



Drishti IAS

Mains

MARATHON₂₀₂₂

Important Q & A for Mains

SCIENCE & TECHNOLOGY



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1. Genetically Modified crops play a significant role in enhancing productivity, fight against hunger and malnutrition. Critically analyze? (250 words)

Approach:

- Introduce by briefly explaining GM crops.
- Discuss its beneficial role in increasing productivity and reducing malnutrition.
- Discuss various challenges of GM crops.
- Conclude accordingly.

Introduction:

- Genetically Modified Organisms (GMO) are defined as organisms including plants, animals, and micro-organisms in which the genetic material (DNA) is altered in a way that does not occur naturally by mating or natural recombination.

Body:

- Benefits of GM crops in increasing agricultural output and removing hunger, malnutrition:
 - **Climate resilient:** Sometimes it is necessary to develop crops that can sustain in adverse climatic conditions. This will enable farmer to save himself from losses that occur due to crop losses. Ex: Water resistant paddy can tackle incessant rain.
 - **Increase farm output:** New crops developed using biotechnology have the capacity to produce more output per area compared to conventional species. This means that **more production from small land** and subsequent increase in profits.
 - **Increase nutrient value of crops:** The GM crops are **drought tolerant** and can develop **nutrient efficient varieties**. Further, it can help produce foods with **better shelf life, taste and texture**.
 - Further, crops can even be engineered to be **more nutritious**, providing critical vitamins to populations that struggle to get specific nutrients needed for healthy living.
 - **Reduce pesticides:** Pests are major threat to farm economy than other sources. To eliminate major threats to crops, scientists have come up with innovative methods using biotechnology to help in elimination of pests.
- **Challenges of GM crops:**
 - **Allergic Reactions:** It states that **genetic modification**

often adds or mixes proteins that were not indigenous to the original animal or plant, which might cause new allergic reactions in our body.

- **Cross-pollination:** Cross-pollination can cover quite large distances, **where new genes can be included in the offspring of organic, traditional plants or crops that are miles away**. This can result in difficulty in distinguishing which crop fields are organic and which are not, posing a problem to the task of properly labeling non-GMO food products.
- **Potential adverse impact on human health:** The impact of growing GMO crops like GM mustard on the health of the population, the environment (the soil on which it is grown), the food chain, the groundwater, etc., is still unknown.

Conclusion:

- GM crops can help India to improve their living standards which will reflect in human development. It will also help India to ensure food security, decreasing hunger and malnutrition to fulfill its international obligation of achieving sustainable development goals and increase farmer's income and agricultural export, but there is need for proper research on its adverse impact on human and environment health on the basis of scientific evidence. Therefore, there is a need for participatory approach in order to bring together all stakeholders to develop regulatory protocols.
- 2. Despite having definite foundational objectives in respective fields, the ISRO as an organisation proved more successful than the DRDO. Discuss. (150 words)**

Approach:

- Introduce the answer by mentioning the vision of the two institutions and how they fared in achieving their respective goals
- Highlight the main reasons why ISRO became more successful than DRDO
- Conclude on a positive note while mentioning the need for reforms in DRDO

Introduction:

ISRO and DRDO are the two institutions conceived in independent India with the vision of making our new nation an advanced space power and achieving self-reliance in defence technology respectively. However,

Note:

after decades of their establishment, while ISRO has grown as an eminent space agency at the global stage, DRDO continues to look for the same success story.

Body:

Reasons for ISRO achieving greater success than DRDO -

- After its constitution in 1969, ISRO was placed under the Department of Space (DOS) in 1972 and Space commission was set up for formulating policy and seeing its implementation. This entire structure functioned directly under the aegis of the Prime Minister, which saved ISRO from cumbersome bureaucratic procedures. For instance, ISRO's current chairman K.Sivan is also chairman of the Space Commission and Secretary of DOS.
- ISRO's structural organisation promotes vertical integration between policymakers, who are in a position to understand the nature of the long-term projects ISRO undertakes and those delivering the end results. In Contrast with this, the DRDO, which functions under the Ministry of Defence and is entrenched in the bureaucratic culture, suffers delays in project clearances and fund acquisition.
- ISRO also benefited from the presence of specialists and technocrats, starting from Vikram Sarabhai himself at the upper echelons of the organisation. DRDO, on the other hand, lacked such expertise in its formative years.
- Despite several impediments, ISRO has been able to work with the international scientific community since inception. This has been a through-line from the first component of the space programme, the Thumba Equatorial Rocket Launching Station to the agreement between ISRO and the US' National Aeronautics and Space Administration (NASA) to work on future joint missions to Mars. The DRDO, on the other hand, faced far greater barriers here. This has partly to do with geopolitics and international restrictions on sharing defense-related technology during the Cold War and thereafter.
- Another difference is accountability in the form of outcome budgets mandated in 2005-06. While DOS submits an outcome budget that contains a detailed breakdown of ISRO projects while DRDO which functions under Ministry of Defence is exempted from such accountability.

Conclusion:

Although ISRO's success story dwarfs DRDO, one cannot deny the success of DRDO in terms of making India capable of developing indigenous missile technology and other essential defence equipment for example- development of Supersonic Cruise Missile 'BrahMos', Light Combat Aircraft 'Tejas', Airborne Early Warning & Control (AEW&C), etc. However, DRDO needs to bring reforms in its organisational structure, functioning and work culture where ISRO could offer itself as a role model. In the present context, it is important to establish ISRO and DRDO both as a valuable asset for rising India.

3. **What are the unique features of James Webb telescope which makes it superior to its predecessor Space Telescopes? What are the key goals of this mission? What potential benefits does it hold for the human race?** (250 words)

Approach:

- Introduce in brief about James Webb telescope.
- Discuss its superiority over predecessor telescopes.
- Elaborate James Webb's key goals and potential benefits to humans.
- Conclude accordingly.

Introduction:

- James Webb telescope is the result of an international collaboration between NASA, the **European Space Agency (ESA)** and the Canadian Space Agency which was launched in December 2021.
- It is currently at a point in space known as the **Sun-Earth L2 Lagrange point**, approximately 1.5 million km beyond Earth's orbit around the Sun.
- It's the largest, most powerful infrared space telescope ever built.
- It's the **successor to Hubble Telescope**.
- Its advanced equipment can look backwards in time to just after the Big Bang (birth of universe) by looking for distant galaxies that are so far away that the light has taken many billions of years to get from those galaxies to our telescopes.

Body:

- **Special Features of James Webb:**
 - The JWST will **observe primarily in the infrared range** and provide coverage from 0.6 to 28 microns.

Note:

- The instruments on its predecessor **Hubble telescope see mainly in the ultraviolet and visible part of the spectrum**. It could observe only a small range in the infrared from 0.8 to 2.5 microns.
 - Whereas, Webb's primary mirror has a **diameter of 6.5 metres while Hubble's mirror was much smaller – 2.4 metres in diameter**.
- **Key goals of the James Webb telescope:**
 - It will **examine every phase of cosmic history**: from the Big Bang to the formation of galaxies, stars, and planets to the evolution of our own Solar System.
 - The goals for the Webb can be grouped into four themes.
 - The first is to **look back around 13.5 billion years** to see the first stars and galaxies forming out of the darkness of the early universe.
 - Second, to compare the faintest, earliest galaxies to today's grand spirals and understand how galaxies assemble over billions of years.
 - Third, to see where stars and planetary systems are being born.
 - Fourth, to observe the atmospheres of extrasolar planets (beyond our solar system), and perhaps find the building blocks of life elsewhere in the universe.
 - **Potential benefits to humans:**
 - It will **reveal new and unexpected discoveries**, and help humanity understand the origins of the universe and our place in it.
 - The telescope will study the atmospheres of a **wide diversity of exoplanets**.
 - It will **also search for atmospheres like Earth's**, and for the signatures of key substances such as methane, water, oxygen, carbon dioxide, and complex organic molecules, in hopes of finding the building blocks of life.

Conclusion:

James Webb's state of the art instruments make it ideal to search for evidence of potentially life-supporting atmospheres around many of the newly documented exoplanets and to observe worlds of Mars and Saturn's icy moon Titan, thus, making it open a whole new world of information about the universe and will bring about a revolution in the astronomical world.

4. What are Microbial Fuel Cells? Discuss its possible applications in various fields. (150 words)

Approach:

- Briefly explain what is Microbial Fuel Cell (MFC)
- Mention its potential as a clean fuel over other conventional fuel
- Conclude suitably

Introduction:

A microbial fuel cell (MFC) is a device that converts **chemical energy to electrical energy** by the action of microorganisms. It is a bio-electrochemical system that uses bacteria as the catalyst to oxidize organic and inorganic matter, and consequently, generate electric current out of it. It has applications in various fields such as power generation systems, bio-recovery, waste-water treatment, etc.

