



PRELIMS SAMPOORNA CURRENT AFFAIRS

-5

SCIENCE & TECHNOLOGY

www.iasscore.in

PRELIMS SAMPOORN

As IAS prelims 2021 is knocking at the door, jitters and anxiety is a common emotion that an aspirant feels. But if we analyze the whole journey, these last few days act most crucial in your preparation. This is the time when one should muster all their strength and give the final punch required to clear this exam. But the main task here is to consolidate the various resources that an aspirant is referring to.

GS SCORE brings to you, **Prelims Sampoorna**, a series of all value-added resources in your prelims preparation, which will be your one-stop solution and will help in reducing your anxiety and boost your confidence. As the name suggests, **Prelims Sampoorna** is a holistic program, which has 360-degree coverage of high-relevance topics.

It is an outcome-driven initiative that not only gives you downloads of all resources which you need to summarize your preparation but also provides you with **All India open prelims mock tests series** in order to assess your learning. Let us summarize this initiative, which will include:

- GS Score UPSC Prelims 2021 Yearly Current Affairs Compilation of All 9 Subjects
- Topic-wise Prelims Fact Files (Approx. 40)
- Geography Through Maps (6 Themes)
- Map Based Questions
- ALL India Open Prelims Mock Tests Series including 10 Tests
- Compilation of Previous Year Questions with Detailed Explanation

We will be uploading all the resources on a regular basis till your prelims exam. To get the maximum benefit of the initiative keep visiting the website.

To receive all updates through notification, subscribe:



Contents

1. INFORMATION 01-10 TECHNOLOGY & COMMUNICATION

Э	5G Countdown	01	1
---	--------------	----	---

- DRDO achieves milestone in key02 Quantum Technology
- EU Cyber Sanctions03
- Spyware, stalkerware apps gained......04 traction during lockdown
- The landscape of Cyber Security04 in India
- Cyber attacks are on rise: INTERPOL 05
- EventBot......08
- RPF busts Real Mango......09
- A Web 3.0 revolution that could09 relieve social dilemmas

2. SPACE TECHNOLOGY.. 11-30 & EVENTS

- NASA's Artemis Project.....11
- NASA's SunRISE Mission......11
- Mars Opposition13
- Copernicus Sentinel-6 Michael13 Freilich satellite
- United Arab Emirates celebrates 15 its first mission at Mars

- IRNSS now part of World Wide17 Radio Navigation System
- Ariel Space Mission......17

- Indian astronomers collaborated 19 with Nobel laureate on Thirty Meter Telescope project
- Moon May Be Rusting Along Poles, 20
 Suggest Chandrayaan-1 Images
- ە Stardust 1.0 21
- GW190412: Mismatched Black Holes.... 22 Merge
- Artificial Neural Networks based24 global Ionospheric Model
- Starship Spacecraft......26
- Space Security......26
- National Space Promotion and27 Authorization Centre (IN-SPACe)
- Detection of fluorine in hot Extreme 28 Helium Stars
- Sun reportedly entering29
 'Solar Minimum'

GSSCORE

3. DEFENCE 31-39 TECHNOLOGY

- Supersonic Missile Assisted Release 31 of Torpedo (SMART) system
- S-400 Triumf Air Defense Systems 32
- Successful test-firing of Hypersonic...... 33 Technology Demonstrator Vehicle (HSTDV)
- What are the MH-60R naval34 choppers, AH-64E Apaches India has bought?

4. ALTERNATIVE 40-50 TECHNOLOGIES

- World's largest solar tree......41

- Hydrogen Fuel Cell 43
- L&T Construction 3D prints India's 45 first building with reinforcement
- Ultraviolet Germicidal Irradiation47 (UVGI)

5. MISCELLANEOUS 51-55

- Engineer's Day in India51
- Digital Quality of Life Index......51
- Ammonium nitrate linked to52 catastrophic Beirut explosion
- ANtarctic Impulsive Transient54 Antenna
- National Science Day: What is the 54 'Raman effect'?

1

INFORMATION TECHNOLOGY & COMMUNICATION

1 5G Countdown

Context: Reliance Jio has declared that they will launch 5G in the 2nd half of 2021.

What is 5G?

- 5G is the 5th generation of mobile networks, a significant evolution over today's 4G LTE networks.
- 5G uses radio waves or radio frequency (RF) energy to transmit and receive voice and data connecting our communities

Pros of 5G Technology

- Greater Transmission Speed
- Lower Latency: Latency refers to the time interval between an order being received and the given instruction being executed.
- Increased Connectivity
- Energy Efficiency Plans

Cons of 5G Technology

- High Cost of Establishment
- Lack of Information
- Limited Coverage
- Overcrowded Radio Frequency
- Security and Privacy Issue

Which countries have already launched 5G services?

Globally, 5G network deployment is rapidly moving from trials to early commercialization.

- In April 2019, South Korea and the U.S. became the first countries to commercially launch 5G services.
- China too has handed out commercial 5G licenses to its major carriers earlier than expected.
- Other countries include Japan, Australia, United Kingdom, Qatar, Kuwait, the United Arab Emirates



Where 5G Technology Has Been Deployed

Countries where 5G networks/technology have been deployed and where 5G investments have been made



2 DRDO achieves milestone in key Quantum Technology

Context: The Defence Research and Development Organisation (DRDO) achieved a milestone in Quantum Key Distribution (QKD) technology

What is Quantum Key Distribution (QKD)?

- QKD is a secure communication method that uses cryptographic protocol involving components of quantum mechanics.
- The technology enables two communicators to produce a random secret key known only to them and later it can be used to encrypt and decrypt messages.

What makes QKD unbreakable?

- The security of QKD stems from the ability to detect any intrusion on the QKD transmission.
- Because of the unique and fragile properties of photons, any third party who tries to read or copy the photons in any way will change the photons' state.
- The change will be detected by the endpoints, alerting them that the key has been tampered with and must be discarded.
- A new key is then transmitted. Moreover, since the keys generated are truly random, they are protected from future hacking attempts.

AI & Robotics Technologies Park (ARTPARK) set up in Bengaluru

Context: The Indian Institute of Science (IISc) Bangalore has set up an Artificial Intelligence and Robotics Technologies Park (ARTPARK).

What is ARTPARK?

- ARTPARK is a unique not-for-profit foundation established by the Indian Institute of Science (IISc), Bengaluru with support from AI Foundry in a public-private model.
- Under the National Mission on Inter-disciplinary Cyber-Physical Systems (NM-ICPS), it will bring about a collaborative consortium of partners from industry, academia, and government bodies.

What ARTPARK will do?

- ARTPARK will develop AI & Robotics facilities to support technology innovations as well as capacity building through advanced skills training of students and professionals in these areas.
- Some of these facilities will be key enablers for whole new sets of technologies, products, and services.
- DataSetu: It will develop DataSetu that will enable confidentiality and privacy-preserving framework to share data and run analytics spurring the data-sharing ecosystem and create a data marketplace, boosting AI applications and solutions.
- **BhashaSetu:** One such service will be BhashaSetu which will enable real-time Indic language translation, both of speech to speech and speech to text.
 - This will further unlock the economic potential of the country, and enable all Indian citizens to equitably participate in the economic progress, regardless of their language.

5 EU Cyber Sanctions

Context: The European Union has imposed 'first-ever' cyber sanctions to protect itself from increasing cyber-attacks.

About EU's Cyber Sanctions

- The restrictive measures were imposed against six individuals and three entities responsible for or involved in various cyber-attacks.
- These include the attempted cyber-attack against the
 - > OPCW (Organisation for the Prohibition of Chemical Weapons) and those publicly known as-
 - WannaCry
 - NotPetya
 - Operation Cloud Hopper

• **WannaCry:** WannaCry is an example of crypto ransomware, a type of malicious software (malware) used by cybercriminals to extort money. Ransomware that uses encryption is called crypto ransomware. The type that locks you out of your computer is called locker ransomware.

GSSCORE

www.iasscore.in 3

- NotPetya: The malware spread like wildfire across the world, eating into every electronic equipment, computers, extracting data and demanding exorbitant amounts for recovery in form of Bitcoins
- **Operation Cloud Hopper:** The hacking campaign includes hacking of the world's biggest technology service providers.

⁶ Spyware, stalkerware apps gained traction during lockdown

Context: Global Cyber-security leader Avast has warned in a note that there was a 51-percent increase in the use of spy- and stalkerware since the lockdown in March until June.

What are spy and stalkerware apps?

- Spyware or stalkerware refers to tools apps, software programs, and devices that let another person (such as an abuser) secretly monitor and record information about your phone activity.
- Spy and stalkerware apps, like viruses and other malware, infect devices that are connected to the internet.
- While viruses and malware can be detected by antivirus software, spyware and stalkerware apps disguise themselves as useful and send-out stolen data to central servers without the users' knowledge.
- A spyware app can also be installed remotely while a stalkerware app can be installed only when someone has physical access to the digitally connected device.

How do such apps work?

- Spyware: For spyware apps, the easiest method is to disguise the spying code inside the unauthorized versions of other apps and then try and market such premium apps.
- Stalkerware: Stalkerware apps, on the other hand, seek explicit permissions at the time of their installation.
 - Once the app is installed in the phone, it can be hidden from the apps menu into the background, from where they continue functioning.

7 The landscape of Cyber Security in India

Context:

 As the world gets absorbed by the COVID-19 pandemic, cyberattacks have become a critical area for all technology-focused organizations in India. In the evolving situation, India needs an updated cybersecurity situation.

Types of Cybercrime

- DDoS Attacks
- Botnets
- Identity Theft
- Cyberstalking
- PUPS (Potentially Unwanted Programs)



- ► Phishing
- Online Scams

Indian laws concerning Cyber Security

- Information Technology Act, 2000: The act provides legal recognition to e-commerce and e-governance and facilitates its development as an alternative to paper-based traditional methods.
- **Crime and Criminal Tracking Network System (CCTNS):** It is a nationwide network infrastructure for the evolution of an IT-enabled state-of-the-art tracking system around "investigation of crime and detection of criminals".
- National Cyber Security Policy, 2013: It provides for:
 - ► To build secure and resilient cyberspace.
 - > Creating a secure cyber ecosystem, generate trust in IT transactions.
 - > Creation of a 24 x 7 National Critical Information Infrastructure Protection Center (NCIIPC).
 - Indigenous technological solutions.
 - ► Testing of ICT products and certifying them.
- National Technical Research Organization (NTRO): NTRO is a highly specialized technical intelligence gathering agency. It develops technology capabilities in aviation and remote sensing, data gathering and processing, cyber security, cryptology systems, strategic hardware and software development, and strategic monitoring.
- National Critical Information Infrastructure Protection Centre (NCIIPC): Creation of National Critical Information Infrastructure Protection Centre, the national nodal agency in respect of the protection of critical information infrastructure.
 - > It is placed under the National Technical Research Organization.
- **CERT-In:** CERT-In has been designated to serve as the national agency to perform the following functions:
 - > Collection, analysis, and dissemination of information on cyber incidents.
 - > Forecast and alerts of cybersecurity incidents
 - > Emergency measures for handling cybersecurity incidents
 - > Coordination of cyber incident response activities
 - ► Issue guidelines, advisories, vulnerability notes, and white papers relating to information security practices, procedures, prevention, response, and reporting of cyber incidents
- **National Cyber Coordination Centre (NCCC):** It is a critical component of India's cyber security against hackers and espionage as well as to track terrorist activity online.

8 Cyber attacks are on rise: INTERPOL

Context: An inter-governmental law enforcement organization, INTERPOL, the International Criminal Police Organization, has cautioned that it has detected a significant increase in cyber-attacks against hospitals around the world that are engaged in the COVID-19 response. Attacks that could "directly lead to deaths."

