT)-compliant RPAS.**
- The import of drones is **now permitted as well.**
- To get permissions to fly, RPAS operators or remote pilots will have to **file a flight plan.**
- Flying in the **'green zones'** will require **only intimation of the time and location of the flights via the portal or the app.**
- **Permissions will be required for flying** in **'yellow zones'** and **flights will not be allowed in the 'red zones'.**
- **Permission, if granted**, will **be available digitally** on the portal.
- If an RPAS does not have permission to fly, it will not be allowed to take-off under the policy of (NPNT).

Why framing regulations took so long?

- Drone technologies have been evolving very rapidly.
- Many countries are still experimenting with their drone regulations and no ICAO (International Civil Aviation Organisation) standards have been developed.
- India's security environment necessitates extra precautions.

Tracking the s-junk: Graveyard Orbit

- A **Graveyard Orbit** also called a **Junk Orbit or Disposal Orbit** is an orbit that **lies away from common operational orbits.**
- One significant graveyard orbit is a **super synchronous orbit** well above **geosynchronous orbit.** Satellites are typically moved into such orbits at the end of their operational life to reduce the probability of colliding with operational spacecraft and generating space debris.

Unravelling cosmos: The Oort Cloud

- The **Oort Cloud is a thick bubble of icy debris** that surrounds our solar system.
- This distant, predicted cloud may extend a third of the way from our Sun to the next star—somewhere between 1,000 and 100,000 astronomical units.
- There may be hundreds of billions, even trillions, of icy bodies in the Oort cloud. Every now and then, something disturbs one of these icy worlds and it begins a long fall toward our Sun. Two recent examples are comets **C/2012 S1 (ISON) and C/2013 A1 Siding Spring**.
- The Oort cloud is too far to be seen with **current telescopes**, so it hasn't been directly seen or discovered.

Important:

- Comets that take more than 200 years to make one revolution around the Sun are notoriously difficult to study. Because they spend most of their time far from our area of the solar system, many **"long period comets"** will never approach the Sun in a person's lifetime.
- In fact, those that travel inward from the distant Oort cloud can have periods of thousands or even millions of years.

World Space Week

- United Nations General Assembly in 1999 declared **4 to 10 October as World Space Week** to celebrate each year at the **international level the contributions of space science and technology** to the betterment of the human declaration.
- **World Space Week** has grown into the largest public space event on Earth. 2019 theme is **"The Moon: Gateway to the Stars." This year the theme is "Satellites Improve Life." In 2021, World Space Week celebrates "Women in Space."**
- World Space Week consists of a myriad of space-related events held by **space agencies, aerospace companies, schools, planetaria, museums, and astronomy clubs in a common timeframe to achieve greater student and public impact through synchronization.**

Space programs across the world

Gravity Recovery and Interior Laboratory (GRAIL)

- GRAIL mission was a **NASA rover cum orbiter mission** designed to create the most **accurate map of the moon** (distribution of gravity), which when combined with topographic data, can provide insight into the moon's internal structure, composition and evolution.

- GRAIL mapped the **moon's gravity** by measuring the push and pull around the moon.
- The spacecraft collected data on the moon's far side by communicating with one another when the signal to Earth is obscured. The mission has ended in December 2012.

Star-Planet Activity Research CubeSat (SPARCS)

- SPARCS is a **space telescope** to study the **habitability and high-energy environment around M-dwarf stars.**
- Dwarf stars **are generally cooler** and they may be **surrounded by many habitable zones**.
- The telescope will study the **Ultra-Violet light emitted by dwarf stars**.