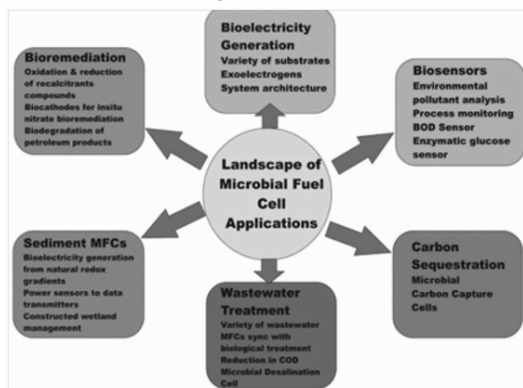
Body:

- MFCs are attractive for power generation applications that require only low power, where replacing batteries may be impractical such as wireless sensor networks. Wireless sensors, powered by microbial fuel cells can then, for example, be used for remote monitoring.
- It is the only technology that can generate energy out of waste, without the input of external/additional energy, and this renders MFCs suitable for remote area access via the robotics route or remote power generation.
- MFC can be used as a convenient biosensor for wastewater streams. Wastewater is evaluated based on the amount of dissolved oxygen required by aerobic bacteria to break down the organic contaminants present in a body of water. The richer the wastewater stream is, the greater the current an MFC can provide.
- The use of MFC is not only enclosed to electricity production and wastewater treatment it has also been expanded to produce clean energy fuel like hydrogen and desalination process.
- Moreover, this emerging technology is significantly devoted to alleviating the environmental stress associated with the emission of greenhouse gases into the environment. It can act as an alternative to reduce the burden of an increased energy crisis and meet societal needs.

Note:

Conclusion:

MFCs is still a nascent technology but through continuous research and development in such technologies, we may find solutions to our global environmental problems. Hence, MFCs can play a role in the future for the next generations.



5. Quantum Computing has become very famous in recent years. In light of this statement discuss the various uses of Quantum Computing.

Approach:

- Start your answer by giving a brief about Quantum Technology.
- Give a brief about the Properties of Quantum Computing.
- Discuss the applications of Quantum computing.
- Discuss some challenges related to Quantum computing.
- Conclude your answer by giving a way forward.

Introduction

Quantum Technology is based on the principles of Quantum mechanics that was developed in the early 20th century to describe nature at the scale of atoms and elementary particles.

The first phase of this revolutionary technology has provided the foundations of our understanding of the physical world, including the interaction of light and matter, and led to ubiquitous inventions such as lasers and semiconductor transistors.

A second revolution is currently underway with the goal of putting properties of quantum mechanics in the realms of computing.

Main Body**Properties of Quantum Computing:**

- The basic properties of quantum computing are superposition, entanglement, and interference.

○ **Superposition:**

- It is the ability of a quantum system to be in multiple states simultaneously.
- The example of superposition is the flip of a coin, which consistently lands as heads or tails—a very binary concept. However, when that coin is in mid-air, it is both heads and tails and until it lands, heads and tails simultaneously. Before measurement, the electron exists in quantum superposition.

○ **Entanglement:**

- It means the two members of a pair (Qubits) exist in a single quantum state. Changing the state of one of the qubits will instantaneously change the state of the other one in a predictable way. This happens even if they are separated by very long distances.
- Einstein called spooky 'action at a distance'.

○ **Interference:**

- Quantum interference states that elementary particles (Qubits) can not only be in more than one place at any given time (through superposition), but that an individual particle, such as a photon (light particles) can cross its own trajectory and interfere with the direction of its path.

Applications of Quantum Technology:

- **Secure Communication:** China recently demonstrated secure quantum communication links between terrestrial stations and satellites. This area is significant to satellites, military and cyber security among others as it promises unimaginably fast computing and safe, unhackable satellite communication to its users.
- **Research:** It can help in solving some of the fundamental questions in physics related to gravity, black hole etc. Similarly, the quantum initiative could give a big boost to the Genome India project, a collaborative effort of 20 institutions to enable new efficiencies in life sciences, agriculture and medicine.
- **Disaster Management:** Tsunamis, drought, earthquakes and floods may become more predictable with quantum applications. The collection of data regarding climate change can be streamlined in a better way through quantum technology.

Note:

- **Pharmaceutical:** Quantum computing could reduce the time frame of the discovery of new molecules and related processes to a few days from the present 10-year slog that scientists put in.
- **Augmenting Industrial revolution 4.0:** Quantum computing is an integral part of Industrial revolution 4.0. Success in it will help in Strategic initiatives aimed at leveraging other Industrial revolution 4.0 technologies like the Internet-of-Things, machine learning, robotics, and artificial intelligence across sectors will further help in laying the foundation of the Knowledge economy.

Challenges Associated with Quantum Computing:

- The dark side of quantum computing is the disruptive effect that it can have on cryptographic encryption, which secures communications and computers.
- It might pose a challenge for the government also because if this technology goes into the wrong hands, all the government's official and confidential data will be at a risk of being hacked and misused.

Way Forward

- Long after the birth of social media and artificial intelligence, there are now demands to regulate them. It would be prudent to develop a regulatory framework for quantum computing before it becomes widely available.
- It will be better to regulate it or define the limits of its legitimate use, nationally and internationally, before the problem gets out of hand like nuclear technology.

6. Despite Hydrogen fuel cells (HFCs) having many advantages, there are some concerns as well. Discuss. (150 Words)

Approach:

- Start your answer by giving a brief about Hydrogen fuel cells (HFCs).
- Discuss the significance of Hydrogen fuel cells (HFCs).
- Discuss the issues with Hydrogen fuel cells (HFCs).
- Conclude your answer by giving a way forward.

Introduction

Hydrogen fuel cells are a **clean, reliable, quiet, and efficient source of high-quality electric power.**

They use **hydrogen as a fuel to drive an electrochemical process** that produces electricity, with water and heat as the only by-products.

Hydrogen is one of the most abundant elements on earth for a cleaner alternative fuel option.

The **National Hydrogen Energy Mission (NHM) was launched in the Union Budget for 2021-22** to promote hydrogen production and its uses.

Main Body

Significance of Hydrogen fuel cells:

- **Best Zero Emission Solutions:** It is one of the best Zero Emission solutions. It is completely environment friendly with no tailpipe emissions other than water.
- **Quiet operation:** The fact that the fuel cells make little noise means that they can be used in challenging contexts, such as in hospital buildings.
- **Easier scaling:** Operation times of fuel cells are longer than those of batteries, with fuel cells, only the amount of fuel needs to be doubled to double the operation time, while batteries require the capacity of the components to be doubled to achieve the same.

Issues associated with Hydrogen fuel cells:

- **High Cost:** Green hydrogen makes up only 0.03% of global hydrogen production and it is up to five times more expensive than 'grey' hydrogen produced from natural gas or worse, 'brown' hydrogen produced from coal.
- **Hydrogen Storage:** Storage and transportation of hydrogen is more complex than that required for fossil fuels. This implies additional costs to consider for hydrogen fuel cells as a source of energy.
- **Hydrogen Extraction:** Despite being the most abundant element in the Universe, hydrogen does not exist on its own so needs to be extracted from water via electrolysis or separated from carbon fossil fuels.
 - Both of these processes require a significant amount of energy to achieve. This energy can be more than that gained from the hydrogen itself as well as being expensive.
 - In addition, this extraction typically requires the use of fossil fuels, which in the absence of carbon capture and storage (CCS) undermines the green credentials of hydrogen.

Way Forward

Note:

- Another alternative that many hydrogen councils across the world are pushing for is 'blue' hydrogen, which is grey hydrogen coupled with additional installations for carbon capture and storage incorporated into the production facility.
 - This way, up to 90% of the CO₂ emitted during hydrogen production can be captured for reuse or storage and prevented from escaping into the atmosphere.
- 7. Even though Ayurveda is currently gaining popularity, there are still certain impediments. Discuss (150 Words)**

Approach:

- Start your answer by giving a brief about Ayurveda.
- Discuss the key challenges associated with Ayurveda.
- Conclude your answer by giving a way forward.

Introduction

Ayurveda, India's traditional medicine, has been in practice for close to 3,000 years and has been serving the healthcare needs of millions of Indians. Currently, it is greatly emphasised by the present government through various programmes and schemes like National Ayush Mission, Aahaar Kranti Mission, New Portals on Ayush Sector, ACCR Portal and Ayush Sanjivani App, etc.