Types of Cybercrimes:

- **Cyberextortion:** A crime involving an attack or threat of an attack coupled with a demand for money to stop the attack.
- Cryptojacking: An attack that uses scripts to mine cryptocurrencies within browsers without the user's consent. Cryptojacking attacks may involve loading cryptocurrency mining software to the victim's system.



- **Identity theft:** An attack that occurs when an individual accesses a computer to glean a user's personal information, which they then use to steal that person's identity or access their valuable accounts, such as banking and credit cards.
- **Cyberespionage:** A crime involving a cybercriminal who hacks into systems or networks to gain access to confidential information held by a government or other organization.
- **Software piracy:** An attack that involves the unlawful copying, distribution, and use of software programs with the intention of commercial or personal use. Trademark violations, copyright infringements, and patent violations are often associated with this type of cybercrime.
- **Dark web:** The deep web refers to all parts of the internet (sites, e-shops, forums, etc.) that are not accessible by a regular search engine like Google or Bing.

About INTERPOL:

- Founded in 1923, Interpol is an international police organization made up of 194 member countries.
- The International Criminal Police Organization or the ¬Interpol is an international police agency that helps other law-enforcement agencies track criminals who operate across national borders.
- In each country, an INTERPOL National Central Bureau (NCB) provides the central point of contact for the General Secretariat and other NCBs.
- An NCB is run by national police officials and usually sits in the government ministry responsible for policing.

Cyber Laws and Legislation in India and Abroad:

Global Level					
Budapest Convention on Cyber Security	 It is the first international treaty seeking to address Internet and computer crime by harmonizing national laws, improving investigative techniques, and increasing cooperation among nations. Its objective is to pursue a common criminal policy aimed at the protection of society against cybercrime, especially by adopting appropriate legislation and fostering international cooperation. 				
International Telecommunication Union (ITU):	 ITU is the specialized agency of the United Nations which deals with adopting international standards to: ensure seamless global communications and interoperability for next-generation networks building confidence and security in the use of ICTs emergency communications to develop early warning systems and to provide access to communications during and after disasters, etc. 				
International Governance Forum (IGF):	 Internet Governance Forum (IGF) is a multi-stakeholder forum for policy dialogue on issues of Internet governance which brings together all stakeholders in the Internet governance debate. 				



	 It facilitates a common understanding of how to maximize Internet opportunities and address risks and challenges. It is convened under the auspices of the Secretary-General of the United Nations.
National Level	
National Technical Research Organization (NTRO):	 NTRO is a highly specialized technical intelligence gathering agency. It develops technology capabilities in aviation and remote sensing, data gathering and processing, cyber security, cryptology systems, strategic hardware and software develo
National Critical Information Infrastructure Protection Centre (NCIIPC):	 National Critical Information Infrastructure Protection Centre is envisaged to act as a 24x7 center to battle cybersecurity threats in strategic areas such as air control, nuclear, and space. It is placed under the National Technical Research Organization.
CERT-In	 The Computer Emergency Response Team (CERT-In) has been designated to serve as the national agency to perform the following functions: To collect and analyze information on cyber incidents To forecast and give alerts of cybersecurity incidents To provide emergency measures for handling cybersecurity incidents To coordinate cyber incident response activities To issue guidelines, advisories, vulnerability notes, and white papers relating to information security practices, procedures, prevention, response, and reporting of cyber incidents
National Cyber Coordination Centre (NCCC):	 NCCC is a critical component of India's cyber security against hackers and espionage as well as to track terrorist activity online.
Crime and Criminal Tracking Network System (CCTNS)	• CCTNS is a nationwide network infrastructure for the evolution of IT-enabled state-of-the-art tracking system around "investigation of crime and detection of criminals".
Information Technology Act, 2000	 It is the most significant piece of legislation addressing conduct in cyberspace in India. It provides legal recognition to e-commerce and e-governance and facilitates its development as an alternative to paper-based traditional methods.
National Cyber Security Policy, 2013	• The policy provides for developing effective Public-Private Partnerships and collaborative engagements through technical and operational cooperation and contribution for enhancing the security of cyberspace.

 Key-features: Creating a secure and resilient cyberspace Creating a secure cyber ecosystem, generate trust in IT transactions
 Creation of a 24 x 7 National Critical Information Infrastructure Protection Center (NCIIPC)
 Testing of ICT products and certifying them

8 EventBot

Context: Indian Computer Emergency Response Team (CERT-In) has issued a detailed warning to people against the trojan called EventBot.

About:

- EventBot is a mobile-banking Trojan and info-stealer that abuses Android's in-built accessibility features to steal user data from financial applications, read user SMS messages and intercept SMS messages, allowing malware to bypass two-factor authentication.
- The EventBot trojan has over 200 different financial applications under its target, including banking applications, money-transfer services, and cryptocurrency wallets, or financial applications based in the US and European region.
- The tricky part about a trojan such as EventBot is that it seems to be a trusted application, as per India's federal cyber-security agency.

What is Trojan?

- A Trojan horse, or Trojan, is a type of malicious code or software that looks legitimate but can take control of your computer.
- A Trojan is designed to damage, disrupt, steal, or in general, inflict some other harmful action on your data or network.
- A Trojan acts as a bona fide application or file to trick you. It seeks to deceive you into loading and executing the malware on your device. Once installed, a Trojan can perform the action it was designed for.

Important terms

- Malware: Malware covers all sorts of software with nasty intent. Not buggy software, not programs you don't like, but the software that is specifically written with the intent to harm.
- Virus: This is a specific type of malware that spreads itself once it's initial run. It's different from other types of malware because it can either be like a parasite that attaches to good files on your machine, or it can be self-contained and search out other machines to infect.
- Worm: In the malware sense, they are viruses that are self-contained (they don't attach themselves like a parasite) and go around searching out other machines to infect.
- Exploit: The strange behavior that can be used to create a hole for hackers or malware to get through generally requires someone to use a particular sequence of actions or text to cause the right (or is that wrong?) conditions. To be usable by malware (or on a larger scale by hackers), it needs to be put into code form, which is also called exploit code.



9 RPF busts Real Mango

Context: Railway Protection Force (RPF) has busted an illegal software operation called "Real Mango" — used for cornering confirmed train reservations during the coronavirus pandemic.

What is 'Real Mango'?

- "Real Mango" is illegal software used for cornering confirmed Railway reservations.
- The software was earlier with the name 'Rare Mango'.
- The operation of an illegal software called "Rare Mango" (later changed its name to "Real Mango") was revealed during action against touts by the field units of RPF.
- The software has now been fully decimated

What made it 'illegal' software?

- In course of the systematic unraveling of the working of the illegal software, it has been found that-
 - > Real mango software bypasses V3 and V2 captcha
 - ► It synchronizes bank OTP with help of a mobile app and feeds it to the requisite form automatically
 - > The software auto-fills the passenger details and payment details in the forms
 - > The software logs in to the IRCTC website through multiple IRCTC Ids
 - The illegal software is sold through a five-tiered structure: System Admin & his team, Mavens, Super sellers, Sellers, and Agents
 - > System admin is receiving payment in bitcoins.

A Web 3.0 revolution that could relieve social dilemmas

Context: Web 3.0 is the next step in the evolution of the Internet and Web applications.

A brief history of the evolution of the Internet

- Websites and web applications have changed dramatically over the last decades. They have evolved from static sites to data-driven sites that users can interact with and change.
- Web 1.0
 - ▶ The original Internet was based on what is now known as Web 1.0.
 - Back in the early 1990s, websites were built using static HTML pages that only had the ability to display information.
- Web 2.0
 - With Web 2.0, users were able to interact with websites through the use of databases, serverside processing, forms, and social media.
 - > This brought forth a change from a static to a more dynamic web.
- Web 3.0
 - Web 3.0 is the next generation of Internet technology that heavily relies on the use of machine learning and artificial intelligence (AI).



- > It aims to create more open, connected, and intelligent websites and web applications, which focus on using a machine-based understanding of data.
- Through the use of AI and advanced machine learning techniques, Web 3.0 aims to provide more personalized and relevant information at a faster rate.



The 4 Properties of Web 3.0

- To understand the nuances and subtleties of Web 3.0, let's look at the four properties of Web 3.0:
 - Semantic Web
 - Artificial Intelligence
 - 3D Graphics
 - Ubiquitous



2

SPACE TECHNOLOGY & EVENTS

1 NASA's Artemis Project

Context: NASA is forging ahead with its 'Artemis program' to land humans on the moon by 2024.

About:

- NASA is committed to landing American astronauts, including the first woman and the next man, on the Moon by 2024.
- Through the agency's Artemis lunar exploration program, NASA will use innovative new technologies and systems to explore more of the Moon than ever before.
- The astronauts going for the Artemis program will wear newly designed spacesuits, called Exploration Extravehicular Mobility Unit, or xEMU.
 - These spacesuits feature advanced mobility and communications and interchangeable parts that can be configured for spacewalks in microgravity or on a planetary surface.

Artemis Base Camp

- Artemis Base Camp, meant to be a long-term foothold for lunar exploration, perhaps in Shackleton Crater at the moon's south pole.
- Artemis Base Camp itself would be a lunar foundation surface habitat that could host four astronauts at the south pole.
- In the long term, the facility would also require infrastructure for power, waste disposal, and communications, as well as radiation shielding and a landing pad.
- The base could also be a site for testing new techniques for dealing with pesky lunar dust and the long, cold lunar nights, turning local materials into resources like water, and developing new power and construction technologies.
- The camp would be accompanied and supported by two mobility systems:
 - > a lunar terrain vehicle to facilitate astronaut movement across the surface
 - > a habitable mobility platform that could support trips away from base for up to 45 days.

2 NASA's SunRISE Mission

Context: NASA has announced a new SunRISE mission to study giant solar particle storms.

GSSCORE

About:

- The Sun Radio Interferometer Space Experiment (SunRISE) will look into how Sun generates and releases the giant weather storms, known as the solar particle storms, into space.
- The SunRISE mission is to understand how such storms affect interplanetary space can help protect spacecraft and astronauts.

What are Solar Energetic Particles (SEPs)?

- Solar energetic particles (SEPs) emitted from the Sun are a major space weather hazard motivating the development of predictive capabilities.
- These events occur when particles (mostly protons) emitted by the Sun become accelerated either close to the Sun during a flare or in interplanetary space by coronal mass ejection shocks.

The mission layout:

- The mission layout depends on 6 solar-powered CubeSats- each regarding the size of a toaster oven- to concurrently observe radio photos of low-frequency emission from the solar task and share them using NASA's Deep Space Network.
- SunRISE contains six CubeSats which will work together as a large radio telescope. Each of the CubeSats would run on solar power.
 - The CubeSats will create 3D maps that pinpoint where giant particle bursts originate on the sun and how they evolve as they expand into space.
 - This, in turn, will help determine what initiates and accelerates these giant radiation jets of radiation.
 - The spacecraft will also work together to map the magnetic field lines reaching from the sun out into interplanetary space.
 - Together, these will observe radio images of low-frequency emission from solar activity and create 3D maps to locate the origin place of a solar particle storm on the Sun.

3

Asteroid 465824 (2010 FR) to cross Earth's orbit soon: NASA

Context: NASA has been tracking asteroid 465824 2010 FR, which is twice as big as the Pyramid of Giza and is expected to cross the Earth's orbit.

About:

- It is classified as a Near-Earth Object (NEO) and a potentially hazardous asteroid (PHA).
 - > NEOs occasionally move close to the Earth as they orbit the Sun.
 - NASA defines NEOs as comets and asteroids nudged by the gravitational attraction of nearby planets into orbits that allow them to enter the Earth's neighborhood.
 - These objects are composed mostly of water ice with embedded dust particles.
- It is categorized as an Apollo-class Asteroid
- 2010 FR orbits the sun every 440 days (1.20 years), coming as close as 0.72 AU and reaching as far as 1.55 AU from the sun.