GOLD and ICON mission

- They refer to **Global-scale Observations of the Limb and Disk (GOLD) and Ionospheric Connection Explorer (ICON) respectively**.
- ICON will be in **low-Earth orbit** at 560 km above Earth and GOLD will be at **35398 km above earth surface in a geostationary orbit.**
- They will study the **Ionosphere region or the boundary area between Earth and the space** where electrically-charged electrons and ions by the Sun's radiation are present.
- The missions will help in **understanding how upper atmosphere changes in response to hurricanes and geomagnetic storms.**

Interplanetary Mission: Mars Mission

- **NASA's Interior Exploration using Seismic Investigations, Geodesy and Heat Transport** (InSight) is a **robot** which touched down on the **Red Planet (in 2018)** after an almost seven-month, 300-million-mile (458million-kilometer) journey from Earth.
- Its **two-year mission** to **study the deep interior of Mars** to learn how **all celestial bodies with rocky surfaces, including Earth and the Moon, formed.**
- Two small satellites **WALL-E and EVE** were launched on the **Atlas V rocket** from California. **Similar in size to a briefcase or large cereal box**, the satellites are on way to Mars, right behind InSight.
- This is the first time that any little **cube-shaped satellites**, **Cube-Sats** as they're known, have been sent to **deep space missions**. The journey will span **6 1/2 months and 485 million kilometers.**

Chang'e 4 project

- China became **world's first country to launch a lunar probe on far side of moon.**
- China announced its plans to launch a lunar probe in 2018 to achieve the world's **first soft landing on the far side of the moon** to showcase its ambitious space Program. The mission is called **Chang'e 4 project.**

About the mission:

- Chang'e 4 is the **fourth mission in the country's lunar mission series** which is being named after the **Chinese moon goddess**.

Significance of the mission:

- According to experts, landing on the far side of the moon is undoubtedly one of the most challenging missions ever launched by any of the world's superpowers. The far side of the moon known **as 'South Pole-Aitken Basin'** still remains a mystery among space scientists and by sending a probe there, China will outdo the historical achievements of the US and USSR.

History of China's lunar exploration Programs:

- **China began their lunar exploration program in 2007** by launching a **simple lunar orbiter** named **'Chang'e 1'**. The second mission in the program named **'Chang'e 2'** was launched in 2010, and it was later followed by the third mission **'Chang'e 3'.**

- '**Chang'e 3'** made headlines all around the world as it marked the **first soft moon landing since 1976.**

Point Nemo

- It is considered the **most remote place on Earth** (at about 2400 km from any spot of land in middle of the South Pacifi c Ocean).
- It is often used to **crash-land defunct satellites** and thus is called the **spacecraft cemetery**.
- Between 1971 and mid-2016, space agencies all over the world have dumped between **260 and 300 spacecraft into the region.**

NASA confirms Saturn's rings will be gone in 100 million years

- **Saturn is losing its iconic rings** at the maximum rate estimated from **Voyager 1 and 2 observations made decades ago**, confirms new NASA research that estimates that the **rings have less than 100 million years to live.**
- The rings are being **pulled into Saturn by gravity** as **a dusty rain of ice particles** under the **influence of Saturn's magnetic field**.

Gaofen – 11

- **China successfully launched Gaofen-11**. It is the **sixth in Gaofen series** launched this year.
- Gaofen means **"high resolution"** in Chinese.
- It is ambitious space project of China that aims to launch **seven high-definition observation satellites before 2020.**

About Gaofen – 11:

- It is an **optical remote sensing satellite**, as part of the **country's high-resolution Earth observation project.** It was developed by **China Academy of Space Technology (CAST).**
- It will become part of **China High-resolution Earth Observation System (CHEOS**) initiated in **2010 to provide all-weather, all-day coverage by 2020.**
- It is placed in **Sun – Synchronous Orbit.**

Applications: The satellite can be used for **land survey, urban planning, road network design, agriculture, and disaster relief.**

GRACE Mission

- NASA's GRACE mission has **confirmed that a massive redistribution of freshwater is occurring across the Earth**, with **middle-latitude belts drying and the tropics and higher latitudes gaining water supplies.**