Main Body

Key Challenges faced by Ayurveda in the Modern World

- **Outdated Ideas:** On benefits of physical exercise, Ayurveda states "A sense of ease, improved fitness, easy digestion, ideal body-weight, and handsomeness of bodily features are the benefits that would accrue from regular exercise." However, such continued validity cannot be claimed for the physiological and pathological conjectures the same text contains.
- **Ineffective Treatment in Emergency Cases:** The inadequacies of Ayurveda in treating acute infections and other emergencies including surgery, and lack of meaningful research in therapeutics continue to limit the universal acceptance of Ayurveda. Ayurveda therapeutics are complex and there are too many dos and don'ts.
- **Lack of Homogeneity:** The medical practices in Ayurveda are not uniform. It is because the medicinal plants used in it vary with geography and climate and local agriculture practices. Unlike Ayurveda, in modern

medicine, the diseases are classified and treated as per prior set uniform criteria.

- **Misleading Propaganda by Ayurvedic Pharmas:** The Ayurvedic pharmacopeia industry claimed that its manufacturing practices were consistent with the classic Ayurveda texts. For better market appeal of ayurvedic medicines, the pharmaceutical companies publicized many medicinal claims about their ayurvedic products without sufficient scientific basis. This led to further obsession for drugs in the community and ailments requiring lifestyle correction were instead treated with poly-pharmacy.

Way Forward

- **Reverse Pharmacology:** It is defined as the science of integrating documented clinical experiences and experiential observations into leads, through transdisciplinary exploratory studies, to develop these into drugs.
 - **New Millennium Indian Technology Leadership Initiative (NMITLI):** It seeks to build, capture and retain for India a leadership position by synergising the best competencies of publicly funded R&D institutions, academia and private industry.
 - **Emulating Kerala Model:** Kerala has been promoting Ayurveda as a way of improving immunity in the general population. It promotes Ayurvedic formulations and recommends Ayurveda practices to all demographics of its population.
- 8. "Indian Biological Data Bank will reduce the dependency of Indian researchers on American and European data banks." In the light of the statement, discuss key features of indigenous data bank centre. (250 words)**

Approach:

- Describe in brief about Indian Biological Data Bank.
- Discuss briefly about its significance in reducing India's dependency on American or European banks.
- Discuss the key features of Indian Biological Bank.
- Conclude accordingly.

Introduction:

- Recently, government has set up '**Indian Biological Data Bank' at the Regional Centre for Biotechnology (RCB), Faridabad.**

Note:

- It is the **first national repository for life science data in India**, where the data will not only be submitted from across India but can be accessed by researchers from across India.

Body:

- **Significance in reducing India's dependency on foreign banks:**
 - The indigenous data bank will **reduce the dependency** of Indian researchers on American and European data banks and **help in protecting the critical data of our citizens**, otherwise data would be left at the mercy of foreign banks to access and exploit critical data of Indian citizens.
 - It will not only provide a platform to researchers to securely store their data within the country, it will **also provide access to a large database of indigenous sequences for analyses**.
- **Key features of Indian Biological Data Bank (IBDC):**
 - The digitised data will be stored on a **four-petabyte supercomputer called 'Brahm'**.
 - **Different sections of IBDC** would typically deal with **particular type(s) of life science data**.
 - IBDC has a backup data **'Disaster Recovery' site at NIC**.
 - Further, IBDC shall also develop **highly curated data sets in order to facilitate knowledge discovery** in various domains of life sciences.
 - It would also provide **infrastructure and expertise for biological data analysis**.
 - It will also **help researchers in studying zoonotic diseases**.
 - Although the database **currently only accepts such genomic sequences, it is likely to expand later to storage of protein sequences and imaging data** such as copies of Ultrasound and Magnetic Resonance Imaging (MRI).
 - It is **mandated to archive all life science data in IBDC generated from publicly funded research** in India.

Conclusion:

- The establishment of Indian Biological Data Bank would provide IT platform for perpetually archiving biological data in the country and helps India in transforming biotechnologically for the betterment

of its citizen as well as for humanity.

9. **"Starlink will change the internet connectivity". Discuss the utility of the project in bringing remote connectivity. (250 words)**

Approach

- Start your answer with describing Project Starlink.
- Discuss the utility of Starlink in helping remote connectivity.
- Conclude accordingly.

Introduction

- It is a SpaceX project to build a broadband network with a cluster of orbiting spacecrafts that could eventually number in thousands.
- The Starlink satellites carry Hall thrusters, which use electricity and krypton gas to generate an impulse, to manoeuvre in orbit, maintain altitude and guide the spacecraft back into the atmosphere at the end of their mission.
- Starlink will be positioned in the Low Earth Orbit (LEO) **around 500km-2000km from earth, compared to stationary orbit satellites** which are approximately **36,000km away**.

Body

- **Utility of Starlink Project:**
 - **Low Latency:** Latency, or the time needed for data to be sent and received, is contingent on proximity.
 - As LEO satellites orbit closer to the earth, they are able to **provide stronger signals and faster speeds** than traditional fixed-satellite systems.
 - Additionally, because signals travel faster through space than through fibre-optic cables, they also have the potential to rival if not exceed existing ground-based networks.
 - **Coverage:** The signals from one geostationary satellite can cover roughly a third of the planet — and three to four satellites would be enough to cover the entire Earth.
 - **Easier Connectivity:** As satellites appear to be stationary, it is easier to link to them.
- **Issue related to satellite-based broadband:**
 - **Increase Space Debris:** Due to an increase in space debris and an increased risk of collision, these constellations of Internet satellites will make it

Note:

impossible to observe other space objects and distinguish their signals.

- **Hindrance of Bad weather:** Weather conditions have an impact on how satellite internet signals travel. Storms, rain, and strong winds may result in a weak signal and prevent the Earth from receiving internet service.

Conclusion

Starlink project will be a revolution in providing satellite-based internet to remote parts of the world and will reduce digital inequity.

10. **“Private players can bring in the innovation needed for developing space-based applications and services”. In the light of this statement, highlight the role of private sector in India’s space science and technology. (150 words)**

Approach

- Start your answer by briefly describing the status of space industry in India.
- Discuss the role of private sector in India’s space sector.
- Discuss various initiatives related to the private sector in the space industry.
- Conclude accordingly.

Introduction

- As of 2021, according to Space Tech analytics, India is the sixth-largest player in the industry internationally having 3.6% of the world’s space-tech companies. US accounts for 56.4% of all companies in the space-tech ecosystem.
 - Other major players include U.K. (6.5%), Canada (5.3%), China (4.7%) and Germany (4.1%).
- The Indian Space Industry was valued at \$7 billion in 2019 and aspires to grow to \$50 billion by 2024. The country’s standout feature is its cost-effectiveness.

Body

- **Role of private sector in India:**
 - **Bolster Innovation:** Private players can bring in the innovation needed for developing space-based applications and services. Additionally, the demand for these services is soaring worldwide and in India, with satellite data, imageries and space technology being used across most sectors.
 - Moreover, ISRO would have to expand 10x

the current level to meet this rising demand. According to industry estimates, India currently has 40+ start-ups working on space and satellite projects and this number is likely to increase.

- **Cost-effective:** The private sector would ensure that the newer technology makes it more effective in terms of price as well as efficiency.
- **Large infrastructure of conglomerates:** Large corporations have capabilities such as testing infrastructure, manufacturing capabilities and assembly lines, but space manufacturing is only a small fraction of their total industrial output. As the space sector is a capital-intensive business, the initial step to increase private sector participation must be taken by these conglomerates.
- **Recent Example of Private Space Launch in India:**
 - Recently, India’s first privately developed rocket, **Vikram-S** was **successfully launched in a sub-orbital mission** from the Sriharikota spaceport marking a new era in India’s space programme.
- **Related Initiatives:**
 - **IN-SPACE:**
 - IN-SPACE was launched to provide a level playing field for private companies to use Indian space infrastructure.
 - It acts as a single-point interface between Indian Space Research Organisation (ISRO), and everyone who wants to participate in space-related activities or use India’s space resources.
 - **New Space India Limited (NSIL):**
 - Announced in Budget 2019, its aim is to use research and development carried out by ISRO over the years for commercial purposes through Indian industry partners.
 - **Indian Space Association (ISpA):**
 - ISpA aspires to be the collective voice of the Indian Space industry. ISpA will be represented by leading domestic and global corporations that have advanced capabilities in space and satellite technologies.

Conclusion

- There is a need for a new policy that ends ISRO’s monopoly of the space sector in India, by sharing knowledge and technology, such as manufacturing rockets and satellites, to all those who want to.

Note:

- With India having one of the best space programs in the world, the move to allow private sector in space will make India a bigger player in the global space economy.

11. Despite the great scientific potential of Artificial Intelligence (AI), there are various challenges arising due to rise of AI. Discuss (250 words)

Approach

- Start your answer by briefly describing Artificial intelligence.
- Discuss the benefits and challenges of Artificial intelligence.
- Conclude by suggesting some measures to resolve its challenges.