What are Asteroids?

• Asteroids are rocky objects that orbit the Sun, much smaller than planets. They are also called minor planets.



- Asteroids are named by the International Astronomical Union (IAU).
- Most such objects can be found in the asteroid belt between Mars and Jupiter, which is estimated to contain somewhere between 1.1-1.9 million asteroids.
 - The explanation for the concentration of asteroids in this belt comes from the formation of Jupiter, whose gravity brought an end to the formation of any planetary bodies in this region, as a result of which the smaller bodies kept colliding with each other, fragmenting into asteroids.
- **Trojans:** Other than those found in the main asteroid belt, asteroids can be classified into trojans, which are asteroids that share an orbit with a larger planet.

4 Mars Opposition

Context: An event referred to as "opposition", which takes place every two years and two months, Mars outshined Jupiter, becoming the third brightest object in the night sky during October.

What is the opposition?

- The opposition is the event when the sun, Earth, and an outer planet are lined up, with the Earth in the middle.
- The time of opposition is the point when the outer planet is typically at its closest distance to the Earth for a given year, and the planet appears brighter in the sky.
- An opposition can occur anywhere along Mars' orbit, but it happens when the planet is also closest to the sun, it is also particularly close to the Earth.
- Like all the planets in our solar system, Earth and Mars orbit the sun. But Earth is closer to the sun and therefore races along its orbit more quickly.
- According to NASA, from an individual's perspective on the Earth, Mars rises in the east and after staying up all night, it sets in the west just as the sun rises in the east and sets in the west.

Mars Oppositions

- Mars oppositions happen about every 26 months.
- Every 15 or 17 years, opposition occurs within a few weeks of Mars' perihelion (the point in its orbit when it is closest to the sun).
- In 2020, Mars opposition occured on October 13, 2020.

5 Copernicus Sentinel-6 Michael Freilich satellite

Context: The Copernicus Sentinel-6 Michael Freilich satellite, designed to monitor oceans, has been launched from the Vandenberg Air Force base in California aboard a SpaceX Falcon 9 rocket.

About:

• The major objectives of the Satellite:

GSSCORE

- > To ensure the continuity of sea-level observations
- ► To provide measurements of global sea-level rise.



Key-highlights

- This is a part of the next mission dedicated to measuring changes in the global sea level.
- The satellite carries a Poseidon-4 radar altimeter and a microwave radiometer.
- Other satellites that have been launched since 1992 to track changes in the oceans on a global scale include the TOPEX/Poseidon, Jason-1, and OSTN/Jason-2, among others.

Significance of the mission

- Data from satellites such as Sentinel-6 help scientists foresee the effects of the changing oceans on the climate.
- Further, in order to measure and track changes in the oceanic heat budget, scientists need to know the ocean currents and heat storage of the oceans, which can be determined from the height of the sea surface.

6 China Launches Chang'e-5 Moon Probe to Bring Back Lunar Rocks

Context: China successfully launched its Chang'e-5 lunar mission to collect rocks from the moon - the first attempt by any country since the 1970s.

About:

- The Chang'e-5 probe will collect 2 kilograms (4.5 pounds) of samples in Oceanus Procellarum.
- Composition: The spacecraft is made up of an orbiter, a lander, an ascender, and a returner.
- Once in the moon's orbit, the probe will deploy a pair of vehicles to the surface to drill into the ground and collect soil and rock samples.
- If successful, the mission will make China only the third country to have retrieved lunar samples, following the United States and the Soviet Union decades ago.

Where will it land?

- The mission will land in the Mons Rumker area of the huge volcanic plain Oceanus Procellarum ("Ocean of Storms"), portions of which have been explored by several other surface missions, including NASA's Apollo 12 in 1969.
- It is a massive lava plain.
- This large dark spot, stretching about 2,900 kilometers (1,800 miles) wide, could be a scar from a giant cosmic impact that created an ancient sea of magma.



The previous attempts

- US astronauts brought back 382 kilograms (842 pounds) of rocks and soil during the Apollo program, between 1969 and 1972.
- The Soviet Union collected 170.1 grams (6 ounces) of samples in 1976.

United Arab Emirates celebrates its first mission at Mars

Context: The United Arab Emirates has put a probe called Hope in orbit around the planet, making it only the fifth spacefaring entity to do so after the US, the Soviet Union, Europe, and India.

What is HOPE?

- The unmanned probe named "Al-Amal", Arabic for "Hope" is a United Arab Emirates mission to Mars.
- Hope launched from the Tanegashima Space Center near Minamitane, Japan last year (July 2020).
- Hope is the Arab world's first mission to another planet.

Other recent Mars Missions

- China's Tianwen-1 dual orbiter-rover and
- Perseverance from NASA,

Mangalyaan

- India became the first Asian country to have successfully launched its Mars orbiter mission Mangalyaan which has entered the orbit of the red planet in 2014.
- India also became the first country to have entered the Martian orbit in its first attempt.
 - India's MOM (Mars Orbiter Mission) successfully achieved orbit in 2014 to image the entire planet, providing a unique perspective on its weather and surface features.

GSSCORE





8 IRNSS now part of World Wide Radio Navigation System

Context: The Indian Regional Navigation Satellite System (IRNSS) has been accepted as a component of the World Wide Radio Navigation System (WWRNS) for operation in the Indian Ocean Region by the International Maritime Organization (IMO).

What is IRNSS?

- IRNSS is an independent regional navigation satellite system developed by India.
- It is designed to provide accurate position information service to assist in the navigation of ships in Indian Ocean waters.
- It could replace the US-owned Global Positioning System (GPS) in the Indian Ocean extending up to approximately 1500 km from the Indian boundary.
- IRNSS will 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

Some applications of IRNSS are:

- Terrestrial, Aerial, and Marine Navigation
- Disaster Management
- Vehicle tracking and fleet management
- Integration with mobile phones
- Precise Timing
- Mapping and Geodetic data capture
- Terrestrial navigation aid for hikers and travelers
- Visual and voice navigation for drivers

Which other countries have their navigation systems?

• After the US, Russia, and China have their navigation systems, India has become the fourth country to have its independent regional navigation system.

9 Ariel Space Mission

Context: The European Space Agency (ESA) has formally adopted Ariel, the explorer that will study the nature, formation, and evolution of exoplanets.

What is the Ariel Space Mission?

- Ariel(Atmospheric Remote-sensing Infrared Exoplanet Large-survey) is the first mission of its kind dedicated to measuring the chemical composition and thermal structures of hundreds of exoplanets.
- These exoplanets will range from gas giants to rocky planets, which will help them to compile a list of their compositions and properties thereby providing insights into how planetary systems form and evolve.
- The mission is expected to be launched in 2029.

What are Exoplanets?

GSSCORE

- Planets that lie outside of the Solar System and orbit around stars other than the Sun are called exoplanets or extrasolar planets.
- Exoplanets are not easy to detect since they are much less bright than the stars they orbit and hence it is difficult to see them directly using telescopes.

How to track exoplanets?

- One of these methods involves tracking the dimming of a star that happens when a planet passes in front of it. NASA's Kepler Space telescope uses this method to spot thousands of planets.
- Other methods to track exoplanets include gravitational lensing and the "wobbling method", which is based on the idea that an orbiting planet will cause its parent star to orbit slightly off-center.

¹⁰ Fast radio bursts detected in the Milky Way for the first time

Context: Intense pulses of radio waves known as fast radio bursts (FRB) that have been frequently detected in other galaxies have now been found in the Milky Way.

About Fast radio bursts (FRB)

- FRBs were first discovered in 2007.
- The latest studies have now confirmed that FRBs are generated by a rare type of neutron star known as a 'magnetar'.
 - ▶ Magnetars are the most powerful magnets in the cosmos.
 - > Their magnetic fields are 5,000 trillion times more powerful than that of the Earth.

Source of FRB

- The source of the FRB was traced to a magnetar known as SGR 1935+2154, located about 30,000 light-years from the earth.
 - > It lies in the center of the Milky Way, in the constellation Vulpecula.
- The FRB generated by this magnetar was so powerful that it emitted as much energy in one millisecond as the sun does in 30 seconds, according to scientists.
- The scientists also concluded that most FRBs in other galaxies also were generated by magnetars.

Significance of the Study

• Until now, astronomers have been struggling to explain why some FRBs aren't one-off events like supernova explosions but seem to repeat themselves instead. Magnetars could provide the answer, since they spin slowly and flare periodically, like a lighthouse beacon.

11 EOS-01, India's latest earth observation satellite

Context: India launched EOS-01 along with nine satellites from foreign countries, by a PSLV rocket.

What is EOS-01?

• EOS-01 is another Radar Imaging Satellite (RISAT) that will work together with RISAT-2B and RISAT-2BR1.

- EOS-01 was initially named RISAT-2BR2, and was supposed to be the third of the three-spacecraft constellation aimed at providing all-weather round-the-clock service for high-resolution images.
- With EOS-01, ISRO is moving to a new naming system for its earth observation satellites which till now have been named thematically, according to the purpose they are meant for.
 - ► For example, the Cartosat series of satellites were meant to provide data for land topography and mapping, while the Oceansat satellites were meant for observations over the sea.
 - Some INSAT-series, Resourcesat series, GISAT, Scatsat, and some more are all earth observation satellites, named differently for the specific jobs they are assigned to do, or the different instruments that they use to do their jobs.

Radar imaging

- EOS-01 uses synthetic aperture radars to produce high-resolution images of the land.
 - The edge radar imaging has over optical instruments is that it is unaffected by weather, cloud or fog, or the lack of sunlight.
 - > It can produce high-quality images in all conditions and at all times.
- Depending on the wavelength of the electromagnetic radiation used by the radar, different properties on land can be captured in the image.
- EOS-01, and its sister RISATs, use X-band radars that operate at low wavelengths and are considered best for monitoring of urban landscape, and imaging of agricultural or forest land.
- EOS-01 is intended for applications in agriculture, forestry, and disaster management support.
- The radar images are also considered to be immensely useful for military requirements.

What is an Earth Observation Satellite?

• An Earth observation satellite is a satellite used or designed for Earth observation (EO) from orbit, including spy satellites and similar ones intended for non-military uses such as environmental monitoring, meteorology, cartography, and others.

12 Indian astronomers collaborated with Nobel laureate on Thirty Meter Telescope project

Context: Indian astronomers had worked closely with Nobel Laureate Andrea Ghez on the design of back-end instruments and possible science prospects of the Thirty Meter Telescope (TMT) project being installed at Mauna Kea in Hawaii.

What is TMT?

- The saga of the TMT began in 2003 when a nonprofit partnership formed between universities in California and counterparts in Japan, China, India, and Canada.
- The Thirty Meter Telescope is a new class of extremely large telescopes that will allow to see deeper into space and observe cosmic objects with unprecedented sensitivity.
- With its 30 m prime mirror diameter, TMT will be three times as wide, with nine times more area, than the largest currently existing visible-light telescope in the world.
- This will provide unparalleled resolution with TMT images more than 12 times sharper than those from the Hubble Space Telescope.
- It will observe wavelengths ranging from the ultraviolet to the mid-infrared

Who is building TMT?

- The Thirty Meter Telescope is being designed and developed by the TMT International Observatory LLC (TIO).
- The TIO is a non-profit international partnership between:
 - ▶ the California Institute of Technology
 - ► the University of California
 - > the National Institutes of Natural Sciences of Japan
 - > the National Astronomical Observatories of the Chinese Academy of Sciences
 - ▶ the Department of Science and Technology of India
 - the National Research Council (Canada)
- 13

Moon May Be Rusting Along Poles, Suggest Chandrayaan-1 Images

Context: Recent images sent by Chandrayaan-1, India's first lunar mission, suggest that the Moon may be rusting along the poles.