Key Findings

- The resulting map of the findings shows an overall pattern, in which **ice sheets and glaciers lose by far the most mass at the poles, but at the same time, middle latitudes show multiple areas of growing dryness even as higher latitudes and the tropical belt tend to see increases in water.**
- The study emphasizes that the **34 separate changes that it detects do not all have the same cause – not close.**

- There's very suspicion that the **melting of glaciers and ice sheets is tied to climate change**. On land, it's possible that **some droughts and rainfall increases may be also, though the study is cautious about that, noting that natural variability can also be a major factor here**.
- There are also some major cases of humans increasing water storage in the landscape, **particularly in China, where massive dam construction has created enormous reservoirs.**
- Mainly, though, what's striking about the map is the way that a combination of human-driven water withdrawals and droughts seem to be punishing the central latitudes of the northern hemisphere in particular, but also the southern hemisphere to a significant extent.

Analysis

- A combination of the **effects of climate change, vast human withdrawals of groundwater and simple natural changes are behind this.**
- If this continues, it could have profound consequences leading to a situation in which some **highly populous regions could struggle to find enough water in the future**.

Resource Prospector Mission

- NASA is developing an **exploration strategy** to meet the **agency's expanded lunar exploration goals.**
- Consistent with this strategy, NASA's **Resource Prospector mission**, this is in pre-formulation, aims to be the first mining expedition on another world.

Key Facts

- Using a suite of instruments to locate **elements from a lunar polar region,** the **planned rover is designed to excavate volatiles such as hydrogen, oxygen and water from the moon.**
- The mission consisted of a **lander and a solar powered rover** equipped with a drill.

Analysis

- **In-situ resource utilization (ISRU**) will foster more affordable and sustainable human exploration to many deep-space destinations.
- Launching one pound of any material into space costs thousands of dollars. One gallon of water weighs more than eight pounds, so **the ability to generate water, air and fuel in space could represent enormous cost savings for future deep-space missions**.
- Humans living, working and exploring other planetary bodies must be able to make their own breathable air and potable water.

Hope Probe

- The Hope Probe, the Arab world's first mission to Mars, took off from Earth in July 2020, and has been orbiting the Red Planet (Mars) since February 2021. It is expected to create the first complete portrait of the planet's atmosphere.
- It has captured images of glowing atmospheric lights in the Mars night sky, known as discrete auroras.
- Studying Martian auroras is important for scientists, for it can offer clues as to why the Red Planet lost its magnetic field and thick atmosphere– among the essential requirements for sustaining life.
- With the information gathered during the UAE's Mars mission, scientists will have a better understanding of the climate dynamics of different layers of Mars' atmosphere.

NASA Robotic mission to Venus

- National Aeronautics and Space Administration (NASA) announced two new robotic missions to Venus. Earlier, scientists obtained new data about Venus by bouncing radio waves off the planet.
- These two sister missions aim to understand how Venus became an inferno-like world capable of melting lead at the surface.
- Da Vinci Plus: First of the two, it will analyze the thick, cloudy Venusian atmosphere in an attempt to determine whether the inferno planet ever had an ocean and was possibly habitable. A small craft will plunge through the atmosphere to measure the gases.
- Veritas: It will be the second one seeking a geologic history by mapping the rocky planet's surface.

Tianwen-1

- China's spacecraft Tianwen-1 landed on Mars carrying its first Mars rover named Zhurong. It became the third country to land on Mars after the US and Soviet Union.
- Purpose is to conduct scientific investigations into the planet's soil, geological structure, environment, atmosphere and water.
- The mission will be the first to place ground-penetrating radar on the Martian surface, which will be able to study local geology, as well as rock, ice, and dirt distribution.

OSIRIS-REx Mission

- Recently, NASA's OSIRIS-REx spacecraft departed from asteroid Bennu, and started its two-year long journey back to Earth. OSIRIS-REx is NASA's first mission to visit a near-Earth asteroid, survey its surface and collect a sample from it.
- Bennu is an ancient asteroid, currently more than 200 million miles from Earth. It is about as tall as the Empire State Building (US) and is named after an Egyptian deity.
- Scientists will use the asteroid samples to study the formation of the solar system and of habitable planets such as Earth.
- NASA will also distribute a part of the samples to laboratories worldwide and will reserve about 75% of the samples for future generations who can study it with technologies not yet created.