Introduction

- Artificial intelligence could be described as the **action of machines accomplishing tasks that have historically required human intelligence.**
- It includes technologies like machine learning, pattern recognition, big data, neural networks, self-algorithms etc.
- **Example:** Neuralink a budding start-up company co-founded by Elon Musk that is working on Artificial Intelligence integration with the human body. They have developed a chip which is an array of 96 small, polymer threads, each containing 32 electrodes and can be transplanted into the brain, where a person could both record brain activity and potentially stimulate it.
- Further, the impact of Artificial Intelligence on human lives and the economy has been astonishing. Artificial Intelligence can add about \$15.7 trillion to the world economy by 2030.

Body

- **Benefits of Artificial Intelligence:**
 - **In Policing:** India still has a conventional policing. AI based products open a new window of opportunity to do **predictive policing** in India. With the help of AI, one can **predict the pattern of crime**, analyze lot of CCTV footage which are available across the country to identify suspects.
 - Government is digitizing all the records, especially the crime records putting it into one single place called **CCTNS** where all the data including the image, biometrics, or the criminal history of a

convict or suspect is available.

- **In Agriculture:** It has many uses, for example, it can help sense one how much water the crop needs.
 - **For solving complex issues** like efficient utilization of available resources.
- **Analyzing the Data:** The AI technology helps in analyzing data and thus can improve the efficiency of the systems like power management in cars, mobile devices, weather predictions, video and image analysis.
- **Challenges:**
 - **The Bias Problem:** The good or bad nature of an AI system really depends on the amount of data they are trained on. Hence, the ability to gain good data is the solution to good AI systems in the future. But, in reality, the everyday data the organizations collect is poor and holds no significance of its own.
 - **Access to Data, Knowledge, Technology:** In an interconnected world, a small number of companies are collecting vast amounts of data - access to this consolidated data would allow an accurate replay of anybody's day-to-day life in terms of activities, interactions and explicitly stated or implicitly identified interests; somebody (or something) could know our mobility history and patterns, or anything of anyone's mundane life pattern.
 - **Privacy:** The right to privacy is under threat, obviously considering the possibility of unauthorized access to one's online activity data. But even in the case of an offline user — somebody who has deliberately decided to stay 'disconnected' — the right to privacy is still under threat, like a disconnected user moving through a 'smart city'.
 - **Technological Unemployment:** This is unemployment which is 'explained' by the introduction of new technologies — i.e. the jobs replaced by intelligent machines or systems.
 - There will be significant changes in the workforce and the markets — some roles and jobs will become obsolete, industries will be radically transformed, employment models and relationships will be redefined.
 - **Security:** Security is a critical aspect — if somebody compromises a smart system, for instance an autonomous car, the consequences can be disastrous, particularly given the ever-increasing cyber security threat.

Note:

- Access to Lethal Autonomous Weapons:
 - In a military context this autonomy in decision-making becomes scary – the Lethal Autonomous Weapons which refer to advanced robotic systems of the future, will be capable of hitting targets without human intervention or approval.

Conclusion

- AI technological revolution brings great opportunities for prosperity and growth — but it has to be ensured that the technology will be applied and used in the right direction.
 - In this regard, some steps are already being taken in different parts of the world, like **Explainable AI (XAI)** and the **‘Right to Explanation’** which allow understanding the models used for artificial intelligence (and how they make particular decisions — which is also required by the **European Union GDPR — General Data Protection Regulation**).
- It can also be said that AI may suffer from what is known as “AI effect” or the “odd paradox” — AI brings a new technology into the common fold, people become accustomed to this technology, it stops being considered AI, and newer technology emerges.

Thus, we can conclude that the growth of AI and AI based applications should not be halted but its growth and usage should be monitored and regulated at various levels respectively.

- 12. Rising advancements in nuclear energy has its own advantages but posed several challenges. Discuss. (150 words)**

Approach

- Start your answer by briefly describing nuclear energy.
- Discuss various advantages of nuclear energy.
- Discuss challenges in the field of nuclear energy.
- Conclude accordingly.

Introduction

- Nuclear fusion and nuclear fission are two different types of energy-releasing reactions used in nuclear energy, through which energy is released from high-powered atomic bonds between the particles within the nucleus.
- The main difference between these two processes

is that fission is the splitting of an atom into two or more smaller ones while fusion is the fusing of two or more smaller atoms into a larger one.

Body

- **Recent advancement in the field of Nuclear Energy:**
 - Recently a few scientists at the Lawrence Livermore facility, the US have achieved a **net gain in energy from a nuclear fusion reaction**, which is seen as a big breakthrough.
 - The experiments forced a minuscule amount of hydrogen **into a peppercorn-sized capsule**, for which scientists used a powerful **192-beam laser that could generate 100 million degrees Celsius of heat**.
 - It is also called **‘Inertial Fusion’**.
- **Challenges of Nuclear Energy:**
 - **Capital Intensive:** Nuclear power plants are capital intensive and recent nuclear builds have suffered **major cost overruns**.
 - **Lack of Public Funding:** Nuclear power has **never received the quantum of generous subsidy the fossil fuel received** in the past and renewable is receiving currently.
 - In absence of public funding, nuclear power will find it tough to compete against natural gas and renewables in the future.
 - **Acquisition of Land:** Land acquisition and selection of location for Nuclear Power Plant (NPP) is also a **major problem in the country**.
 - NPP’s like **Kudankulam in Tamil Nadu** and **Kovvada in Andhra Pradesh** have **met with several delays** due to the land acquisition related challenges.
 - **Impact of Climate Change:** Climate change will **increase the risk of nuclear reactor accidents**. During the world’s **increasingly hot summers**, several nuclear power plants have already had to be **temporarily shut down** or taken off the grid.
 - Further, nuclear power plants depend on nearby water sources to cool their reactors, and with many rivers drying up, those **sources of water are no longer guaranteed**.
 - The frequency of such extreme weather events is likely to increase in the future.
 - **Deployment at Insufficient Scale:** It might not

Note:

be the appropriate choice for mitigating India's carbon emissions since it cannot be deployed at the necessary scale.

- **Nuclear Waste:** Another side effect of nuclear power is the amount of nuclear waste it produces. Nuclear waste can have drastically **bad effects on life, causing cancerous growths**, for instance, or causing **genetic problems** for many generations of animals and plants.
 - In a densely populated country such as India, land is at a premium and **emergency health care is far from uniformly available**.
- **Advantages of Nuclear Energy:**
 - **Emissions from Nuclear Power Generation:** Nuclear power is **zero-emission**. It has **no greenhouse gases** or air pollutants.
 - **Land Usage:** According to US government data, a 1,000-megawatt nuclear plant **requires 360 times less land than a similar-capacity wind farm** and 75 times less land than solar plants.
 - **High Power Output:** Nuclear power plants produce **high levels of energy compared to most power sources** (especially renewables), which makes them a great provider of baseload electricity.
 - "Baseload electricity" simply means the minimum level of energy demand on the grid over a span of time, say a week.
 - **Inexpensive:** Nuclear power plants incur low operational costs because they rely on relatively simple operations. Additionally, nuclear plants only need to refuel every 18–24 months, meaning that fluctuating fuel prices affect them less than more volatile industries like oil and natural gas.
 - Heavy metals like uranium, nuclear power's main energy source, appear throughout the world and are only needed in small amounts, meaning that they also cost less.

Conclusion

Nuclear energy is a safe, reliable, and cost-effective source of energy. It's one of the most promising energy sources of the future. It will be one of the most effective solutions to fight climate change and global warming.

- 13. Discuss the need for regulation in addressing issues related to online gaming in India and suggest potential approaches for addressing these challenges. (250 words)**

Approach

- Start your answer by briefly explaining online gaming and present its India specific data facts.
- Discuss challenges of online gaming.
- Discuss potential approaches to address these challenges.
- Conclude accordingly.

Introduction

- Online gaming refers to playing video games over the internet with other players. This can be done through a computer or through a gaming console or smartphone that is connected to the internet.
 - It allows players to interact with each other and compete in real-time, regardless of their location.
 - It has become increasingly popular in recent years, with the proliferation of high-speed internet connections and the availability of a wide range of games to choose from.
- The online gaming industry grew at a compound annual growth rate (CAGR) of 38% in India between 2017-2020, as opposed to 8% in China and 10% in the US.
- Further, it is expected to grow at a CAGR of 15% to reach Rs 153 billion in revenue by 2024, as per a report by VC firm Sequoia and management consulting company BCG.