Chandrayaan-1

- Chandrayaan-1 was the first Indian lunar probe under the Chandrayaan program. It was launched by the Indian Space Research Organisation in October 2008.
- Chandrayaan-1 orbiter, which discovered water ice and mapped out a variety of minerals while surveying the Moon's surface in 2008.
- Among its suite of instruments, it carried NASA's Moon Mineralogy Mapper (M3), an imaging spectrometer that helped confirm the discovery of water locked in minerals on the Moon.

More about the discovery

- The new research suggests that the moon is turning slightly red, indicating the formation of a reddish-black mineral form of iron named hematite on its surface, particularly at the poles.
- The formation of rust or iron oxide can be attributed to the presence of two key elements—water and oxygen—when they come in contact with iron.
- The lunar surface is littered with iron-rich rocks, which may facilitate this chemical reaction when combined with the other two elements.

The rusting chemistry

- Rust is the common name for iron oxide. The most familiar form of rust is the reddish coating that forms flakes on iron and steel (Fe2O3), but rust also comes in other colors including yellow, brown, orange, and even green
- For iron to become iron oxide, three things are required:
 - ► Iron
 - ▶ Water
 - ► Oxygen



• Rust forms when iron or its alloys are exposed to moist air. The oxygen and water in the air react with the metal to form the hydrated oxide.

14 Stardust 1.0

Context: Stardust 1.0, a rocket powered by bio-derived fuel took off from former military base in Maine. It flew one mile into the sky before parachuting back to Earth

What is Stardust 1.0?

- Stardust 1.0 is a first biofuel-powered launch vehicle suited for student and budget payloads.
- The rocket is 20 feet tall and has a mass of roughly 250 kg.
- **Payloads:** The rocket can carry a maximum payload mass of 8 kg and during its first launch carried three payloads. The payloads included:
 - a CubeSat prototype
 - > a metal alloy designed to lessen vibrations called nitinol
 - ► a CubeSat from software company Rocket Insights
- **Manufactured by:** The rocket is manufactured by bluShift, an aerospace company based in Maine that is developing rockets that are powered by bio-derived fuels.

Significance of the biofuel-powered rocket

• **Cheaper and environment-friendly:** These rockets will help to launch small satellites called **CubeSats** into space in a way that is relatively cheaper than using traditional rocket fuel and is less toxic for the environment.

15 NASA approved EUVST and EZIE missions

Context: NASA has approved two heliophysics missions to explore the Sun and the system that drives space weather near Earth.

About:

- The Extreme Ultraviolet High-Throughput Spectroscopic Telescope Epsilon
 - ▶ Led by: The EUVST Mission is led by the Japan Aerospace Exploration Agency (JAXA), in partnership with other international organizations.
 - **Launching:** The EUVST is targeting a launch date in 2026.
 - It is a solar telescope that will study how the sun's atmosphere releases solar wind and drives eruptions of solar material.
 - NASA's hardware contributions to the mission include an intensified UV detector and support electronics, spectrograph components, a guide telescope, software, and a slip-jaw imaging system to provide Context: for the spectrographic measurement.

• The Electrojet Zeeman Imaging Explorer

- > Launched by: NASA in June 2024.
- ► The EZIE mission is made up of three Cubesats which will study electric currents in Earth's atmosphere linking aurora to the Earth's magnetosphere.

Magnetosphere

- The magnetosphere is the region of space surrounding Earth where the dominant magnetic field is the magnetic field of Earth, rather than the magnetic field of interplanetary space.
- The magnetosphere is formed by the interaction of the solar wind with Earth's magnetic field.

16 GW190412: Mismatched Black Holes Merge

Context: Scientists working with the LIGO and Virgo gravitational-wave observatories have detected an oddball event: the merger of two black holes of notably different sizes.

About:

- All 10 black hole mergers detected in the first two observing runs had binary components with similar masses.
- But the new event, called GW190412, involved objects of about 8 and 30 solar masses, respectively.
- This is the first time researchers have been able to confidently measure the spin of a black hole about to merge.

What is a black hole?

- A black hole is a place in space where gravity pulls so much that even light cannot get out. The gravity is so strong because the matter has been squeezed into a tiny space.
- This can happen when a star is dying.
- Because no light can get out, people cannot see black holes. They are invisible. Space telescopes with special tools can help find black holes.
- The special tools can see how stars that are very close to black holes act differently than other stars.

17 First-ever digital geological map of the moon

Context: The first-ever digital, unified, global, geological map of the moon was released virtually by the United States Geological Survey (USGS), National Aeronautics and Space Administration (NASA), and the Lunar Planetary Institute.

About:

- Called the 'Unified Geologic Map of the Moon', it is a 'seamless, globally consistent, 1:5,000,000scale geologic map'.
- The moon the closest cosmic body to Earth through which space discovery can be attempted and documented.
- The researchers built on the original digital renovation of the six 1:5,000,000-scale lunar geologic maps comprising of the near, central far, east, west, north, and south sides that was released in 2013.
- The final map consists of 43 geologic units across the entire lunar surface, broken down into groups based on characteristics like materials of craters, basins, terra, plains, and volcanic units.

- Data from recent satellite missions to the moon and resources data from NASA's Apollo Missions were used to come up with the map.
- This version of the map is a digital release only. The map can be downloaded from the Unified Geologic Map of the Moon website.

The mapping process:

- The existing historical maps were redrawn to line them up with more modern datasets. This preserved previous observations and geological interpretations.
- In addition to merging new and old data, USGS researchers also worked on a unified description of stratigraphy also called rock layers on the surface of the moon.
- This helped resolve issues from previous maps, when rock names, ages, and descriptions were periodically inconsistent.

The moon profile:

- The Moon, otherwise known as Luna, is the only natural satellite of Earth.
- It was created 4.6 billion years ago, and it is widely accepted that it was created when Earth collided with a planet-sized object called Theia.
- It's the fifth-largest moon in our solar system and is the second brightest object in the sky (after the Sun).



Orbital characteristics

- Average distance from Earth: 238,855 miles (384,400 km)
- Perigee (closest approach to Earth): 225,700 miles (363,300 km)
- Apogee (farthest distance from Earth): 252,000 miles (405,500 km)
- Orbit circumference: 1,499,618.58 miles (2,413,402 km)
- Mean orbit velocity: 2,287 mph (3,680.5 km/h)

Moon's South Pole:

- The moon's South Pole is especially interesting because the area is much larger than the North Pole and there could be the possibility of the presence of water in these permanently shadowed areas.
- Further, the South Pole region also contains the fossil record of the early Solar System.

Artificial Neural Networks based globalIonospheric Model

Context: Researchers from the Indian Institute of Geomagnetism (IIG), Navi Mumbai, under the Department of Science & Technology, have developed a global model to predict the ionospheric electron density with larger data coverage.

About:

- The new Artificial Neural Networks based global Ionospheric Model (ANNIM) is developed using long-term ionospheric observations to predict the ionospheric electron density and the peak parameters.
- ANNs replicate the processes in the human brain (or biological neurons) to solve problems such as:
 - pattern recognition
 - classification
 - clustering
 - generalization
 - linear and nonlinear data fitting
 - time-series prediction
- Currently, very few attempts have been made to model the global ionosphere variability using ANNs.

How they did it?

- The researchers developed a neural network-based global ionospheric model by using:
 - an extensive database of global Digisonde (an instrument that measures real-time on-site electron density of the ionosphere by sending the radiofrequency pulses)
 - > Global Navigation Satellite System (GNSS) radio occultation
 - topside sounders observations
- These datasets were processed with various quality control measures to eliminate spurious data points (outliers) and prepared for the training.
- Day number, Universal Time, latitude, longitude, F10.7 index (responsible for Photo-ionization), Kp (represents the disturbed space weather conditions), magnetic declination, inclination, dip latitude, zonal and meridional neutral winds were taken as inputs in the study.

- The target (output) of ANNs is the electron density as a function of altitude for any given location and time.
- The data was trained with the ANNs using a high-performance computer at IIG to develop the ANNIM.

What is the ionosphere?

- A dense layer of molecules and electrically charged particles, called the ionosphere, at about 35 miles (60 kilometers) above the planet's surface and stretching out beyond 620 miles (1,000 km).
- The ionosphere overlaps the mesosphere, thermosphere, and exosphere. It is a very active part of the atmosphere, and it grows and shrinks depending on the energy it absorbs from the sun.
- In the ionosphere, charged particles are affected by the magnetic fields of both Earth and the sun.
- This is where auroras happen. Those are the bright, beautiful bands of light that you sometimes see near Earth's poles.
- They are caused by high-energy particles from the sun interacting with the atoms in this layer of our atmosphere.

19 Discovery of Li-rich giant stars

Context: Researchers at the Indian Institute of Astrophysics (IIA) have discovered hundreds of Li-rich giant stars indicating that Li is being produced in the stars and accounts for its abundance in the interstellar medium.

About:

• Lithium (Li), is one of the three primordial elements, apart from Hydrogen and Helium (He), produced in the Big Bang Nucleosynthesis (BBN) whose models predict primordial Li abundance.

Big Bang Nucleosynthesis:

- The theory predicts rather successfully the primordial abundances of light elements.
- It gives a detailed mathematical description of the production of the light "elements" like deuterium, helium-3, helium-4, and lithium-7.
- Specifically, the theory yields precise quantitative predictions for the mixture of these elements, that is, the primordial abundances at the end of the big-bang.
- It predicts that roughly 25% of the mass of the Universe consists of Helium. It also predicts about 0.01% deuterium and even smaller quantities of lithium.
- Natural lithium is a mixture of two stable isotopes, lithium-6 and lithium-7. Lithium-7 accounts for over 92% of the natural abundance of the element.
- Lithium is an alkali metal. It's silver-white in pure form and is so soft it can be cut with a butter knife. It has one of the lowest melting points and a high boiling point for a metal.

Significance of the finding:

- This is an important discovery that will help to eliminate many proposed theories such as planet engulfment or nucleosynthesis during the red giant evolution in which helium at the center is not burning.
- Moreover, the identification of sources of Li enrichment in our Galaxy has been of great interest to researchers to validate Big Bang Nucleosynthesis as well as a stellar mixing process.



20 Starship Spacecraft

Context: Just two days after SpaceX's Crew Dragon capsule landed in the Gulf of Mexico, a prototype of the company's uncrewed "Mars ship", a test vehicle called SN5, and which is a part of the Starship spacecraft, successfully flew to an altitude of over 500 feet for a little less than 60 seconds.

What is Starship?

- Designed by SpaceX, Starship is a spacecraft and super-heavy booster rocket meant to act as a reusable transportation system for crew and cargo to the Earth's orbit, Moon and Mars.
- SpaceX has described Starship as "the world's most powerful launch vehicle" with an ability to carry over 100 metric tonnes to the Earth's orbit.
- Starship has been under development since 2012 and is a part of Space X's central mission to make interplanetary travel accessible and affordable and to become the first private company to do so.

Why the focus is on 'reusable transportation system'?

- Reusability is at the heart of making interplanetary travel accessible.
- Since a majority of the launch cost is attributed to the expense of building a rocket which is ultimately designed to burn up during re-entry.
- Following the commercial model, a rapidly reusable space launch vehicle could reduce the cost of traveling to space by a hundredfold.