Suborbital Flight

- A six person crew on Virgin Galactic's VSS Unity spaceship undertook a brief trip to the "edge of space" which is known as Suborbital Flight.
- Sirisha Bandla, an astronaut born in India, was a part of the crew. She was the third woman of Indian origin to go to space after Kalpana Chawla and Sunita Williams.
- Virgin Galactic is a British-American spaceflight company, operating in the United States.

EnVision Mission to Venus

- European Space Agency (ESA) has announced a new mission- EnVision mission to Venus.
- The mission will carry a range of instruments to study the planet's atmosphere and surface, monitor trace gases in the atmosphere and analyse its surface composition.

- EnVision will follow another ESA-led mission to Venus called 'Venus Express' (2005-2014) that focussed on atmospheric research and pointed to volcanic hotspots on the planet's surface.
- India plans to launch a new orbiter named Shukrayaan to Venus in 2024

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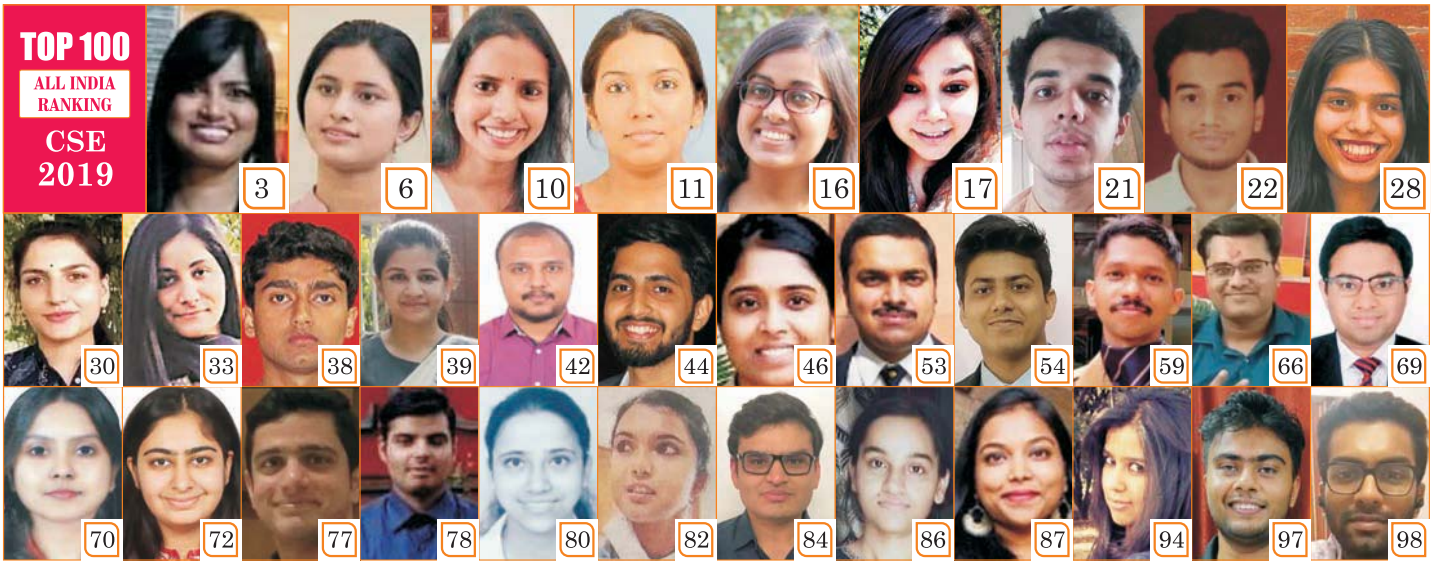

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