Body

- There are several challenges related to online gaming in India that may require regulation in order to be effectively addressed. Some of these challenges include:
 - **Problematic gaming behavior:** Online gaming can be addictive and can lead to problematic gaming behavior, which can negatively impact an individual's personal, social, and professional life. This can be particularly concerning for children and young people who may be more vulnerable to developing addictive behaviors.
 - **Cybersecurity risks:** Online gaming can also expose users to cybersecurity risks such as hacking, phishing, and identity theft.
 - **Fraud and cheating:** There have been instances of fraud and cheating in online gaming, which can undermine the fairness and integrity of the games.
 - **In-game purchases:** Many online games rely on in-game purchases as a source of revenue. However,

Note:

there have been instances of fraudulent or predatory practices related to in-game purchases, which can be harmful to consumers.

- **Social responsibility:** There is a need to ensure that online gaming platforms are socially responsible and do not promote harmful or offensive content.

➤ **Government Initiatives:**

- **Draft Rules for Online Gaming:** The proposed rules have been introduced as an amendment to the **Information Technology (Intermediary Guidelines and Digital Media Ethics Code) Rules, 2021.**

- **Self-Regulatory Body:**

- Online games will have to register with a self-regulatory body, and only games cleared by the body will be allowed to legally operate in India.

- **Restrictions on Betting:**

- Online gaming companies **will not be allowed to engage in betting on the outcome of games.**

- **Compliance:**

- **The online gaming platforms will also have to appoint a compliance officer** who will ensure that the platform is following norms.

➤ **There are several potential approaches for addressing these challenges:**

- **Age verification:** One approach is to implement age verification measures to ensure that children and young people are not able to access games that are not suitable for their age.
- **Parental controls:** Another approach is to provide parental controls that allow parents to set limits on the amount of time their children spend playing online games and to restrict access to certain games.
- **Education and awareness:** Raising awareness about the potential risks and challenges of online gaming can help individuals make informed decisions about their gaming habits.
- **Industry self-regulation:** The online gaming industry could adopt self-regulatory measures to address issues such as fraud, cheating, and predatory in-game purchases.
- **Government regulation:** In cases where self-regulation is not effective, governments may need to step in and regulate the industry in order to protect consumers and address challenges such as cybersecurity risks and problematic gaming

behavior.

Conclusion

Overall, it is important for the government and other stakeholders to carefully consider the potential risks and benefits of online gaming, and to take a balanced approach to regulation that helps to ensure the safety and well-being of players while also allowing the industry to thrive.

14. Analyse the challenges posed by the rise of Metaverse and Artificial Intelligence (AI), suggest measures to tackle these challenges. (250 words)

Approach

- Start your answer by briefly explaining metaverse and artificial intelligence.
- Discuss challenges of metaverse and AI and Suggest measures to tackle challenges.
- Conclude accordingly.

Introduction

- The Metaverse is an emerging concept in technology that refers to a created world, in which people can live under the rules defined by the creator. It is a combination of numerous components of technology, including augmented reality, virtual reality, and video.
- Further, Artificial Intelligence (AI) is the simulation of human intelligence in machines that are programmed to think and learn like humans. AI systems are designed to perform tasks that typically require human intelligence, such as visual perception, speech recognition, decision-making, and language understanding.

Body

As the Metaverse continues to gain popularity, it is important to consider the challenges posed by the rise of this technology and AI. The following are some of the major challenges posed by them are as follows:

- **Societal and Economic impacts:**

- AI and the Metaverse have the potential to disrupt traditional industries and change the way people work and interact, which could lead to job loss and income inequality.

- **Ethical concerns:**

- AI systems and the Metaverse raise questions about bias, transparency, and accountability. There is also a risk that these technologies could be used to perpetuate or amplify societal problems such

Note:

as discrimination and inequality.

- **Dependence on technology:**
 - As people increasingly rely on AI and the Metaverse for daily activities, there is a risk of people becoming too dependent on technology, which could lead to a loss of important life skills.
- **Governance:**
 - The Metaverse and AI are global and borderless, which makes it difficult to govern and regulate them. This may lead to lack of oversight and accountability.
- **Psychological and emotional effects:**
 - Spending excessive time in the Metaverse and interacting with AI systems may have negative effects on people's mental and emotional well-being.
- **Technical challenges:**
 - Building and maintaining the Metaverse and AI systems requires significant technical expertise and resources, which can be a challenge for both developers and users.
- **Impact on physical health and well-being:**
 - As the Metaverse becomes more immersive, there is a risk that users will spend increasing amounts of time in virtual worlds, potentially at the expense of their physical health and well-being.
- **Data privacy and security:**
 - With the increasing amount of personal data being shared within the Metaverse, there is a risk of data breaches and other security threats.

Further, to curb the challenges posed by metaverse and AI we need to implement the following measures like:

- **Reduce Digital Divide:** Governance mechanisms for virtual worlds would need to be supported with strengthening and scaling efforts to promote digital literacy, safety and wellbeing so that participants can engage meaningfully in online communities while consciously navigating harmful content and behaviors.
- **Policy Backing:** It is the right time for the government to create the right policy background for its operation and leverage the metaverse for public services.
 - The government needs to focus on information accessibility, information utilization and information receptiveness.
- **Promote Safe and Secure Metaverse Ecosystem:** There is a strong need to develop and regulate effective

ecosystems to address the distinct elements of safety, privacy, and security within the DNA of this technology.

- Building a citizen-friendly meta-governance infrastructure will need a collaboration by experts from various disciplines, including designers, business model experts and lawyers, to mitigate any potential legal hurdles. Private sector intervention may be required as well.
- **Meta Help Desk:** In e-governance, essential information is released to a targeted audience through ICT. Meta-help desks or meta-divisions in a particular ministry/ other government agency can help in providing the critical data required.
- **Transparent and Consent-based Applications:** Technology companies will need to be more responsible and transparent in their data processing and safety practices.
 - Fostering an informed consent-based model while collecting personal data and abiding by the principles of data minimization and purpose limitation will be critical to prevent unchecked data processing and collection for commercial gains.
- **Global Cooperation:** As the metaverse continues to develop, we are seeing a glimpse of a more digitally advanced borderless world that is full of promise.
 - While this new world continues to expand, we have to be aware of the set of challenges it brings with every new development and to look forward towards uniform regulations across the globe.

Conclusion

The Metaverse and AI are emerging concepts in technology that presents a new way for people to interact and engage in a virtual world. However, this technology also poses a number of challenges but with proper set of governance and regulation, this technology could help humanity in unimaginable ways.

- 15. Evaluate the significance of BharOS in promoting the use of indigenously developed technology and reducing dependence on foreign Operating System in smartphones in India. (150 words)**

Approach

- Start your answer by briefly explaining BharOS.
- Discuss its significance in promoting indigenous technology and reducing dependence on foreign operating system.

Note:

- Conclude accordingly.

Introduction

- BharOS, has been developed as a **free and open-source operating system (OS)** with the aim of promoting the use of indigenously developed technology and reducing dependence on foreign operating systems in smartphones in India. It is **based on the Android Open-Source Project (AOSP)** but does not have default Google apps or services, giving users the option to choose applications they trust and are familiar with.

Body

- Significance of BharOS in promoting indigenous technology and reducing dependence on foreign operating system:
 - **Promotion of Indigenously Developed Technology:** BharOS is a significant step towards promoting the use of indigenously developed technology in India.
 - By providing a **free and open-source operating system**, the government is encouraging the development and use of technology that has been created within the country.
 - This not only helps to **create a self-sufficient tech ecosystem** but also **boosts the economy by supporting local businesses and entrepreneurs**.
 - **Boosting national pride and self-sufficiency:** BharOS is a symbol of national pride and self-sufficiency, as it showcases **India's technological capabilities** and reduces dependence on foreign technologies.
 - **Encouraging domestic innovation:** By providing an alternative to foreign operating systems, BharOS is encouraging domestic innovation and investment in the technology sector, leading to the **creation of new jobs and economic growth**.
 - **Improving data security:** By using an indigenous operating system, India can better **control and protect sensitive data**, as there are reduced security risks associated with using foreign technologies.
 - **Cost-effective solution:** BharOS is a cost-effective solution compared to foreign operating systems, making it **accessible to a wider range of consumers and businesses**, especially those in rural areas.
 - **Encouraging open-source software:** BharOS is promoting the use of open-source software, which allows for **greater transparency and collaboration** in software development, leading to more secure

and reliable technology.