Significance of the Starship

- Functional at lower cost: Starship can deliver satellites further and at lower marginal costs than SpaceX's Falcon vehicles and it can ferry both cargo and crew to the International Space Station (ISS).
- **Ability to carry large amounts of cargo:** Once developed, Starship is also expected to help carry large amounts of cargo to the Moon, for human spaceflight development and research.
- Interplanetary missions: Beyond the Moon, the spacecraft is being designed for carrying crew and cargo for interplanetary missions as well.

21 Space Security

Context: Britain recently moved a UN Resolution to prevent arms race in outer space

What are the current space regulations?

- Several legally binding international instruments (treaties) governing the use of outer space for peaceful purposes have been adopted within the framework of the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS), with the 1967 Outer Space Treaty (OST) at its core.
- UNCOPUOS (1958):
 - The UNCOPUOS was established in 1958 as an ad hoc committee of the UN (later made permanent in 1959) with the UN Office for Outer Space Affairs (UNOOSA) as its secretariat.
 - UNCOPUOS oversees the implementation of five UN treaties related to outer space activities, namely,

- Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies of 1967 (Outer Space Treaty)
- Agreement on the Rescue of Astronauts
- the Return of Astronauts and the Return of Objects Launched into Outer Space of 1968 (Rescue Agreement),
- Convention on International Liability for Damage Caused by Space Objects of 1972 (Liability Convention),
- Convention on Registration of Objects Launched into Outer Space of 1976 (Registration Convention)
- the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies of 1979 (Moon Treaty)
- It also oversees other related international agreements like the
 - Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space, and Under Water (NTB) of 1963
 - ► the Brussels Convention Relating to the Distribution of Programme–Carrying Signals Transmitted by Satellite (BRS) of 1979

• Outer Space Treaty

- ► The Treaty declares outer space "the province of mankind".
- It bars states party to the treaty from placing weapons of mass destruction in Earth orbit, installing them on the Moon or any other celestial body, or otherwise stationing them in outer space
- It specifically limits the use of the Moon and other celestial bodies for peaceful purposes, and expressly prohibits their use for testing weapons of any kind, conducting military maneuvers, or establishing military bases, installations, and fortifications.
- Treaty does not prohibit the placement of conventional weapons in orbit, and thus some highly
 destructive attack tactics, such as kinetic bombardment, are still potentially allowed.
- The exploration of outer space shall be done to benefit all countries and that space shall be free for exploration and use by all the states.

22 National Space Promotion and Authorization Centre (IN-SPACe)

Context: The Government of India has launched a new initiative by the name Indian National Space Promotion and Authorization Centre (IN-SPACe) to provide a level playing field for private companies to use Indian space infrastructure, which will be extended into the Indian Space Research Organisation (ISRO).

About:

- The new Indian National Space Promotion and Authorisation Centre (IN-SPACe), will-
 - assess the needs and demands of private players, including educational and research institutions
 - > explore ways to accommodate these requirements in consultation with ISRO
- IN-SPACe is supposed to be a facilitator, and also a regulator. It will act as an interface between ISRO and private parties and assess how best to utilize India's space resources and increase space-based activities.
- Existing ISRO infrastructure, both ground- and space-based, scientific and technical resources, and even data are planned to be made accessible to interested parties to enable them to carry out



their space-related activities.

- National Space, Promotion & Authorisation Centre (IN-SPACe) will help private players through encouraging policies, through a regulatory environment that is friendly as well as guiding private players in space activities.
- Indian Space Research Organisation (ISRO) will remain the basic body that decides what missions are to be undertaken but this new body will help fill the gaps.

Indian Space Research Organization (ISRO)

- India decided to go to space when Indian National Committee for Space Research (INCOSPAR) was set up by the Government of India in 1962.
- With the visionary Dr. Vikram Sarabhai at its helm, INCOSPAR set up the Thumba Equatorial Rocket Launching Station (TERLS) in Thiruvananthapuram for upper atmospheric research.
- Indian Space Research Organisation, formed in 1969, superseded the erstwhile INCOSPAR.
- The Indian Space Research Organization (ISRO) is the pioneer space exploration agency of the Government of India, headquartered at Bengaluru.
- The prime objective of ISRO is to develop space technology and its application to various national needs.

23 Detection of fluorine in hot Extreme Helium Stars

Context: A recent study by the Indian Institute of Astrophysics (IIA) detected the presence of singly ionized fluorine for the first time in the atmospheres of hot Extreme Helium Stars.

About:

- An extreme helium star or EHe is a low-mass supergiant that is almost devoid of hydrogen, the most common chemical element of the universe.
- There are 21 of them detected so far in our galaxy.

Key-findings of the research

 The research which showed fluorine abundances determined from singly ionized fluorine (F II) lines suggest a very high enrichment of fluorine, about a factor of 100 to 10000 times higher than normal stars.

Fluorine

- Fluorine is a univalent poisonous gaseous halogen, it is pale yellow-green and it is the most chemically reactive and electronegative of all the elements.
- Fluorine readily forms compounds with most other elements, even with the noble gases krypton, xenon, and radon.
- It is so reactive that glass, metals, and even water, as well as other substances, burn with a bright flame in a jet of fluorine gas.

24 Sun reportedly entering 'Solar Minimum'

Context: As per experts report, the Sun has gone into a state called the 'solar minimum' and is about to enter the deepest period of 'sunshine recession' as sunspots are virtually not visibly at all.

About Solar Minimu

- Sun has a cycle that lasts on average 11 years, and right now we are at the peak of that cycle.
- Every 11 years or so, sunspots fade away, bringing a period of relative calm. This is called the solar minimum. And it's a regular part of the sunspot cycle.
- While intense activity such as sunspots and solar flares subside during solar minimum, that doesn't mean the sun becomes dull.
- Solar activity simply changes form.

How does it happen?

- The solar cycle is based on the Sun's magnetic field, which flips around every 11 years, with its north and south magnetic poles switching places.
- It's not known what drives these cycles recent research suggests it has to do with an 11.07-year planetary alignment but the poles switch when the magnetic field is at its weakest, also known as solar minimum.
- Because the Sun's magnetic field controls solar activity sunspots, coronal mass ejections, and solar flares the cycle is detectable as that activity changes.
- During solar minimum, there are, well, minimal sunspots and flares. This gradually changes as the Sun ramps up to solar maximum.
- The magnetic field grows stronger, and sunspot and flare activity increases, before subsiding again for the next solar minimum.

Is it a repeat of Dalton Minimum?

- NASA scientists fear it could be a repeat of the Dalton Minimum, which happened between 1790 and 1830 leading to periods of brutal cold, crop loss, famine, and powerful volcanic eruptions.
 - Temperatures plummeted by up to 2 degrees Celsius (3.6 degrees Fahrenheit) over 20 years, devastating the world's food production.
- It also led to the so-called Year Without a Summer in 1816

Impacts:

- Affecting Earth's upper atmosphere: Excess cosmic rays pose a health hazard to astronauts and polar air travelers, affect the electro-chemistry of Earth's upper atmosphere, and may help trigger lightning.
- Affecting radio communication & satellites: More aurora activity can be noticed during solar maximum since auroras are generated by solar activity. Increased solar activity can also affect radio communications and navigation satellites.
- **Affecting higher altitudes:** At a solar minimum, solar ultraviolet radiation decreases, but the effect of this primarily hits the stratosphere and higher altitudes.
- Shrinkage: It causes Earth's atmosphere to shrink slightly, which reduces drag on satellites.
- **More rainfall:** Conversely, the increase in UV radiation during solar maximum contributes to rainfall, but the effect on temperature is negligible.

25 Solar Cycle 25 Is Here: NASA & NOAA

Context: NASA and the National Oceanic and Atmospheric Administration (NOAA) discussed their analysis and predictions about the new solar cycle – and how the coming upswing in space weather will impact our lives and technology on Earth, as well as astronauts in space.

About:

- The new solar cycle, called Solar Cycle 25 is believed to have begun.
 - Solar Cycle 25 officially began in December 2019, when solar minimum occurred, marking the end of Solar Cycle 24. Because the sun is so variable, it can take months to calculate when the new cycle starts.
 - Solar Cycle 24 had the fourth-smallest intensity since regular record-keeping began with Solar Cycle 1 in 1755. It was also the weakest cycle in 100 years. Scientists forecast that Solar Cycle 25 will be a fairly weak one, similar to Solar Cycle 24.
- The Sun is a huge ball of electrically-charged hot gas. This charged gas moves, generating a powerful magnetic field.
- The Sun's magnetic field goes through a cycle, called the solar cycle.
- Every 11 years or so, the Sun's magnetic field completely flips. This means that the Sun's north and south poles switch places.
- Then it takes about another 11 years for the Sun's north and south poles to flip back again.
- As the magnetic fields change, so does the amount of activity on the Sun's surface.

Tracking solar activity

- Scientists track a solar cycle by using sunspots, which are the dark blotches on the Sun that are associated with solar activity.
- Sunspots are associated with the origins of giant explosions such as solar flares that can spew light, energy, and solar material into space.

What is Sunspot?

- A Sunspot is an area on the Sun that appears dark on the surface and is relatively cooler than the surrounding parts.
- These spots, some as large as 50,000 km in diameter, are the visible markers of the Sun's magnetic field, which forms a blanket that protects the solar system from harmful cosmic radiation.
- When a Sunspot reaches up to 50,000 km in diameter, it may release a huge amount of energy that can lead to solar flares.



3

DEFENCE TECHNOLOGY

¹ Supersonic Missile Assisted Release of Torpedo (SMART) system

Context: A successful flight test of the Supersonic Missile Assisted Release of Torpedo (SMART) system was conducted from Wheeler Island, off the coast of Odisha.

About:

- SMART is a missile-assisted release of lightweight anti-submarine torpedo system for antisubmarine warfare (ASW) operations far beyond torpedo range.
- SMART is a hybrid missile
- While the long-range torpedo available in the world is around 50 km and rocket-assisted torpedoes can strike at a range of 150 km, the SMART will have a range of over 600 km.



GSSCORE

India test-fires new version of nuclear-capable Shaurya missile

Context:

 India successfully test-fired indigenously developed hypersonic nuclear-capable Shaurya missile

About:

- 'Shaurya', has a strike range of 700 km to 1000 km and is capable of carrying payloads of 200 kg to 1000 kg.
- The missile can be stored in a composite canister.
- The missile is less vulnerable to anti-ballistic missile defense systems due to its high maneuverability.
- This surface-to-surface tactical missile is 10 meters long, 74 cm in diameter, and weighs 6.2 tonnes.
- Its two stages use solid propellants.
- Launching platform: The missile can be launched from silos and canisters mounted on a truck and fixed on the ground, they said adding that it can be easily moved around. A truck itself can become a launching platform.
- Shaurya missile is considered as a land version of the Sagarika missile of the K Family.

The K Family of missiles

- The K family of missiles are primarily Submarine Launched Ballistic Missiles (SLBMs)
- The development of these naval platforms launched missiles helped to complete **India's nuclear triad** the capability of launching nuclear weapons from land, sea, and air-based assets.
- Because these missiles are to be launched from submarines, they are lighter, smaller, and stealthier than their land-based counterparts.

3 S-400 Triumf Air Defense Systems

Context: The US has yet again warned India that it could face sanctions over acquiring five Russian S-400 Triumf air defense systems.

What is S-400?

- The S-400 is a mobile, surface-to-air missile defense system (SAM) designed by Russia.
- It integrates the 91N6E multi-function panoramic radar with a 600 km range, autonomous detection, and targeting systems and launchers.
- It can fire four missile types with strike ranges of between 400 km and 40 km to provide multilayered defense against incoming fixed-wing and rotary aircraft, unmanned aerial vehicles (UAVs), and ballistic missiles at altitudes of up to 30 km.
- The S-400 is organized around the 30K6E administration system, with protection against jamming.

• It can simultaneously locate 72 targets and track another 160 alongside, compared with PAC-3s 36 and 125 respectively.