- **Reduction of Dependence on Foreign Operating System:** The development of BharOS has the potential to reduce India's dependence on foreign operating systems.
 - It will reduce India's dependence on foreign operating systems and increase the country's strategic independence and security and make it less reliant on foreign companies and technologies.
 - This not only helps to create a more secure technology infrastructure but also protects the country's data and privacy.
- **Promote User Choice:** BharOS allows users to **choose which apps and services they use on their smartphones**.
 - Unlike Android, BharOS does not come with bundled default Google apps and services, thus giving users the freedom to choose what they use.
 - This level of choice is important as it **allows users to make informed decisions** about the technology they use and **reduces the risk of unwanted data collection or privacy breaches**.
- **Despite its potential benefits, BharOS faces several challenges, including:**
 - **Competition with Established Operating Systems:** BharOS competes with well-established operating systems such as Android, IOS, Windows and Linux, which already have a large user base and well-established ecosystems. This makes it difficult for BharOS to gain market share.
 - **Technical Challenges:** Developing an operating system is a complex task that requires significant technical expertise and resources.
 - It faces the challenge of developing an **operating system that is secure, stable, and user-friendly**, while also meeting the unique needs and requirements of the Indian government and citizens.
 - **Lack of Available Applications:** One of the biggest challenges for BharOS is the lack of available applications for the operating system. This can **limit its usefulness and make it less appealing to potential users**.
 - **Security Concerns:** BharOS must ensure the

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security and privacy of its users, especially in light of increasing **cyber-attacks and security threats**. This requires significant resources and expertise and is a major challenge for the operating system.

Conclusion

BharOS is a significant step towards promoting the use of indigenously developed technology and reducing dependence on foreign operating systems in smartphones in India.

Its promotion of user choice and protection of data and privacy are important factors in the development of a self-sufficient and secure technology ecosystem. The government's support of this project is a positive move towards the growth and development of the Indian tech industry and economy.

16. Examine opportunities and challenges presented by electric vehicles in India. (250 Words)

Approach

- Start your answer by briefly introducing the present scenario of electric vehicles in India.
- Discuss opportunities and challenges of electric vehicles.
- Conclude accordingly.

Introduction

- The growing demand for clean energy and environmental concerns has led to a shift towards sustainable transportation. Electric vehicles (EVs) are gaining momentum globally, and India is no exception. With its growing population and increasing number of vehicles on the road, India is **facing the challenge of controlling its pollution levels**. The shift towards EVs could potentially address this issue. However, there are both opportunities and challenges that come with adopting electric vehicles in India.

Body

- **Opportunities Presented by Electric Vehicles (EV):**
 - **Reduced Pollution:** The primary advantage of EVs is the **reduction in pollution levels**.
 - India's cities have some of the **worst air quality levels in the world, and EVs could help address this problem**.
 - Further, the **Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India)** scheme was launched in 2015 to promote

the adoption of electric vehicles in India.

- The scheme provides incentives for the purchase of electric vehicles and the establishment of charging infrastructure.
- **Cost Savings:** EVs offer significant cost savings over traditional gasoline vehicles, especially when considering the long-term costs.
 - Fuel costs for electric vehicles are much lower than gasoline vehicles, and the **cost of maintenance is also significantly reduced**.
- **Employment Generation:** The shift towards EVs will also create employment opportunities in areas such as **manufacturing, research and development, and charging infrastructure development**.
- **Energy Security:** India's dependence on imported crude oil is a significant concern. EVs can help address this issue by **reducing the dependence on imported crude oil** and instead using domestic renewable energy sources.
- **Technological Advancements:** The adoption of electric vehicles can drive technological advancements and innovation in India.
 - **Several Indian startups are working on developing innovative solutions for electric vehicles**, such as battery technology, charging infrastructure, and mobility services.
 - The Indian government has also launched several initiatives, such as the **National Electric Mobility Mission Plan (NEMMP), to promote the development and adoption of EVs**.
- **Challenges Faced by Electric Vehicles:**
 - **Charging Infrastructure:** One of the most significant challenges for EV adoption is the **lack of charging infrastructure in India**.
 - There is a need to develop a robust charging infrastructure network to support the growth of EVs.
 - **High Initial Cost:** The initial cost of EVs is higher than traditional gasoline vehicles. The high cost of batteries is one of the primary reasons for this.
 - However, as the technology develops, the cost of EVs is expected to come down.
 - **Range Anxiety:** Range anxiety is a concern for many potential EV buyers. The limited range of EVs and the lack of charging infrastructure can cause anxiety among drivers.

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- **Battery Disposal:** The disposal of batteries used in EVs is a significant challenge. Proper disposal methods must be developed to ensure that the batteries do not harm the environment.

Conclusion

- Electric vehicles present significant opportunities for India, but there are also several challenges that need to be addressed for their widespread adoption. The Indian government, automobile manufacturers, and private players **need to work together to overcome these challenges and promote the adoption of EVs in India.**
- This requires **developing a robust charging infrastructure network, providing incentives to make EVs more affordable, developing better battery technology,** and ensuring the proper disposal of batteries.
- By addressing these challenges, India can lead the way towards a sustainable future, reduce its dependence on imported crude oil, and improve the quality of life for its citizens.

17. How has India's space program evolved over time and what are some of the key achievements of India's space program? (250 words)

Approach

- Start your answer by briefly introducing evolution of India's space program.
- Discuss key achievements of India's space program.
- Conclude accordingly.

Introduction

- India's space program, which began in 1962, has developed into a significant aspect of the country's technological and scientific progress. India's space program has advanced to the point that it is now an independent space-faring nation, with its own satellites and rocket launch capabilities.

Body

- **Evolution of India's Space Program:**
 - The Indian Space Research Organisation (ISRO) was founded in 1969, and its primary goal was to design and launch satellites for telecommunications, meteorology, and earth observation.
 - The organization's early missions were carried out

with the help of other countries, such as the United States, France, and the Soviet Union.

- The **Satellite Instructional Television Experiment (SITE)** was India's first major satellite-based telecommunications experiment, which began in 1975.

- India's space program took a significant leap forward in the 1980s when the organization **launched its first satellite, Aryabhata, in 1975.** The **Rohini satellite was launched using India's first satellite launch vehicle, the Satellite Launch Vehicle (SLV-3),** in 1983.
- ISRO achieved its **first successful satellite launch using the Polar Satellite Launch Vehicle (PSLV)** in 1993, and the organization launched its first remote-sensing satellite, IRS-1A, in 1988.
- India's space program **became self-sufficient in the 1990s,** with the organization designing and launching its satellites without foreign assistance.
 - India launched its **first geostationary satellite, INSAT-2B, in 1993,** and the organization launched its **first dedicated meteorological satellite, METSAT, in 2002.**

➤ Key Achievements of India's Space Program:

- India's space program has achieved several significant milestones over the years, demonstrating the organization's technological capabilities and advancements. Here are a few examples:
 - **Mars Orbiter Mission:**
 - India's Mars Orbiter Mission (MOM), also known as Mangalyaan, was launched on November 5, 2013, and entered the Martian orbit on September 24, 2014.
 - India became the **first nation to successfully reach Mars on its first attempt,** and the mission's success put India in the same league as the United States, the Soviet Union, and the European Union.
 - **Chandrayaan-1:**
 - Chandrayaan-1, India's first lunar mission, was launched on October 22, 2008, and was the **first mission to confirm the presence of water on the Moon.**
 - Chandrayaan-1 orbited the Moon for ten months and discovered over 40 craters with water ice. It was also the first Indian spacecraft to be placed in the lunar orbit.

Note:

- Record-Breaking Satellite Launch:
 - In February 2017, India **launched 104 satellites into orbit**, breaking the previous record held by Russia, which launched 37 satellites in a single launch.
- The PSLV-C37 mission, which launched from the Satish Dhawan Space Centre, included satellites from six countries, including India, the United States, and the Netherlands.
- **GSLV Mk III:**
 - In 2017, India's **Geosynchronous Satellite Launch Vehicle Mark III (GSLV Mk III) was successfully launched**, making India one of the few countries with a **capability to launch heavy satellites**.
- **Anti-Satellite Test:**
 - In 2019, India successfully tested an anti-satellite (ASAT) missile, making it one of the few countries with this capability.

Conclusion

- India's space program has evolved significantly since its inception in 1962, and the organization has made significant achievements in the field of space technology and exploration. The organization's technological achievements, such as launching satellites and exploring other planets, have put India in the global space technology race.
 - India's space program will undoubtedly continue to progress, and its achievements will contribute to the country's economic, technological, and scientific growth.
- 18. Discuss the role of technology in promoting sustainable development in India. What are the challenges in adopting sustainable technologies, and how can they be overcome? (250 words)**

Approach

- Start your answer with a brief introduction about Technology in various fields.
- Discuss the role of technology in promoting sustainable development.
- Discuss Challenges in adoption of sustainable technologies.
- Suggest some measures to overcome challenges.
- Conclude accordingly.

Introduction:

Technology has been playing a crucial role in promoting sustainable development across various sectors, from energy to agriculture to transportation. Technology has the potential to contribute significantly to sustainable development by promoting resource efficiency, reducing waste, and improving environmental and social outcomes

Body:

Role of Technology in Promoting Sustainable Development in India:

○ Renewable Energy:

- Renewable energy technologies, such as solar, wind, and hydropower, can play a critical role in promoting sustainable development in India by reducing greenhouse gas emissions, increasing energy security, and promoting rural electrification.

○ Energy Efficiency:

- Technological advancements in energy-efficient devices, buildings, and appliances are reducing energy consumption and lowering greenhouse gas emissions.
- Smart grid technology, for instance, enables the efficient distribution and management of electricity, reducing wastage and costs.

○ Waste Management:

- Advanced technologies, such as waste-to-energy and recycling, can help in reducing waste and promoting sustainable waste management practices.

○ Water Conservation:

- Technology can help in promoting water conservation by enabling efficient use of water resources through technologies such as drip irrigation and water-efficient appliances.

○ Sustainable Agriculture:

- Precision agriculture technologies, including sensors, drones, and GPS mapping, are being used to optimize crop yields while reducing inputs like water and fertilizers.
- This helps to increase agricultural productivity while minimizing the negative impact on the environment.

○ Circular Economy:

Note:

- Technology is facilitating the transition from a linear economy to a circular one, where waste is minimized and resources are reused and recycled.
- For instance, 3D printing technology is enabling the production of spare parts on demand, reducing the need for new products and associated resource consumption.

Challenges in Adopting Sustainable Technologies:

- **High Costs:**
 - One of the biggest challenges in adopting sustainable technologies is the high cost of implementation and deployment.
 - For example, installing solar panels or wind turbines can be expensive. This high cost can deter individuals and businesses from adopting sustainable technologies.
- **Limited Scalability:**
 - Some sustainable technologies may not be scalable, meaning they may not be able to meet the demand of large populations or industries.
 - For example, some renewable energy sources may not be able to provide the same level of energy as traditional sources.
- **Lack of Awareness:**
 - Many people may not be aware of sustainable technologies and their benefits.
 - They may not know how to use them or how to maintain them. This lack of knowledge can be a barrier to adoption.
- **Lack of Supportive Policies:**
 - Inadequate policy support and regulatory frameworks also hinder the adoption of sustainable technologies.
- **Overcoming the Challenges:**
 - **Financial Incentives:**
 - Providing financial incentives, such as tax credits, subsidies, and low-interest loans, can help in promoting the adoption of sustainable technologies.
 - **Improve Infrastructure:**
 - Governments and organizations can invest in the infrastructure required to support sustainable technologies, such as electric vehicle charging stations or renewable energy transmission lines.

○ Awareness Campaigns:

- Education and awareness campaigns can help in promoting the understanding and acceptance of sustainable technologies among stakeholders.

○ Foster Collaboration:

- Collaboration between businesses, governments, and communities can help overcome resistance to change and promote the adoption of sustainable technologies.

Conclusion:

With the growing need to mitigate the impacts of climate change and environmental degradation, sustainable technologies offer a solution that can help achieve economic growth while protecting the planet.

19. Discuss the significance of space technology in promoting sustainable development in India. (150 words)

Approach

- Start your answer with a brief introduction to Space Technology.
- Discuss its significance in promoting sustainable development.
- Conclude accordingly.

Introduction:

Space technology or space tech refers to the application of engineering principles to the design, development, manufacture, and operation of devices and systems for space travel and exploration. Space technology has played a significant role in promoting sustainable development in India.

Body:

Significance of Space Technology

➤ Environmental Monitoring:

- Space technology has enabled accurate and continuous monitoring of environmental factors such as land use, deforestation, oceanography, and weather patterns, allowing policymakers to make informed decisions on natural resource management.

➤ Disaster Management:

- India has a history of natural disasters such as floods, earthquakes, and cyclones.

Note:

- Space technology has enabled rapid response and disaster management capabilities, with remote sensing and communication technologies providing critical information to emergency responders.

➤ **Agriculture:**

- Space technology has been instrumental in improving agricultural productivity through remote sensing and monitoring of crop growth and soil moisture.
- This data helps farmers make informed decisions about water usage and fertilizer application, resulting in increased yields and reduced environmental impact.

➤ **Communication:**

- Space technology has improved communication and connectivity in India, with satellite communication providing reliable and cost-effective connectivity in remote and rural areas.
- This has enabled better access to information, education, and healthcare services.

➤ **National Security:**

- Space technology has contributed significantly to India's national security, with satellites used for strategic communication, surveillance, and intelligence gathering.
- This has helped to safeguard the nation's borders and protect its citizens.

Conclusion:

Space technology has played a crucial role in promoting sustainable development in India, with its contribution ranging from environmental monitoring to disaster management and from agriculture to national security. Its continued investment and development will remain a crucial priority for India in the years to come.

20. Discuss the concept of Mitochondrial Replacement Therapy (MRT) and its potential implications for human health and reproduction. (250 Words)

Approach:

- Start your answer by defining Mitochondrial Replacement Therapy.
- In the body section, mention its potential implications.
- Conclude accordingly.

Introduction:

Mitochondrial Replacement Therapy (MRT) is a medical technique that aims to prevent the transmission of mitochondrial diseases from a mother to her offspring. Mitochondrial diseases are genetic disorders caused by mutations in the DNA of mitochondria, which are the cellular powerhouses responsible for producing energy. These mutations can lead to severe health conditions affecting various organs and systems in the body.

Body:

This procedure has potential implications for human health and reproduction:

- **Preventing Mitochondrial Diseases:** MRT replaces faulty mitochondria to prevent transmission of mtDNA mutations that cause severe mitochondrial diseases. It reduces the risk of debilitating conditions caused by mitochondrial dysfunction.
- **Safety and Efficacy:** It could pose safety and efficacy challenges, as the long-term effects of MRT are unknown and the techniques are still experimental.
- **Unintended Consequences:** Critics argue that this procedure could lead to unintended consequences and could open the door to designer babies or genetic enhancements.
- **Inheritance and Genetic Identity:** MRT involves the introduction of genetic material from a donor, leading to the inheritance of mitochondrial DNA from a third individual. This raises questions about genetic identity and familial relationships. The long-term impact on family dynamics and the psychological well-being of individuals conceived through MRT should be considered.
- **Social and Cultural Implications:** MRT may have broader social and cultural implications. It challenges traditional concepts of reproduction, inheritance, and kinship.

Conclusion:

Mitochondrial Replacement Therapy has the potential to prevent the transmission of severe mitochondrial diseases but raises important ethical, safety, and regulatory considerations. As this technology advances, ongoing research, robust regulations, and careful evaluation are necessary to maximize the benefits while minimizing potential risks and societal implications.

21. The Indian Space Sector has been globally recognized for building cost-effective satellites,

Note:

and now India is even taking foreign satellites to space. In this light discuss the significance of New Space Policy and challenges associated with it. Also, suggest measures to harness the full potential of space sector. (250 words)

Approach:

- **Introduction:** Briefly introduce the Indian Space Sector and mention India's recent endeavours.
- **Body:** Discuss the significance and key features of the New Space Policy, challenges and suggest measures to harness the full potential of space sector.
- **Conclusion:** Conclude with a forward-looking statement on the future prospects of the Indian space program.

Introduction:

The Indian space sector has achieved remarkable feats: launching over 300 satellites, missions to the Moon and Mars, indigenous technology development, and experimental flights. The vision is to use space technology for national development and regional cooperation. To adapt to emerging technologies and challenges, India needs a new policy framework. It should encourage private sector participation, foster innovation, ensure security and sustainability, and promote international cooperation.

Significance of New Space Policy

The New Space Policy (NSP) 2023 promotes private sector involvement, investment, and collaboration in the space sector. It enhances competitiveness and efficiency by defining roles and responsibilities of stakeholders like ISRO, NSIL, and IN-SPACe.

Some of the key features and benefits of the NSP are:

- It allows non-government entities (NGEs) to undertake end-to-end space activities, such as building rockets, satellites and launch vehicles.
- It establishes IN-SPACe as a single-window nodal agency for authorizing and regulating NGEs' space activities.
- It empowers New Space India Limited (NSIL) as the commercial arm of ISRO to undertake production and marketing of space products and services developed by ISRO.
- It enables ISRO to focus more on research and development of advanced space technologies, exploration missions and other non-commercial activities.

- It promotes a culture of innovation and entrepreneurship in the space sector by creating opportunities for NGEs to develop new products, services and solutions.
- It enhances India's strategic interests and capabilities in space by ensuring security and sustainability of its space assets and activities.

Challenges associated with New Space Policy:

- Creating a robust regulatory framework is essential to balance stakeholder interests, ensure compliance with laws and norms, prevent misuse of space resources, and resolve conflicts.
- Developing a skilled workforce that can meet the growing demand for talent and expertise in the space sector.
- Ensuring adequate funding and financing for NGEs' space activities.
- Fostering a conducive ecosystem that can support NGEs' growth and innovation.
- Addressing the emerging threats and challenges in the space domain, such as space debris, congestion, competition, militarization and weaponization.