Which countries have sanctions imposed on them?

- So far, the US has imposed sanctions on Turkey and China for taking delivery of S-400 systems.
- US removed Turkey, a NATO ally, from the F-35 joint strike fighter (JSF) program.
- A White House statement declared that the F-35 cannot coexist with a Russian intelligencecollection platform, as that can be used to learn about its advanced capabilities.

India's other air defense system

- Long Range interception: Indian Ballistic Missile Defence Programme
 - ➤ It is a double-tiered system consisting of two land and sea-based interceptor missiles, namely the Prithvi Air Defence (PAD) missile for high altitude interception, and the Advanced Air Defence (AAD) Missile for lower altitude interception.
- Intermediate Interception: S-400 Triumph
- Short Range interception: Akash Air Defense System and Similar Systems
- Very Short-range interception: MANPADS and Anti- Aircraft Guns.

Successful test-firing of Hypersonic Technology Demonstrator Vehicle (HSTDV)

Context: DRDO successfully test-fired the Hypersonic Technology Demonstrator Vehicle (HSTDV), making India the fourth country in the world.

What is HSTDV?

4

- The HSTDV is an unmanned scramjet demonstration aircraft for hypersonic speed flight.
- Hypersonic flight means a speed greater than five times the speed of sound (Mach 5).
- Apart from being used as a vehicle for hypersonic and long-range cruise missiles, the HSTDV is a dual-use technology that will have multiple civilian applications, including the launch of small satellites at low cost.

What are Hypersonic nuclear missiles?

- Hypersonic missiles travel at speeds faster than 3,800 miles per hour or 6,115 km per hour, much faster than other ballistic and cruise missiles.
- They can deliver conventional or nuclear payloads within minutes.
- They are highly maneuverable and do not follow a predictable arc as they travel.
- They are said to combine the speed of ballistic missiles with the maneuvering capabilities of cruise missiles.
- The speed makes them hard to track compared to traditional missiles.

Different types of missiles

- Cruise and ballistic missiles
 - > Cruise missiles: A cruise missile either locates its target or has a preset target.
 - It navigates using a guidance system such as inertial or beyond visual range satellite GPS guidance and comprises a payload and aircraft propulsion system.



- Cruise missiles can be launched from land, sea, or air for land attacks and anti-shipping purposes, and can travel at subsonic, supersonic, and hypersonic speeds.
- Since they stay relatively close to the surface of the earth, they cannot be detected easily by anti-missile systems, and are designed to carry large payloads with high precision.
- Ballistic missiles: Ballistic missiles, meanwhile, are launched directly into the upper layers of the earth's atmosphere.
 - They travel outside the atmosphere, where the warhead detaches from the missile and falls towards a predetermined target.
 - They are rocket-propelled self-guided weapons systems that can carry conventional or nuclear munitions.
 - They can be launched from aircraft, ships and submarines, and land.

• ICBMs

- Intercontinental ballistic missiles (ICBMs) are guided missiles that can deliver nuclear and other payloads.
- ► ICBMs have a minimum range of 5,500 km, with maximum ranges varying from 7,000 to 16,000 km.
- Only a handful of countries, including Russia, the United States, China, France, India, and North Korea, have ICBM capabilities.

• Anti-satellite missiles

- > ASAT can incapacitate or destroy satellites for strategic military purposes.
- Other anti-satellite weapons include ground-based jammers to disrupt the signal from navigation and communications satellites.
- > The United States, Russia, and China are among countries pursuing anti-satellite weapons.

⁵ What are the MH-60R naval choppers, AH-64E Apaches India has bought?

Context: United States President announced: "deals to sell over \$3 billion in the absolute finest, state-of-the-art military helicopters and other equipment to the Indian Armed Forces."

About:

 Agreements for India to purchase advanced American military equipment, including Apache and MH-60 Romeo helicopters, will enhance our joint defense capabilities as the militaries continue to train and operate side-by-side.

MH-60 Romeo helicopters

- The incoming 24 multirole MH-60 Romeo helicopters are expected to boost the Indian Navy's efforts to expand its role in the Indian Ocean Region.
- The Navy had long asked for these helicopters, and the \$2.2 billion deal was cleared by the Cabinet Committee on Security.
- The MH-60 Romeo Seahawk, made by defense giant Lockheed Martin, is one of the most advanced naval helicopters in the world, used by the US Navy among others.
- It will be purchased directly from the US government under a Foreign Military Sales (FMS) agreement with the US Department of Defence (DoD).

- It is the most capable and mature Anti-Submarine Warfare (ASW) Anti-Surface Warfare (ASuW) multi-mission helicopter available in the world today.
- The MH-60 is designed to hunt down submarines and will add to the strategic depth and combat capability of the Indian Navy.
- It is capable of launching Hellfire missiles from the right and left extended pylons.
- It also has an advanced system for passive detection, location, and identification of emitters.
- It can not only track and hunt ships but is also used by the US Navy as an anti-submarine weapon.
- MH-60 Romeo Seahawks have been equipped with anti-submarine Mark 54 torpedoes and Hellfire air-to-surface missiles, along with precision-kill rockets.

Apache helicopters

- The Army will receive six Apache helicopters that will cost approximately \$800 million.
- The six choppers for the Army will be in addition to the 22 Apache helicopters that have already been ordered for the Air Force.
- This will be a direct commercial sale.
- The Apaches can operate at high altitudes and will be deployed along the Pakistan border.
- The Army is likely to get the helicopters armed with Stinger air-to-air missiles and Hellfire Longbow air-to-ground missiles.
- Among the Apache's modern capabilities are the ability to shoot fire-and-forget anti-tank missiles, air-to-air missiles, rockets, and other munitions.
- It also has modern electronic warfare capabilities to provide versatility in network-centric aerial warfare.
- The choppers are all-weather capable and have high agility and survivability against battle damage.
- They can be easily maintained in field conditions as well as during operations in the tropical and desert regions.

6 5 Rafales Joins Indian Air Force

Context: The first batch of five **Rafale multirole fighter jets** are formally inducted into the Indian Air Force at **Ambala air base in Haryana**, at a time when India is engaged in an escalating border row with China in eastern Ladakh.

About:

- The Rafale jets, built by French aerospace major Dassault Aviation, are known for air-superiority and precision strikes on ground targets, making them truly multirole jets.
- **Speed:** The state-of-the-art **4.5 Generation Rafale jet** can reach almost double the speed of sound, with a top speed of 1.8 Mach.
- The Rafales (literally meaning "gust of wind", and "burst of fire" in a more military sense) are capable of carrying a range of potent weapons.
- European missile maker MBDA's Meteor beyond visual range (BVR) air-to-air missile and Scalp cruise missile will be the mainstay of the weapons package of the Rafale jets.
 - MBDA developed the Meteor to combat common threats facing the UK, Germany, Italy, France, Spain, and Sweden.

- The multirole French-made fighter jets will become a part of the IAF's 17 Squadron **"Golden Arrows".**
- **SCALP missile:** The Rafale jets also come with SCALP, the air-to-ground cruise missile with a range over 300 km. It is a long-range deep strike missile.
- The MICA air-to-air missile on Rafale is for both, close-quarter dogfights, and for BVR.
- HAMMER: At the last-minute, India has also asked for HAMMER (Highly Agile and Manoeuvrable Munition Extended Range), which is an air-to-ground precision guided missile produced by French conglomerate Safran, and can be used against bunker-type hardened targets within the range of 70 km.
- India will only be the fourth country, after France, Egypt and Qatar, to fly the Rafale.

Rafale Specifications				
Maximum take-off weight	24.5 Tonnes			
Height	5.30 m			
Length	15.30 m			
Fuel (internal)	4.7 Tonnes			
Fuel (external)	Up to 6.7 Tonnes			
Top Speed	1.8 Mach at High Altitude			
Lending ground run	450 m (1,500 ft)			

Sukhoi Su-30 MKI fighter jet

- The Sukhoi Su-30MKI is the most advanced fighter jet in operation with the Indian Air Force and is the primary air to air and air to ground strike machine.
- Su-30 MKI is built in India by HAL under license agreement with Russia's Sukhoi.
- The Sukhoi Su-30MKI has a top speed of Mach 2 (2120 kmph) and has a maximum takeoff weight of 38,800 kg.
- The jet can carry a wide range of equipment from radars to missiles, bombs and event rockets.
- **Weapon carrying capacity**: It is capable of carrying a variety of medium-range guided air to air missiles with active or semi-active radar or Infrared homing close range missiles.
- It can be used in carrying out nuclear strikes.
- The Su-30 MKI aircraft is capable of being refuelled by an Air to Air refuelling aircraft or by another Su-30 MKI aircraft carrying a buddy refuelling strap on pod.
- India's Su-30MKI multi-role fighter-bomber is one of the best 4 generation aircraft currently available.

RAFALE vs China's J20

- While China's J20 Chengdu jets are called fifth generation combat jets, compared to 4.5 generation Rafale, the J20 have no actual combat experience.
- Whereas the Rafale is combat proven, having been used by the French Air Force for its missions in Afghanistan, Libya and Mali.

- It has also been used for missions in Central African Republic, Iraq and Syria.
- Rafale can also carry more fuel and weapons than the J20.



Abhyas High-speed Expendable Aerial Target (HEAT)

Context: The Defence Research and Development Organisation (DRDO) conducted successful flight-tests of the indigenously-designed **Abhyas High-speed Expendable Aerial Target (HEAT)** in Balasore.

About:

7

- Abhyas High-speed Expendable Aerial Target (HEAT) is a autonomous flying machine that will be used as a target for various missile systems.
- > Abhyas is capable of fully-autonomous flight and runs on a gas turbine engine.



- Its inertial navigation system is based on micro-electromechanical systems (MEMS) and it uses a flight control computer for guidance and control.
- MEMS is a process technology used to create tiny integrated devices or systems that combine mechanical and electrical components.
- > Abhyas has RCS, Visual and IR augmentation systems required for weapon practice.
- > The air vehicle is launched using twin underslung boosters.
- ► It is powered by a small gas turbine engine and has an **Inertial Navigation System (INS)** along with a **Flight Control Computer (FCC)** for guidance and control.
- ► The vehicle has been programmed for fully autonomous flight. The check out of the vehicle is done using laptop- based Ground Control Station (GCS).
- > It is designed and developed by the Aeronautical Development Establishment (ADE) of DRDO.

What are drones (UAV)?

- Unmanned aerial vehicle technology covers everything from the aerodynamics of the drone, materials in the manufacture of the physical UAV, to the circuit boards, chipset and software, which are the brains of the drone.
- UAV drones are equipped with different state of the art technology such as infrared cameras, GPS and laser (consumer, commercial and military UAV).
- Drones are controlled by remote ground control systems (GSC) and also referred to as a ground cockpit.

GSSCORE



IAS 2022 GS FOUNDATION



ALTERNATIVE TECHNOLOGIES

1 Novichok nerve agent

Context: The German government says Russia's opposition leader, Alexei Navalny, has been poisoned with a Novichok nerve agent.

What are Novichok agents

- The name Novichok (A-230) means "newcomer" in Russian and applies to a group of **advanced nerve agents** developed by the Soviet Union in the 1970s and 1980s.
- They were known as **fourth-generation chemical weapons** and were developed under a **Soviet program codenamed Foliant.**



How is it used?

- Novichok agents are dispersed as ultra-fine powder rather than a gas or vapor.
- They can be inhaled, ingested, or absorbed through the skin.

Variants of Novichok

- Some variants of Novichok are thought to be five to eight times more toxic than the VX nerve agent.
- While some Novichok agents are liquids, others are thought to exist in solid form. This means they could be dispersed as an ultra-fine powder.
- Some of the agents are also reported to be "binary weapons", meaning the nerve agent is typically stored as two less toxic chemical ingredients that are easier to transport, handle and store.
- When these are mixed, they react to produce the active toxic agent.



Is there an antidote?

- All nerve agents have an antidote in atropine, but it needs to be administered as soon as possible.
- A common problem is that it can take time to diagnose that a nerve agent has been used.

Who controls the world's most toxic chemicals?

- TheworkoftheOrganisation for the Prohibition of Chemical Weapons (OPCW) is carried out as part of an international control regime that governs what is, or is not, permissible as far as very toxic chemicals are concerned.
- This was established by the 1997 Chemical Weapons Convention (CWC), to which 192 countries are signed up members.



- Only four countries are outside the CWC **North Korea, Israel, Egypt, and South Sudan**. They are still bound by the treaty's provisions, under international law.
- Novichoks were added to the **Chemical Weapons Convention**'s list of **controlled substances.**

2 World's largest solar tree

Context: Scientists at the Central Mechanical Engineering Research Institute (CMERI) in West Bengal have installed a 'solar tree' that is likely to be the largest of its kind in the world.

What is the solar tree?

- A solar tree is a structure resembling a tree that has solar panels fitted on the branches.
- The solar panels connected through branches produce solar power.
- The working of a solar tree is much like that of a real one—leaf-like solar panels connected through metal branches using sunlight to make energy.
- The Solar tree panels charge batteries during the day. At dusk, the tree automatically switches on LED lights. It is programmed to regulate the amount of light it produces.
- Solar trees are flexible and **rotate to face the sun** and produce the maximum possible amount of energy using a technique called **"spiraling phyllataxy"**.

Key-details of CMERI solar tree

• This is producing up to 11,500 watts (11.5kw).

- The CMERI solar tree has 35 panels each with a capacity of 330 watts.
- The solar tree has capabilities to adapt a group of Internet of Things (IoT)-based features, such as
 - ► round-the-clock CCTV surveillance in agricultural fields
 - ▶ real-time humidity, wind speed, rainfall prediction
 - soil analytics sensors
 - The solar tree can also be connected to CSIR-CMERI's solar-powered e-suvidha kiosks for real-time access to the massive agricultural database, as well as to the eNAM (National Agricultural Marketplace) for instant and real-time access to a unified online market.

3 Transparent wood is coming

Context: As per a new study, researchers have found a way to make wood transparent without using huge amounts of energy in the process.

AboutL

- Wood is an ancient material used for the construction of housing, ships and as a source of fuel for burning.
- Wood is essentially composed of two basic ingredients **cellulose** and **lignin**:
 - Cellulose is tiny fibers and lignin is the bonds that keep these fibers together and resists compression.
 - Lignin is a glue-like material that bonds the fibers together, a little like the plastic resin in fiberglass or carbon fiber. The lignin also contains molecules called chromophores, which give the wood its brown color and prevent light from passing through.
- It's also a renewable source, and one way to capture excess carbon dioxide from the Earth's atmosphere.

Wood's lack of transparency

- Wood's lack of transparency comes from the combination of its two main components- cellulose and lignin.
- The lignin absorbs light, and the presence of chromophores light-activated compounds in the material makes the wood look brown.
- The fibers in the wood, which mainly comprise cellulose, are **hollow tube-like** structures.
- The air in these hollow tubes scatters light, further reducing the material's transparency.

The new method

- The new study demonstrates how to make wood transparent using a simple chemical **hydrogen peroxide** commonly used to bleach hair.
- This chemical modifies the **chromophores**, changing their structure so they no longer act to absorb light and color the wood.
- The chemical can be brushed onto the wood, and then activated using light to produce a brilliant **white material**
- The other reason paper is white is because pores or holes in its structure scatter light, just like the hollow cellulose fibers in wood.

• Filling these fibers with resin reduces that scattering, allowing light to pass through the wood and making it transparent while retaining its original mechanical properties.

Usage of transparent wood

- Transparent wood would be much more resistant to accidental breakage
- It could become an alternative to glass in energy-efficient buildings, or perhaps coverings for solar panels in harsh environments.

4 Desalination Plants

Context: In the latest development, Maharashtra announced the setting up of a desalination plant in Mumbai, becoming the fourth state in the country to experiment with the idea.

What is a desalination plant?

- A desalination plant turns salt water into water that is fit to drink.
- These plants are mostly set up in areas that have access to sea water.

Which technology is preferred?

- The most commonly used technology for the process is **reverse osmosis** where external pressure is applied to push solvents from an area of high-solute concentration to an area of low-solute concentration through a membrane.
- The **microscopic pores** in the membranes allow water molecules through but leave salt and most other impurities behind, releasing clean water from the other side.

How widely is this technology used in India?

- The following states are using the technology:
- **Tamil Nadu:** Tamil Nadu has been the pioneer in using this technology, setting up two desalination plants near Chennai in 2010 and then 2013.
- **Gujarat:** The other states that have proposed these plants are Gujarat, which has announced to set up a 100 MLD RO plant at the Jodiya coast in Jamnagar district.
 - ► There are also proposals to set up desalination plants in Dwarka, Kutch, Dahej, Somnath, Bhavnagar, and Pipavav, which are all coastal areas in Gujarat.
- **Andhra Pradesh:** Andhra Pradesh, too, has plans of setting up a plant.

5 Hydrogen Fuel Cell

Context: NTPC Ltd has invited Global Expression of Interest to provide 10 Hydrogen Fuel Cellbased electric buses and cars.

About:

- A fuel cell is a device that converts chemical potential energy (energy stored in molecular bonds) into electrical energy.
- A PEM (Proton Exchange Membrane) cell uses hydrogen gas (H₂) and oxygen gas (O₂) as fuel. The products of the reaction in the cell are water, electricity, and heat.

Hydrogen + Oxygen -> Electricity + Water Vapour

- This is a big improvement over internal combustion engines, coal-burning power plants, and nuclear power plants, all of which produce harmful by-products.
- Since O₂ is readily available in the atmosphere, we only need to supply the fuel cell with H₂ which can come from an electrolysis process

What is Hydrogen?

- Hydrogen is the simplest element. An atom of hydrogen consists of only one proton and one electron.
- It's also the most plentiful element in the universe. Despite its simplicity and abundance, hydrogen doesn't occur naturally as a gas on Earth it's always combined with other elements.
- Water, for example, is a combination of hydrogen and oxygen (H_2O).
- Hydrogen is high in energy, yet an engine that burns pure hydrogen produces almost no pollution.
- NASA has used liquid hydrogen since the 1970s to propel the space shuttle and other rockets into orbit.
- Hydrogen fuel cells power the shuttle's electrical systems, producing a clean byproduct pure water, which the crew drinks.

6 CollabCAD

Context: Atal Innovation Mission, NITI Aayog, and National Informatics Centre (NIC) jointly launched CollabCAD.

About:

- CollabCAD is a collaborative network, computer-enabled software system, providing a total engineering solution from 2D drafting & detailing to 3D product design.
- This initiative aims to provide a great platform for students of Atal Tinkering Labs (ATLs) across the country to create and modify 3D designs with a free flow of creativity and imagination.
- This software would also enable students to create data across the network and concurrently access the same design data for storage and visualization.
- ATLs established across India, provide tinkering spaces to children to hone their innovative ideas and creativity.
- A customized version of CollabCAD for ATLs with features that are most relevant to school students to materialize their ideas and creativity into physical solutions has been developed to enable designing without constraints and, thus, allowing creativity and innovation to thrive.

What is 3D Printing?

- 3D printing or additive manufacturing is the process of making three-dimensional solid objects from a digital file.
- The creation of a 3D printed object is achieved using additive processes. In an additive process, an object is created by laying down successive layers of material until the object is created.
- Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object.
- 3D printing is the opposite of **subtractive manufacturing** which is cutting out / hollowing out a piece of metal or plastic with for instance a milling machine.
- 3D printing enables you to produce complex shapes using less material than traditional manufacturing methods.

• Examples of 3D Printing include consumer products (eyewear, footwear, design, furniture), industrial products (manufacturing tools, prototypes, functional end-use parts), dental products, prosthetics, architectural scale models & maquettes, reconstructing fossils, etc.

2D Drafting:

- 2D Drafting is the creation of accurate representations of objects for manufacturing and engineering needs.
- It is used to fully and clearly define requirements for concepts or products to convey all the required information that will allow a manufacturer to produce that component.

7

L&T Construction 3D prints India's first building with reinforcement

Context: L&T Construction, the construction arm of the \$21 billion technology, engineering & construction conglomerate, Larsen & Toubro, has 3D printed a G+1 (Ground plus one) building with reinforcement for the first time in India.

About:

- The 3D printed building has a built-up area of 700 sq. feet and is located at L&T Construction's Kanchipuram facility.
- It has been built with a special, in-house-developed concrete mix using indigenously available regular construction materials.
- The building was printed with both vertical reinforcement bars and horizontal distributors using welded mesh, that satisfy provisions in the Indian Codes and optimize the cost of construction.
- Barring the horizontal slab members, the entire building structure was 3D printed 'Cast in Situ' at the job site in an 'open to sky' environment within 106 printing hours, using a fully automated 3D printer.



8 Brain Fingerprinting Technology

Context: The four accused in the Hathras case were said to undergo brain fingerprinting, the neuropsychological interrogation.

GSSCORE

Background:

The brain fingerprinting technique was first developed and patented in 1995 by Lawrence A.
 Farwell of the U.S.A. Police in India has used brain fingerprinting since 2003.

What is Brain Fingerprinting?

- In brain fingerprinting, a headset with two electrodes is put on the head of the suspect. One electrode is placed on the forehead between the eyebrows while the other is put on the back of the head where the brain stores experiential memory.
- The electrodes are connected to a laptop with brain fingerprinting software.
- Details and photographs of the crime scene which are not in the public domain are projected on the screen in front of the suspect.
- If the suspect is involved in the crime the moment he sees the details, his brain recognizes the picture and sends a specific, measurable brain response to the software.
- In 1997, Indian neuroscientist Champadi Raman Mukundan developed a different technique called the Brain Electrical Oscillatory Signature (BEOS) Profiling.



What is the BEOSP test?

- BEOS is an electroencephalogram (EEG) technique by which a suspect's participation in a crime is detected by eliciting electrophysiological impulses.
- The technique also referred to as a type of 'brain fingerprinting', has been categorized as "noninvasive" and a legitimate neuro-psychological method of interrogation.

Other important tests

These tests, which are often used as an aid during investigations by probe agencies, are different from each other but are all aimed at collecting vital information.

- **Narco-analysis** is a controlled administration of intravenous hypnotic medications called truth drugs on a suspect to procure vital information.
- **A polygraph**, popularly referred to as a lie detector, is an instrument that measures and records several physiological indices such as blood pressure, pulse, respiration and breathing rhythms, and skin conductivity while a suspect is asked a series of questions.
 - Deceptive answers are said to produce physiological responses that can be differentiated from those associated with non-deceptive answers.

9 Ultraviolet Germicidal Irradiation (UVGI)

Context: Scientists are studying the use of ultraviolet germicidal irradiation (UVGI) to kill the virus in schools, restaurants, and other public places. Through this method, ultraviolet (UV) lights would be able to disinfect contaminated public spaces to stop the transmission of the virus.

About:

- Ultraviolet germicidal irradiation (UVGI) is the use of ultraviolet (UV) energy (electromagnetic radiation with a wavelength shorter than that of visible light) to kill or inactivate viral, bacterial, and fungal species.
- UVGI is a method of disinfection that uses short-wavelength ultraviolet light (UV-C) to inactivate or kill microorganisms and pathogens.
- Essentially, UVGI is the use of UV light with sufficiently short wavelengths to disinfect surfaces, air, and water.
- The effectiveness of germicidal UV light depends on the length of time a microorganism is exposed to UV, as well as the intensity and wavelength of the UV radiation.

What is UV light?

- Ultraviolet light from the sun has shorter wavelengths than visible light and, therefore, is not visible to the naked eye.
- The full spectrum of UV radiation is sourced from the sun and can be subdivided into:
 - UV-A rays
 - UV-B rays
 - ► UV-C rays
- In this spectrum, UV-C rays are the most harmful and are completely absorbed by the Earth's atmosphere.
- Further, while both UV-A and UV-B rays are harmful, exposure to UV-B rays can cause DNA and cellular damage in living organisms.
- UV light kills cells. Increased exposure to it can cause cells to become carcinogenic, thereby increasing the risk of getting cancer.

- It is the increased direct exposure to UV rays from the sun that most commonly causes skin cancers.
- UV light with wavelengths less than 290nm is considered to have "germicidal" properties (more on this later).
- Earth's atmosphere absorbs ultramagnetic radiation with wavelengths less than 290nm, meaning that most of the UV-C and UV-B generated by the sun are blocked by our planet's ozone.

How does UV Light Kill Viruses and Bacteria?

- Ultraviolet light kills cells by damaging their DNA.
- Exposure to electromagnetic radiation (light) at certain UV wavelengths modifies the genetic material of microorganisms and destroys their ability to reproduce.
- The UV energy triggers the formation of specific thymine or cytosine dimers in DNA and uracil dimers in RNA, which causes the inactivation of microbes by causing mutations and/or cell death as well as failure to reproduce.

10 Facial-Recognition Research

Context: Although facial recognition software proves to be useful in certain scenarios, what happens if this technology falls into the wrong hands. Researchers must recognize that unethical facial recognition practice is fundamentally dangerous.

What is facial recognition, and how does it work?

- Facial recognition is a biometric technology that uses distinguishable facial features to identify a person.
- Facial recognition is a subcategory of biometrics. It's made possible by advanced computing components, such as processors and memory, and Artificial Intelligence tools, such as machine learning.
- Facial recognition is when a device uses a camera to identify a face for security or other purposes.
- Today, it's used in a variety of ways from allowing people to unlock their phones, go through security at the airport, purchase products at stores, etc.
- Today, the world is inundated with data of all kinds, but the plethora of photo and video data available provides the dataset required to make facial recognition technology work.
- Facial recognition systems analyze the visual data and millions of images and videos created by high-quality Closed-Circuit Television (CCTV) cameras, smartphones, social media, and other online activities.
- Machine learning and artificial intelligence capabilities in the software map distinguishable facial features mathematically, look for patterns in the visual data and compare new images and videos to other data stored in facial recognition databases to determine identity.

History of facial recognition

- Facial Recognition research started in 1964 in the USA for an intelligence agency by a team led by Woodrow Wilson Bledsoe, mathematician and computer scientist.
- Initially it involved manual matching of the facial characteristics assisted by computers.
- The difficulties then encountered in the 1960s over head rotation, tilt, angle, facial expression, skin, and slight variation continue to be problematic even in the 21st century.
- It becomes more difficult in case of unruly crowds with fast and unpredictable movements.
- The first time Facial Recognition Technology (FRT) was used in the USA in a crowd was in January 2001 in Tampa, Florida.

What's the Law on Facial Recognition?

- The direct implementation of such technologies has not been recognized by law.
- As such, there is a need for having in place detailed legal frameworks passed by the Parliament of India which authorize the implementation and maintenance of such automated facial recognition technologies.
- Currently, in India, there is no specific law that authorizes the deployment of these technologies.
- The Indian Information Technology Act, 2000 being India's mother legislation on the electronic format is completely silent on facial recognition. Also even under the rules passed under the Information Technology Act, 2000, there has no reference to facial recognition.
- As such, for long-term deployment of these technologies, it will be imperative, that the Parliament should pass strong laws to not just enable legal implementation of such technologies but also the law should establish the various instances where such technologies can be so implemented.



IAS 2022 TEST SERIES

MAINS & PRELIMS





BATCH

STARTS

APRIL

2021

\[
 \overline{\colored{S}}
 \overline{\colored{S}}
 \overline{\colored{S}}
 \]
 \[
 8448496262
 \]

Single source for Integrated Preparation



1B, 2nd Floor, Pusa Road Karol Bagh, New Delhi-110005, (Adjacent to Karol Bagh Metro Gate No. 8)

5

MISCELLANEOUS

1 Engineer's Day in India

Context: The birth anniversary of Sir M Visvesvaraya (September 15) is celebrated every year as Engineer's Day in India.

About Sir MV:

- Popularly called 'Sir MV', he was awarded the Bharat Ratna in 1955 for his immense contribution to India's early infrastructure development, education, and social welfare.
- After completing his undergraduate degree in Arts, M Visvesvaraya changed track and went for a degree in civil engineering from the College of Engineering in Pune.
- As the Diwan of Mysore, M Visvesvaraya founded the Mysore Soap Factory, Bangalore Agricultural University, State Bank of Mysore, and Mysore Iron and Steel Works.
- He also founded the Government Engineering College, now known as University Visvesvaraya College of Engineering.

2 Digital Quality of Life Index

Context: India ranks among the lowest in the world in terms of Internet quality, according to global research released by online privacy solutions provider SurfShark.

About:

- The Digital Quality of Life Index 2020 is prepared by Surfshark, a virtual private network (VPN) provider based in the British Virgin Islands.
- The study sampled the quality of digital wellbeing in 85 countries across the globe over five key pillars:
 - Internet affordability
 - ► Internet quality
 - electronic infrastructure
 - electronic government
 - electronic security
- All parameters have equal weightage.



Key-highlights of the Index

- As per the "Digital Quality of Life Index 2020", in terms of e-infrastructure, India occupies 79th place, ranking below countries including Guatemala and Sri Lanka.
- India makes it into the top 10 in terms of Internet affordability. With a ranking of nine, it outperforms countries such as the U.K., the U.S., and China.
- Additionally, when it comes to e-government, India occupies 15th place globally, just below countries like New Zealand and Italy.
- However, India's Internet quality is one of the lowest across 85 countries analyzed in the research.
- In position 78, India is at the bottom of the pillar with unstable and slow mobile Internet dragging it down in the overall Internet quality index.
- This year's Digital Quality of Life Index found that seven of the 10 countries with the highest digital quality of life are in Europe, with Denmark leading among 85 countries.
- Canada stands out as a country with the highest digital quality of life in the Americas, while Japan takes the leading position in Asia.
- Among the countries in Africa, people in South Africa enjoy the highest quality of digital lives whereas New Zealand leads in Oceania, outperforming Australia in various digital areas.

Ammonium nitrate linked to catastrophic Beirut explosion

Context: Beirut was declared a "disaster city", in the wake of a huge explosion in the port of the Lebanese capital

Ammonium nitrate, the substance used

- In its pure form, ammonium nitrate (NH4NO3) is a white, crystalline chemical that is soluble in water.
- It is the main ingredient in the manufacture of commercial explosives used in mining and construction.

Regulation of Ammonium Nitrate in India

- The manufacture, conversion, bagging, import, export, transport, possession for sale, or use of ammonium nitrate is covered under The Ammonium Nitrate Rules, 2012.
- The rules also make the storage of ammonium nitrate in large quantities in populated areas illegal in India.
- For the manufacture of ammonium nitrate, an Industrial license is required under the Industrial Development and Regulation Act, 1951.
- A license under the Ammonium Nitrate Rules, 2012 is also required for any activity related to ammonium nitrate.

Is it explosive?

• Pure ammonium nitrate is not an explosive on its own. It is classified as an oxidizer under the United Nations classification of dangerous goods.

- If mixed with ingredients like fuel or some other contaminants, or because of some other external factors, it can be very explosive.
- However, for combinations to explode, triggers like detonators are required. Many Improvised Explosive Devices (IEDs) used by terrorists around the world have ANFO(ammonium nitrate fuel oil) as the main explosive, triggered by primary explosives like RDX or TNT.

Is stored ammonium nitrate a major fire hazard?

- Large quantities of stored ammonium nitrate are regarded as a major fire hazard.
- The explosion of large storage can happen primarily in two ways.
 - Contact with an explosive mixture: One is by some type of detonation or initiation because the storage comes in contact with the explosive mixture.
 - Fire or heat generation: Second, the blast can result due to a fire that starts in the ammonium nitrate store because of the heat generated due to the oxidation process at a large scale.
- There are several documented examples of deadly ammonium nitrate fire and explosion incidents in the past, some with large numbers of fatalities like in China in 2015 and Texas in 1947.



GSSCORE

4 ANtarctic Impulsive Transient Antenna

Context: In a significant breakthrough, a team of researchers has succeeded in finding "a fountain of high-energy particles erupting from the ice" in Antarctica which according to the researchers could be proof of a parallel universe. The event was recorded by NASA's ANITA.

What is ANtarctic Impulsive Transient Antenna or ANITA?

- Designed by NASA, the ANITA instrument is a radio telescope that is used to detect ultra-high energy cosmic-ray neutrinos from a scientific balloon flying over Antarctica.
- ANITA, a stratospheric balloon payload flying over the Antarctic, is the first NASA observatory for neutrinos of any kind.

The findings:

- ANITA succeeded in detecting the 'fountain' of high-energy particles in 2006 and 2014 but the researchers initially thought of them as background noise or glitches.
- Low-energy, subatomic neutrinos can pass completely through Earth, but higher-energy objects are stopped by solid matter, which means that the high-energy particles can only be detected coming "down" from space.
- But the team's ANITA detected heavier particles, so-called tau neutrinos, which come "up" out of the Earth, implying that these particles are traveling backward in time, suggesting evidence of a parallel universe.

What are neutrinos?

- Neutrinos are high-energy particles that pose no threat to us and pass through most solid objects without anyone even noticing.
- Neutrinos constantly bombard Earth and as per some estimates emerging from studies, 100 trillion neutrinos pass through your body every second!
- Rarely do they interact with matter. But if they do smash into an atom, they produce a shower of secondary particles we can detect, which allows us to probe where they came from in the universe.
- ANITA detects neutrinos pinging in from space and colliding with the matter in the Antarctic ice sheet.

5 National Science Day: What is the 'Raman effect'?

Context: In 1986, the Government of India designated February 28 as National Science Day, to commemorate the announcement of the discovery of the "Raman effect".

About:

- National Science Day is an occasion to salute the talent and tenacity of our scientists. Their innovative zeal and pioneering research have helped India and the world.
- The theme of this year's science day is "Future of STI: Impacts on Education, Skills, and Work".
- Born on November 7, 1888, CV Raman was a physicist of Tamil origin who made a ground-breaking discovery in the spectrum of light scattering.
- The Raman Effect won scientist, Sir CV Raman, the Nobel Prize for physics in 1930.
- The nation honored him with the Bharat Ratna, its highest civilian award, in 1954.

- CV Raman was appointed to be the first Indian director of the Indian Institute of Science (IIS) in 1933.
- After India gained independence in 1947, Raman became the first National Professor of the country.

The Raman Effect

- The Raman effect is the inelastic scrambling of a photon by molecules that are energized to higher rotational energy or vibrational levels. This effect is also known as the Raman scattering.
- This phenomenon also forms the foundation of Raman spectroscopy which is utilized by physicists and chemists to know more information about materials.
- In 1928, Raman discovered that when a stream of light passes through a liquid, a fraction of the light scattered by the liquid is of a different color.
- The Raman Effect is when the change in the energy of the light is affected by the vibrations of the molecule or material under observation, leading to a change in its wavelength.







SUCCESS IS A PRACTICE WE DO!