Measures to harness the full potential of space sector:

- Enacting a comprehensive space law that can provide a legal basis for the NSP and its implementation. The space law should also define the rights and obligations of NGEs, ISRO, NSIL, IN-SPACe and other stakeholders, as well as the mechanisms for enforcement, adjudication and redressal.
- Establishing a national space council or commission comprising representatives from various ministries, departments and other stakeholders that can provide strategic direction, coordination and oversight for India's space program.
- Enhancing effectiveness and efficiency, ISRO, NSIL, and IN-SPACe need strengthened capacity and capability. This entails bolstering human, financial, and technical resources, along with organizational structures and processes.
- Establish transparent and equitable procedures to assess, monitor, and support NGEs' participation in national and international initiatives.
- Promoting a culture of excellence, innovation and entrepreneurship in the space sector by rewarding

Note:

the achievements of NGEs, ISRO, NSIL, IN-SPACE and other stakeholders. This requires creating platforms and forums for showcasing, celebrating and disseminating best practices.

Conclusion:

The NSP 2023 is a visionary document that can usher in a new era of space development in India. It can enable India to leverage its strengths and opportunities in the space sector for achieving its national goals and aspirations. However, the success of the NSP depends on its effective implementation and constant review. Therefore, it is imperative that all the stakeholders work together to overcome the challenges and realize the potential of the NSP.

22. What are the main causes and consequences of cyberattacks on critical infrastructure? How can India enhance its cybersecurity preparedness to deal with such threats? (250 words)

Approach

- Start your answer with a brief introduction of Cyber Attacks.
- Explain its Causes and consequences separately.
- Write some ways to enhance cybersecurity preparedness.
- Conclude accordingly.

Introduction:

Cyberattacks on critical infrastructure are malicious attempts to disrupt or damage the essential services and systems that support the functioning of a nation, such as power grids, transportation networks, communication systems, banking and financial services, etc.

Body:

- The main causes of cyberattacks on critical infrastructure are:
 - **Technological Vulnerabilities:**
 - **Weak Security Measures:** Inadequate implementation of security protocols and outdated software can create vulnerabilities that cybercriminals exploit.
 - **Software Bugs and Exploits:** Vulnerabilities in software codes or undiscovered bugs can be exploited by attackers to gain unauthorized access.

○ Human Factors:

- **Insider Threats:** Malicious actions or unintentional mistakes by insiders, such as disgruntled employees or contractors, can lead to cyber attacks.
- **Social Engineering:** Manipulating individuals through deception and psychological techniques to gain unauthorized access or sensitive information.
- **Lack of Awareness and Training:** Insufficient knowledge about cyber threats, phishing techniques, and safe online practices make individuals more susceptible to attacks

○ Advanced Persistent Threats (APTs):

- **State-sponsored Attacks:** Governments or state-sponsored groups may engage in cyber espionage or sabotage to gain strategic advantages.
- **Cybercriminal Organizations:** Organized criminal groups with sophisticated capabilities seek financial gains through attacks on businesses and individuals.
- **Hactivism:** Activists or hacktivist groups may target organizations or individuals to promote their ideological or political agendas.

○ Cybersecurity Policy and Regulation:

- **Inadequate Legal Frameworks:** Weak or outdated laws and regulations related to cybersecurity can create loopholes and insufficient deterrence.
- **Lack of International Cooperation:** Cyber attacks often transcend national boundaries, making it essential to have global collaboration and information sharing to combat cyber threats effectively.

○ Economic and Financial Incentives:

- **Financial Gain:** Cybercriminals are motivated by monetary rewards, such as stealing sensitive information for sale on the dark web or ransomware attacks.
- **Economic Espionage:** Competing organizations or nation-states may engage in cyber attacks to gain a competitive advantage by stealing intellectual property.

The main consequences of cyberattacks on critical infrastructure are:

- **Loss of Life and Property:**

Note:

- Loss of life and property, due to physical damage or disruption of vital services such as health care, water supply, emergency response, etc.
- **Loss of Trust:**
 - Loss of trust and confidence, due to breach of privacy, security, and integrity of personal or official data and information.
- **Economic Loss:**
 - Loss of economic growth and competitiveness, due to reduced productivity, efficiency, innovation, and trade.
- **Threat to National Security:**
 - Threat to national security and sovereignty, due to exposure of strategic assets, vulnerabilities, and secrets.

India can enhance its cybersecurity preparedness to deal with such threats by:

- Strengthening its legal and institutional framework for cybersecurity governance, coordination, regulation, and enforcement.
- Developing its human and technological capabilities for cybersecurity research, innovation, education, and awareness.
- Enhancing its public-private partnership for cybersecurity collaboration, information sharing, best practices, and standards.
- Building its regional and international cooperation for cybersecurity dialogue, cooperation, capacity building, and norms.

Conclusion:

Cyberattacks on critical infrastructure pose a serious threat to the national and global security and stability. India needs to adopt a proactive and holistic approach to enhance its cybersecurity preparedness and resilience, involving all the stakeholders and partners. This will not only protect its vital interests and assets, but also enable it to play a leading role in shaping the cyber domain in a responsible and cooperative manner.

23. What are the objectives and components of the Samudrayan mission? How will it help in enhancing India's capabilities and interests in the deep ocean exploration? (250 words)

Approach

- Start your answer with a brief introduction of Samudrayan mission.
- Write its objectives.
- Explain how it can help in enhancing India's capabilities in ocean exploration.
- Conclude accordingly

Introduction:

The Samudrayan mission is an Indian initiative to undertake the deep ocean exploration focused on India's exclusive economic zones and continental shelf. It is a part of the Deep Ocean Mission approved by the Ministry of Earth Sciences (MoES) in June 2021.

Body:

The objectives of the Samudrayan mission are:

- To develop a self-propelled manned submersible vehicle called Matsya 6000 to carry three human beings to a water depth of 6,000 meters in the ocean with a suite of scientific sensors and tools for deep ocean exploration.
- To enhance India's scientific and technological capabilities and human resources in the field of deep sea research and development.
- To explore the potential of ocean resources such as minerals, energy, water, biodiversity, etc. for sustainable use and development.
- To support India's Blue Economy initiatives and maritime security interests in the Indian Ocean Region.

The components of the Samudrayan mission are:

- Design and development of Matsya 6000, which will have a titanium alloy personal sphere of 2.1-meter diameter enclosed space with an endurance of 12 hours and an additional 96 hours in case of emergency situation.
- Qualification and testing of Matsya 6000, which will undergo various trials by December 2024 before being deployed for deep sea missions.
- Operation and maintenance of Matsya 6000, which will involve trained personnel, infrastructure, logistics, etc. for conducting safe and efficient missions.
- Data acquisition and analysis of Matsya 6000, which will involve collection and processing of various types of data such as bathymetry, geology, biology, chemistry, etc. from the deep sea environment.

The Samudrayan mission will help in enhancing

Note:

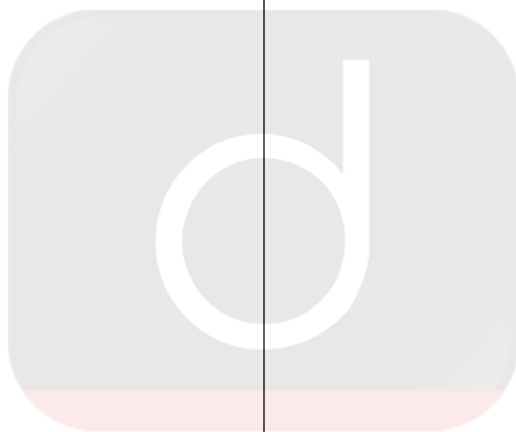
India's capabilities and interests in the deep ocean exploration by:

- Providing India with a niche technology and vehicle to carry out subsea activities that only a few countries such as the US, Russia, France, Japan, and China have.
- Enabling India to access and utilize the vast ocean resources that are estimated to be worth billions of dollars such as polymetallic nodules, gas hydrates, hydrothermal sulfides, cobalt crusts, etc.
- Contributing to India's scientific knowledge and innovation in the field of oceanography, marine biology, geology, etc. that can have various applications and benefits.

- Strengthening India's role and influence in shaping the regional and global order and norms related to the ocean governance, cooperation, and security.

Conclusion:

The Samudrayaan mission is a ambitious undertaking, but it has the potential to make significant contributions to our understanding of the deep ocean and to the development of new technologies for ocean exploration and exploitation. The mission is still in the planning stages, but it is already generating excitement and anticipation among the scientific community.



Note: