

- Given the fractured politics in many countries withdrawal of any major emitter would lead to rapid unraveling of the agreement. (for e.g. the US had withdrawn from the agreement)
- » **Financing in real terms have come down when various data shows need for increase**
- » **Even after eight years of the deal**, by 2023, a lot of work still needs to be done about market mechanism; increasing funding; and making NDCs more ambitious.

A) INDIA'S UPDATED NDC UNDER PARIS AGREEMENT (AUG 2022)

- India submitted its INDC on 2nd Oct 2015.
- The NDC submitted in Aug 2022 is India's first NDC under the Paris Agreement. The Article 4, paragraph 9 of the Paris Agreement provides that each Party shall communicate a nationally determined contribution every five years in accordance with the decision of COP21.
- So, in Aug 2022, India communicated an update to its first NDC submitted earlier on Oct 2, 2015 for the period upto 2030, as under:
 - To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation, including through a mass movement for 'LIFE'– 'Lifestyle for Environment' as a key to combating climate change [UPDATED].
 - To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.
 - To reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level [UPDATED].
 - To achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030, with the help of transfer of technology and low-cost international finance including from Green Climate Fund (GCF) [UPDATED].
 - To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030.
 - To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management.
 - To mobilize domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.
 - To build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative R&D for such future technologies.
- This update to India's existing NDC is a step towards our long-term goal of reaching net-zero by 2070.

B) INDIA'S LONG TERM LOW EMISSION DEVELOPMENT STRATEGY (LT-LED STRATEGY) (NOV 2022)

- **Why in news?**
 - India on Nov 14, 2022, announced its long-term strategy to transition to a "low emissions" pathway at the UNFCCC COP.
- **Details**

- LT-LED is a requirement emanating from the 2015 Paris Agreement whereby countries must explain how they will transition their economies beyond achieving near-term NDC targets, and work towards the larger climate objective of cutting emissions by 45% by 2030 and achieve net zero around 2050. This is what scientists say, offers the best chance of keeping temperature rise below 1.5 degree C. So far, no country is on track towards such a pathway.
- While 195 countries, signatories to the UN Climate agreements, were obliged to submit the long-term document by 2022, only 57 countries (to which India is the latest addition) have done so.
- **Highlight of India's Long Term Strategy:**
 - i. **Nuclear Power Capacity** - It will be increased at least 3 fold in the next decade.
 - ii. India will focus on increasing the proportion of ethanol in petrol - with ethanol blending to reach 20% by 2025 and a strong shift to public transport for passenger and freight traffic.
 - iii. India would also become an international hub of producing green hydrogen.
 - iv. India will also focus on **energy efficiency** by the Perform, Achieve and Trade (PAT) scheme; increasing electrification; enhancing material efficiency; and recycling and ways to reduce emissions.
 - v. The country is also on track to achieve the NDC commitment of 2.5 to 3 billion tonnes of additional carbon sequestration in forest and tree cover by 2030.
 - vi. The emphasis is on ensuring energy security, energy access and employment, while keeping focus on our vision of Atmanirbhar Bharat.

4) THE CONTINUING UNFCCC NEGOTIATION

- **The Continuing UNFCCC Negotiations:**
 - After the COP-21 - Paris Agreement, the negotiations have continued. COP-22 (Marrakech Summit, 2016), COP-23 (Bonn Summit, 2017), COP-24 (Katowice Summit, 2018), COP-25 (Madrid Summit, 2019), COP-26 (Glasgow, 2021);
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- A) COP 26 (GLASGOW PACT) - KEY OUTCOMES: 2021**
- **Mitigation:**
 - » It asked countries to strengthen their 2030 climate action plan or NDCs by 2022.
 - » First clear recognition of the need to move away from fossil fuels -> it called for "phase down of coal" and "phase out of inefficient fossil fuel subsidies".
 - **Adaptation:**
 - » Asked developed countries to atleast double the money being provided for adaption by 2025 from the 2019 levels.
 - » It created a two year work program to define a goal on adaptation.
 - **Paris Rule Book has been finalized.**
 - » 'Transparency Framework' was completed - it included reporting rules and formats for emissions, progress on pledges and financial contributions.
 - » Carbon Market provisions have been finalized [a major achievement of COP26].

- Credit generated from earlier periods, including through Clean Development Mechanism were transferred to the Paris Agreement but only since 2013. This will allow developing countries to meet its first NDC targets.
- On the issue of double counting, it has been decided that a country that generates a credit will decide whether to authorize it for sale to other nations or to count towards their climate targets. The emission cuts will be counted only once.
- Various Positive "Parallel Outcomes" (not part of the official COP26 negotiations)
 - » India's announcement of a Panchamitra
 - » Plurilateral Agreement on Methane Reduction among 100 countries is crucial. (Note: India is not a member)
 - » Plurilateral Agreement to reverse deforestation among another group of 100 countries. (Note: India didn't join the group due to concerns over a clause on possible trade measures related to forest products).
 - » COP26 Transport Declaration -> 100% transition to emission less (electric vehicles) cars by 2040.
 - This has also been signed by over 30 countries.
 - » Glasgow Financial Alliance for Net Zero (Gfanz): 450 of the world's banks and other financial institutions have pledged to report annually on the carbon emissions linked to the projects they lend to.
 - They also plan to lend trillions of dollars in green finance - while committing to net zero emission across the board by 2050.
- Problems that remained:
 - » Funding
 - » L&D
 - » Didn't specifically raise emission reduction targets.

B) COP-27 (SHARM EL SHEIKH, EGYPT)

- Quotes:
 - » The UN Secretary General had declared at the start of the conference, "We are on a highway to climate hell with foot still on the accelerator".
- Key Highlights:
 - » Nod for establishment of Loss and Damage Fund.
 - » Estimates of Financial Requirements -> COP27 agreement for the first time, quantified the financial needs for climate action. It said about US\$ 4 trillion had to be invested in the renewable energy sector every year till 2030 if the 2050 target of net zero was to be achieved.

C) COP28: DUBAI, UAE (30TH NOV 2023 – 12TH DEC 2023)

- Practice Question:
 - "The COP28 Declaration has left almost all the problems where they were before" Elaborate [10 marks, 150 words]

- The meeting reviewed the Progress of commitment made by 197 countries under the Paris Agreement to mitigate the razing global warming.
- **Outcome: Dubai Consensus:**
 - Negotiators adopt resolution titled "Dubai Consensus"; the text reflects a compromise between developed and developing countries on emissions.
- **Highlights of Global Stocktake (GST):**
 - The GST text echoed the GST input findings that 1.5 degree target would require "deep, rapid and sustained" reduction in global emissions of 43% by 2030 and 60% by 2035 from the 2019 levels and eventually reaching net zero by 2050.
 - **Fossil Fuel Phase-out:**
 - » Fossil fuels was the most hotly contested issue of the COP28; It was first time that fossil fuel was at the centre of discussion at UNFCCC COP.
 - » **Outcome:**
 - COP28 agreement has called upon countries to contribute towards "transitioning away" from fossil fuels and phase down of unabated coal power so as to achieve net zero by 2050.
 - » **Criticisms:**
 - No timelines
 - Not using the phrase "fossil fuel phase-out" and instead the use of "transitioning away".
 - While calling for phase down of "unabated coal power", the door was left open for "low-carbon fuels", "low emission" technologies, "low-carbon hydrogen" - all terms with very loose definitions.
 - **Tripling global renewable energy capacity by 2030** (from 3400 GW today to 11000 GW) and doubling of global average rate of energy efficiency improvements by 2030.
 - COP28 calls the member countries to achieve these two targets which have the potential to avoid emissions of about 7 billion tonnes of carbondioxide equivalent between now and 2030.
 - **Tripling is a global** targets for renewables is not incumbent on every country individually. It is not thus clear how this tripling will be achieved.
 - This is the only outcome that contribute to additional emission reduction between now and 2030.
 - **Accelerating and substantially reducing non-carbon-dioxide emissions globally**, including in particular methane emissions by 2030.
 - **Criticisms:** No target mentioned
 - **Note:** A group of about 100 countries at Glasgow (in 2021) had made a voluntary commitment to reduce methane emissions by 30% by 2030.
 - **Reduction of emission from road transport** on a range of pathways, including through development of infrastructure and rapid deployment of zero-and low-emission vehicles;

- **Phase down of inefficient fuel subsidies** that don't address energy poverty or just transition, as soon as possible.
- **Operationalization of L&D Fund:**
 - **Background:** A decision to set up a Loss and Damage Fund had been taken last year in Sharm el-Shaikh (COP27) but it had not been created, and no money had been promised.
 - **COP28 operationalized the fund** and several countries have already made commitments worth around \$800 million by the end of the conference.
 - COP28 decided that the fund will be serviced by new, dedicated and independent secretariat. It will be supervised and governed by the Board.
 - The fund is accountable to and functions under the guidance of the CoP serving as the meeting of the Parties to Paris Agreement (CMA).
 - **This is the most significant outcome for vulnerable countries** as L&D fund is meant to provide financial help to countries trying to recover from climate-induced disasters.
 - **Santiago network** has also decided to avert, minimize, and address loss and damage to catalyze the technical assistance of relevant organizations, bodies, networks and experts for the implementation of relevant approaches associated with climate change impacts.

Santiago Network: At COP25, the parties to UNFCCC decided to set up a Santiago network as part of Warsaw International Mechanism (WIM) for loss and damages. It is aimed to organize the technical assistance of relevant organizations for the implementation of relevant approaches in developing countries that are particularly vulnerable to adverse impacts of climate change.

- **Global Goal on Adaptation (GGA):**
 - » **Background:** COP26 at Glasgow had decided to set up a two-year work program to define the contours of adaptation framework.
 - Adaptation hasn't received enough attention and the entire focus of various agreements have been on mitigation. But, developing countries have been arguing for a global framework for adaptation.
 - The two year work program resulted in identification of some common adaptation goals like reduction in climate-induced water scarcity, attaining climate-resilience in food and agricultural production, supplies and distribution and resilience against climate induced health impacts.
 - » The COP28 retains calls for a doubling in adaptation finance and plans for assessment and monitoring of adaptation needs in the coming year.
 - An explicit 2030 date has been integrated into the text for targets on water security, ecosystem restoration, health.
- **Issue of Climate Finance Targets** will be reviewed in next COP:
 - » Currently, the \$100 billion goal hasn't yet been met (although it appears on track this year) and is far short of what is needed.
 - » **COP28 saw an agreement to draft a post 2025 finance target ahead of COP29**. This is a step forward, but details will only be hammered next year.

- **COP28 Declaration on Climate Change and Health**
 - » This is the first ever move to commit action and finance to combat the health impact of climate change.
 - » The COP28 Presidency and the WHO together issued the 'COP28 UAE Declaration on Climate and Health'.
 - Its signatories aim to accelerate action to protect public health and communities from negative and growing climate impacts and strengthen healthcare systems to cope with the effects of extreme heat, air pollution, infectious and zoonotic diseases and environmental risk factors.

- **Other Related Outcomes:**
 - » A group of **22 countries** signed a declaration to triple nuclear energy capacity between 2020 and 2050, in order to reduce dependence on oil, gas, and coal.
 - » **G7 countries** have announced to phase out coal by 2030 and have urged G20 countries to also agree on it.
 - » India and Sweden co-launched Phase II of the Leadership Group for Industry Transition (LeadIT 2.0) for the period 2024-26 at COP-28. They also launched the Industry Transition Platform, which will connect the governments, industries, technology providers, researchers, and think tanks of the two countries.
 - » **Green Industrialization Initiative**: African leaders came together on the third day of COP28 to launch the initiative. The GII is set to accelerate green growth of industries in Africa and attract finances and investment opportunities.

- **Limitations/Criticisms:**
 - » **Countries failed to adopt rules to set up global carbon market**: Civil society has hailed the move as parties didn't agree to adopt weak rules for carbon markets.
 - » **Climate Finance issue** is still pending and would be taken up in COP25.
 - » **No timelines for fossil fuel transitioning**: The text related to fossil fuel transitioning is weak, in-adequate and with loopholes.
 - » **NDCs remain far away from achieving Net Zero by 2050**.
 - » **Net Zero by 2050** target is expected to bring pressure on China and India whose net zero targets are for 2060 and 2070 respectively.
 - » **Major Decisions** have not been integrated with agendas like 'Common but differentiated responsibilities'.

5) NET ZERO

- **Details**
 - » Achieving a global balance between emissions and removal of greenhouse gases to and from the atmosphere is called net zero (or no net emissions). The Paris agreement targets this to be achieved somewhere in the second half of this century, but the earlier this happens, the greater the chances of keeping global warming below 2-degree C.

- » Electricity and heat are responsible for 25% of global GHGs. The International Energy Agency envisages that in a net-zero world, almost 90% of electricity could come from renewable sources, mostly solar and wind, with nuclear power making up most of the rest.
- Achieving Net Zero:
- » Focus on 2030 goal first:
 - IPCC's AR6 emphasized that to keep temperature rise within 1.5 degree C, global emissions should be reduced by 45% from 2010 levels by 2030, on the way to net zero by 2050.
 - But the UN NDC report says that as per the current NDCs, the global emission is expected to increase by 16.3% in 2030 (compared to 2010 levels).
 - » Energy Conservation and Efficiency: Global emissions show that energy is the biggest emitter (73.2%) including its use in transport, industry, and building. Therefore, energy efficiency can play a crucial role in achieving net zero.
 - Targeted consumer education and behavioral change would also be important here.
 - » Renewable Energy: Gradually phasing out thermal energy (coal, petrol, gas etc.) and increase the capacity of renewables with improved grid infrastructure, smart grids, etc.
 - Insure against Renewable Droughts through other sources like Nuclear Energy.
 - » Transport Sector: Accelerated transition to e-mobility and non-motorized transport is required.
 - » Create Offset: Inspite of all the efforts, humans would still produce some billions of tonnes of emissions by mid-century. This will have to be balanced by removals to achieve net zero. Offset can be in the form of afforestation, increasing soil organic carbon, and advanced carbon sequestration techniques.
 - » Enhancement in Funding: The Promised funding from developed to developing countries need to be delivered.
 - » More R&D in advanced technology like low and zero emission technologies across all sectors. There is also a need of innovation for renewable integration, power to x-storage, and conversion and reconversion pathways. Moreover, carbon-removal technologies need to be focused upon.
 - » CBDR should not be ignored: Developed countries should achieve net zero earlier and few extra decades should be available to developing countries.

- Conclusion:

- » Net zero will be achieved in three decades if driven by clear policies, supported by technology development, and delivered through massive financial mobilization.

6) INDIA'S DECISION TO ACHIEVE NET ZERO BY 2070: CRITICAL ANALYSIS

- At COP26, PM Modi has proposed a **fivefold strategy** for India to play its part in helping the world get closer to 1.5 degrees Celsius. India's 'Panchamrita' promises include:
 - » India will get its **non-fossil energy capacity** to **500 GW** by 2030.
 - This is a **50 GW increase** from its existing target.
 - » India will **meet 50% of its energy requirements** till 2030 with **renewable energy**.
 - » India will **reduce its projected carbon emission** by **one billion tonnes** by 2030.
 - » India will **reduce the carbon intensity** of its economy by 45% by 2030.
 - » India will **achieve net zero** by 2070.

- **India's demand from developed countries:**
 - » In the spirit of climate justice, the developed countries should be providing at least \$1 trillion in climate finance to assist the developing countries and those most vulnerable.

- **Analysis:**
 - This is a very positive move as India had resisted any net zero target in the run up to the COP26. This announcement is expected to put India on a firm path towards decarbonization.
 - This announcement also keeps in mind the Common but Differentiated Responsibilities and Respective Capabilities (CBDR-RC).
 - India's net zero comes in 2070 and NDC is subject to funding from developed countries
 - **India is contributing more than its share:** Despite a 2070 net zero year for India, India's cumulative emissions between 1900-2100 would be lower than the US, China or EU.
 - **India continues to show international leadership** - It has launched the Infrastructure for Resilient Island States - an initiative under the coalition for Disaster Resilient Infrastructure to support vulnerable island countries. India has also launched Green Grids Initiative in partnership with UK to tap into renewable energy resources everywhere.

- **Critics of shifting to a Net Zero target**
 - **Over-appropriation of global carbon budget** by a few.
 - Countries which have higher emissions presently are taking more advantages of the environment.
 - The campaign to achieve net zero by 2050 is designed to achieve Paris goals by the "lowest cost" methods, foregoing equity and climate justice.
 - **Wasn't mandated by Paris Agreement**.
 - **India is anyways a small contributor** - Our emissions are 4.37% of the world's share (with 18% population).

Critics of Sustainability of India's Net Zero Strategy

- India's plan to increase dependence on hydro projects and nuclear energy will create displacement, deforestation, hazardous radiation etc.
- Solar and Wind Energy is also focused on Mega energy parks which may cause displacements.

Way Forward:

- **Identify short-term and medium-term targets** to achieve the long-term goals.
- **Areas of GHG Reduction:**
 - **Decarbonizing India's Energy Sector** - Replace fossils with renewables; Improve efficiency of existing fossil fuel using sectors; Remove unavoidable carbon release through Carbon Sequestration.
 - **Green Transformation of Mobility:**
 - Shift in modal mix from road to rail and fuel diversification approach to encourage sustainable fuels (biofuels, CNG, LNG) in short term.
 - Electrification in medium term.
 - Hydrogen based heavy mobility in the long term.
- **Radical Decarbonization of Industrial sector** including steel, cement, chemicals and fertilizers.
 - Accelerate circular economy; efficiency improvement; electrification of heat; carbon capture and low carbon fuels such as biomass and hydrogen.

- **Green Building, Infrastructure and Cities:** India's top 25 cities contribute to 15% of its estimated GHG emissions.
 - Rethink urban planning with a focus on transit oriented urban development and an emphasis on low-carbon buildings and infrastructure construction.
- **Agriculture:** Agriculture sector is the largest contributor to nitrous oxide (N_2O) and Methane (CH_4).
 - A national campaign to empower, educate and enable more than 100 million farmers in adopting precision agriculture, sustainable animal husbandry, and green energy.
- **Integrate emission reduction with Climate Adaptation**
 - Strengthen a suit of social protection program, especially for people facing rural distress.
 - Invest in disaster preparedness.
- **Corporate India** has a vital role to complement government efforts. The goals of 21st century India Inc should be to foster innovative and inclusive green development.
- **Strengthening State Capacity** can help the country move from reactive decision making to proactive planning and execution. A **Low-Carbon Development Commission** supported by the overarching framework of a climate law, could play this role.

Conclusion:

- Through its announcement of 'Net-Zero' target, India has silenced its critics. Now, its time to follow through on these commitments with transparent and credible action. This would allow India to demonstrate genuine climate leadership for the rest of the developing world, and secure a better, greener future for its citizens.

7) MECHANISMS AND ISSUES WITH CLIMATE FUNDING

- **Introduction**
 - » Money has been central to many a fight at the Climate Change negotiations. UNFCCC as part of its CBDR principle requires developed countries to provide financial assistance to developing nations in their fight against the climate change.
 - » Globally, there are two funding mechanisms - **The Green Climate Fund** and the **Global Environment Facility**.
- **Green Climate Fund (GCF)**
 - » Established at COP-16 in 2010, it is the financial mechanism for UNFCCC under article 10. It is regarded as the chief instrument for the fulfillment of developed world's annual support of \$100 billion annually till 2025.
 - » COP-21 held at Paris also decided that GCF shall serve the Paris Agreement.
- **Global Environment Facility (GEF)**
 - » Created at Rio Earth Summit in 1992 to help tackle planet's most important environmental problems.
 - **What has it done so far? / What does GEF do?**
 - » GEF also serves as financial mechanism for the following conventions:
 - CBD
 - UNFCCC
 - UNCCD

- Stockholm Convention on Persistent Organic Pollutants (POPs)
 - Minamata Convention on Mercury
 - It also supports implementation of Montreal Protocol on substances that deplete the ozone layer in countries with economies in transition.

- **Current Funding Situation:**
 - **Requirement:** As per COP27 (Sharm el-Sheikh agreement), the global transition to a low-carbon economy would likely require about US\$ 4-6 trillion every year till 2050. This is 5% of the global GDP.
 - The cumulative requirement of developing countries, just for implementing their climate action plans, was about US\$ 6 trillion between now and 2030.
 - **Availability:**
 - The \$100 billion amount, that the developed countries have promised is the only money in play right now. And of this only around US\$50-80 billion per year is being mobilized. This indicates that the fund available in less than 10% of what is required.

- **Key Problems of current climate funding are:**
 - **Requisite finance** hasn't been mobilized.
 - **Funding bias in favour of climate change mitigation activities.** This bias is there because mitigation efforts are easily visible in short run and returns from adaptation efforts will be visible after long time.
 - For e.g., if we adapt by moving away from coasts, the benefit of this adaptation efforts would be visible much later.
 - **Developing world** in itself cannot fight the climate crisis as they are still struggling for finance for their development needs.
 - **A number of countries** are unable to access global finance. Present rules and regulations of global financial systems, make it difficult for many countries to access international finance, particularly those with political instabilities
 - **Lack of transparency** is leading to problems of double counting and green washing.

- **Way Forward:**
 - **Availability and Access** are two main dimensions to the problem of climate finance.
 - **Increasing Availability:**
 - **Developed countries** need to increase their contribution.
 - But, even if this happens, this won't be able to fulfill the requirement of around \$6 trillion needed annually.
 - **Mobilize resources from private sector:** Businesses and Corporations need to invest money into green projects.
 - In climate finance thus far, private investment have lagged behind public money. Barely 30% of current financial flows are coming from private sources.
 - **Creation of right environment for investments in green project** -> Private sector will not invest unless they are reasonably sure of healthy returns.
 - Here, international financial institutions should engage with governments, central banks, commercial banks etc. to incentivize climate friendly investments and discouraging, or even penalizing, dirty investments.
 - **Carbon Tax** - Common citizens will have to contribute to the bulk of the additional financial resources.

- **Increasing Access:** There is a need to simply lending mechanisms and overhaul credit rating systems.
- **Increased Transparency:**
 - Climate finance flows through a maze of channel - bilateral, regional, multilateral. It is in the form of grants, concessionary loans, debt, equity, carbon credit, and more. As a result, there are widely different opinion on the quantum of climate finance currently being mobilized. This needs to be addressed.
- **Conclusion**
 - » Though, more money is flowing in green economy than a few years ago, but the pace of increase is nowhere adequate. When it comes to climate change, along with money, it is the time which is in short supply.

8) GEO-ENGINEERING, CARBON CAPTURE AND STORAGE (CCS) AND CARBONDIOXIDE REMOVAL (CDR) TECHNOLOGIES

- **Introduction:**
 - » **Definition:** Geo-engineering is a theoretical concept which aims to modify and cool environment to defeat the global warming. It may involve reduction of Sunlight reaching earth or absorption of CO₂ to reduce global warming (Carbon Capture Technologies).
 - » Since the global community is looking for a Net Zero target by 2050, the Geo-engineering technologies are expected to play a key role in this.
- **Reduction of sunlight reaching Earth:**
 1. **Stratospheric Aerosol Injection:** Injecting the atmosphere with Sulphur/ Hydrogen Sulphide (copies volcanic effect and scatters sunlight).
 2. **Putting Large Mirrors in Space** - reduce the amount of sunlight reaching earth.
 3. Using Wind-Powered Motors to **whiten the cloud** -> by spraying water into the sky -> reflect solar radiation.
- **Carbon Capture and Storage (CCS)** (Or Carbon Capture Utilization and Storage (CCUS)) refers to technologies that can capture CO₂, at a source of emissions before it is released into atmosphere.
 - The process starts with capture of CO₂ which undergoes a compression process to from a dense fluid. This eases the transport and storage of the captured CO₂.
 - This dense fluid is transported via pipelines and then injected into the underground storage facilities. It can also be used as a raw material in other industrial processes such as bicarbonates.
- **CDR** takes the form of both natural means like afforestation or reforestation, and technologies like direct air capture where machines mimic trees by absorbing CO₂ from their surrounding and storing it underground.
 - E.g. Fake Trees containing compounds which can react with CO₂ to absorb it and store it in solid form.
- **Other Carbon Capture Technologies**
 - i. **Ocean Iron Fertilization:** Seeding the Sea with Iron
 - Phytoplankton prefer iron and flourish in its presence, thus absorbing a lot of CO₂.

- How significant is the role of CCS and CDR in achieving net-zero by 2050?
 - » In IPCC AR6, there is no pathway to 1.5 degrees C that doesn't use CDR.
- Limitations/Problems with these CCS and Geoengineering method:
 - » CCS and CDR are still technologies under development without demonstrated feasibility at large scale despite decades of development.
 - It also suffers from other challenges like high energy requirements; high cost; challenges in the transport and long term storage of carbon.
 - » CDR methods like afforestation, reforestation, Bioenergy with Carbon Capture and Storage (BECCS) are constrained by their need of land. It may also hamper food and water security.
 - » Ocean Iron Fertilization: The Convention of Biological Diversity has already imposed a de facto moratorium based on precautionary principle. It could result in eutrophication, which may adversely affect the ocean ecosystem.
 - » Stratospheric Aerosol Injection is also highly controversial as this could have unintended effects on global and regional climates.
 - » Further, there are concerns related to fairness, equity, and justice in the adoption of geo-engineering technologies as most of the R&D is dominated by North American and Western Euro.
- So far, there has been very little progress on these technologies and most of the R&D is dominated by North American and Western European Nations. Emerging economies like China and India have also begun to look into these options more seriously.
 - » CCS is absent from INDCs of most of the countries, indicating that most of the countries have not yet accepted it as promising technology.
- Why very little progress? - Lack of policy support and spending on R&D.
- Situation of CCS in India - Not much progress
 - » Some industries, especially steel and cement have been proactively pursuing CCS as part of their emission reduction ambitions. In Sep 2020, an 'Industry Charter' for near zero emissions by 2050 was agreed to by six Indian companies that will explore different decarbonization measures including carbon sequestration.
 - » Government initiatives: The DST has established a nation wide program on CO2 storage research and in Aug 2020, made a call for proposals to support CCS research, development, pilot and demonstration projects. This is part of the accelerating CCS technologies (ACT) initiative, for which India has committed one million Euros to support Indian participants.
- Geopolitics of Geoengineering:

Since, developed countries dominate the R&D and discussions on futuristic governance framework, there are concerns about the representation of positions of developing and underdeveloped countries.

 - It could widen north-south divide, by dividing the world into haves and havenots.
 - Then there are concerns about potential militarization of these technologies.
- Way forward

- » **Improved policy support**
- » **Learn from successful implementation of technology in industrialized countries.** Increased collaboration with global industries.
- » **Strengthen international geo-engineering governance:**
 - Future use of geo-engineering should take into consideration the core principles of UNFCCC like common but differentiated responsibilities.
 - The international governance should introduce accountability, oversight and transparency into the use of geo-engineering in future. The governance framework should be inclusive in approach.

4. EFFORTS BY INDIA TO FIGHT CLIMATE CHANGE

1) NATIONAL ACTION PLAN ON CLIMATE CHANGE

- Launched in 2008
- Consist of 8 submissions – National Solar Mission, National Mission on Enhanced Energy Efficiency; National Mission on Sustainable Habitat; National Water Mission; National Mission on Sustainable Himalayan Ecosystem; the National Mission on Strategic Knowledge for Climate Change; National Mission for Green India; National Mission for Sustainable Agriculture.

2) UPDATED NDC TO UNFCCC

3) LONG TERM-LOW EMISSION DEVELOPMENT STRATEGY

4) MISSION LIFE

- **Details about Mission LiFE**
 - It was first proposed by PM Modi at COP 26 of UNFCCC in Nov 2021. It is envisioned as an India led global mass movement that will nudge individual and collective action to protect and preserve the environment.
 - PM Modi has underlined that Mission LiFE makes the fight against climate change democratic, in which everyone can contribute with their respective capacities.
 - It emboldens the spirit of the P3 Model: Pro Planet People.
 - It functions on the basic principles of 'Lifestyle of the planet, for the planet and by the planet'.
 - At the launch, PM Modi also highlighted that the concept of 'Reduce, Reuse and Recycle' and circular economy; and mentioned that it has been part of the Indian Lifestyle for thousands of years.
 - LiFE also resonates with **climate justice** -> it highlights enhanced obligations for those in developed countries and supports climate adaptation and mitigation for those most affected and yet least responsible.
- NITI aayog will curate and incubate Mission Life in the first year, and it will subsequently be implemented by MoEF&CC.
- It is a five-year program.

- **Significance:**
 - According to UNEP, more than 2/3rd of the GHG emissions can be attributed to household consumption and lifestyles -> therefore the urgent cuts to global emissions we need can only be achieved through widespread adoption of greener consumption habits.
 - Life recognizes that small individual actions can tip the balance in the planet's favor.
 - Actions such as saving energy at home; cycling and using public transport instead of driving; eating more plant-based foods and wasting less; and leveraging our position as customers and employees to demand climate-based friendly choices.
 - Many of the goals of LiFE can be achieved by deploying 'nudges', gentle persuasion technique to encourage positive Behaviour.
 - The UNEP employs proven nudging techniques:
 - Discouraging Food waste by offering smaller plates in cafeterias.
 - encouraging recycling by making bin lids eye-catching;
 - and encouraging cycling by creating cycle paths
- **Note: Other Recent global initiatives launched/initiated by India:**
 - Panchamrita Targets announced by Mr Modi at COP26
 - International Solar Alliance
 - The Coalition for Disaster Resilient Infrastructure

5) SCALING UP EFFORTS TO MOBILIZE GREEN FUND

- Though the Paris Agreement provides for mobilization of resources from developed countries, the process has been very slow.
- Thus, India has scaled up its efforts towards greater mobilization of private capital to meet its ambitious climate action goals.
- **Green Bonds** are financial instruments that generate proceeds for investment in environmentally sustainable and climate suitable projects.
 - Developed countries such as UK, France, Germany etc have been using Green bonds to raise billions of dollars of sovereign green debts.
- In India, as per SEBI's data between 2017 and Sep 2022, 15 Indian corporates have issued green bonds of value of Rs 4,539 crores. Most of this is related to renewable energy generation.
- **Union Budget 2022-23** announced the issuance of **Sovereign Green Bonds**.
 - The final sovereign green bond framework of India has been issued.
 - The Green Financing working committee has also been set up to oversee and validate key decisions on the issuance of Sovereign green bonds.
 - The committee has the mandate to select the projects for allocation of proceeds, do a time-bound review of the allocation and carry out annual reporting along with an impact assessment of the proceeds from sovereign green bonds issued.
 - The RBI also regularly notifies indicative calendar for the issuance of sovereign Green Bonds (SGrB)

- The security-wise allocation would include 5 year and 10 year SGrBs for ₹4,000 crore each for both auctions.
 - Five per cent of the notified amount of sale has been reserved for retail investors as specified under the ‘Scheme for Non-competitive Bidding Facility in the auction of Government of India Dated Securities and Treasury Bills’.
 - The SGrBs will be designated as specified securities under the ‘Fully Accessible Route’ for investment in Government Securities by non-residents.
 - Over time, the SGrBs would provide a pricing reference for private sector entities in India for their domestic borrowings through Environment, Social, and Governance (ESG) bonds.
 - Thus, the issuance of SGrBs would help in creating an ecosystem which fosters a greater flow of capital into green projects and entities undertaking such projects.

6) OTHER STEPS TO PROMOTE RENEWABLE ENERGY AND ENERGY EFFICIENCY



CURRENT AFFAIRS PROGRAM

PRE CUM MAINS 2024

JAN 2024: PART-1

LAND REFORMS

TABLE OF CONTENTS

1. <i>Syllabus: Land Reforms in India</i>	1
2. <i>PYQs</i>	1
3. <i>Other Practice Questions</i>	1
4. <i>Land Reforms in India</i>	2
5. <i>Abolition of Intermediaries</i>	3
6. <i>Tenancy Reform</i>	4
7. <i>Ceiling on Agricultural Holding</i>	6
8. <i>Current Landholding Situation in India: Agri-Census 2015</i>	7
9. <i>Cooperative Farming</i>	8
10. <i>Key things which limited the success of land reforms</i>	9
11. <i>Land Leasing Reforms needed today</i>	10
12. <i>Contract Farming</i>	12
13. <i>Land Pooling Policy</i>	13

1. SYLLABUS: LAND REFORMS IN INDIA

2. PYQS

- a. State the Objectives and measures of land reforms in India. Discuss how land ceiling policy on landholding can be considered as an effective reform under economic criteria [Mains 2023, 10 marks, 150 words]
- b. How did land reforms in some parts of the country help to improve the socio-economic conditions of marginal and small farmers? [Mains 2021, 10 marks, 150 words]
- c. Discuss the role of land reforms in agriculture development. Identify the factors which were responsible for the success of land reforms in India [Mains 2016, 12.5 marks, 200 words]
- d. In the view of the declining average size of land holdings in India which has made agriculture-nonviable for a majority of farmers should contract farming and land leasing be promoted in agriculture? Critically evaluate pros and Cons [Mains 2015, 12.5 marks, 200 words]
- e. The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 has come into effect from 1st Jan 2024. What are the key issues which would get addressed with the act in place? What implications would it have on industrialization and agriculture in India [2014, 12.5 marks, 200 words]
- f. Establish relationships between land reforms, agriculture productivity, and elimination of poverty in the Indian economy. Discuss the difficulties in designing and implementation of agriculture-friendly land reforms in India [2013, 10 marks, 200 words]
- g. Give your assessment on land reforms in India [1997, 20 marks]

3. OTHER PRACTICE QUESTIONS

- a. Critically analyze the role of land reforms in post-independence agrarian and economic development. Have the objectives of these reforms been fully achieved? Give reasons. [15 marks, 250 words]
- b. Why were Land Ceiling Acts introduced in India? Have they been able to achieve their objectives? [10 marks, 150 words]
- c. Evaluate the influence of land reforms on the socio-economic structures of rural India. [10 marks, 150 words]
- d. Analyze the achievements and limitations of Bhoodan Movement [10 marks, 150 words]
- e. Analyze the role of land reforms in achieving the SDGs particularly the eradication of poverty (Goal 1) and zero Hunger (Goal 2) [10 marks, 150 words]
- f. Climate change poses significant challenges to land and agriculture. Discuss the role of land reforms in promoting climate-resilient agriculture and sustainable land use. [10 marks, 150 words]
- g. **Land Fragmentation** is a common problem in Indian agriculture. Analyze its causes and consequences and suggest measures to address this issue. [15 marks, 250 words]

- h. Land Acquisition for development projects has often been a contentious issue in India. Critically examine the existing legal framework for land acquisition and suggest possible reforms to balance development with the rights of landowners and affected communities [15 marks, 250 words]

4. LAND REFORMS IN INDIA

- **Introduction:**
 - **Definition:** Changes brought in the agrarian structure through direct intervention are characterized as land reform.
- **Need of Land Reforms in India after Independence:**
 - **The exploitative nature of land tenure system** (Zamindari and Ryotwari system) prevailing during the pre-independence period:
- **Under Zamindari System:**
 - **High rent:** As much as 25% of produce was taken away by the intermediaries in the form of rent.
 - **Illegal extraction:** Encroachment of communal rights in pastures, forests, etc and the farmers were made to pay for accessing these.
 - **Begar and force labor were common:** Other than high rent and illegal extractions, farmers were also forced by zamindars into forced labor
 - **Low capital investment:** Low income for famers led to lack of investment in agriculture, low capital intensity and antiquated methods -> stagnant productivity.
 - **Poor records maintenance:** It led to difficulty in mortgaging and selling of land. It also led to poor development of credit institutions in these areas.
- **Even under Ryotwari system** where rent was directly paid by Ryots (cultivators) to government, several shortcomings had developed. Here, moneylenders and Mahajan had come to play a very important role. By the time of independence, more than 20% of the area under cultivation had passed under open tenancy.
- **Objectives of Land Reforms:** The government defined the objectives of land reforms as follows:
 - i. **Increased Agri-Productivity:** Land reforms were focused on removing impediment to agri production through creation of efficient landholding; encouraging investment in agriculture and boosting production.
 - ii. **Ensuring Equity and Social Justice:** Land reforms would provide equality of status and opportunity to all sections in the rural areas.
 - iii. **Reducing Exploitation:** Tilers for e.g. are provided with security of tenure; higher share of crops with sharecroppers etc.
- **Measures taken** to achieve the above objectives were:
 - i. **Abolition of intermediaries:**
 - » Abolishment of Zamindars and bringing farmers in direct contact with state
 - ii. **Tenancy Reforms:**
 - » It included regulation of rent, security of tenure and ownership rights of tenants.
 - iii. **Ceilings on Agricultural Landholdings**

- » So that access land could be redistributed.
- iv. **Reorganization of Agriculture**
 - » Redistribution of land, consolidation of land holding and cooperative farming.
- v. **Land Titling and Registration:** Establishing a clear system of land titling and registration to secure land rights.

Despite various implementation challenges, these land reforms significantly contributed to rural poverty reduction, and social equity in India, thus underlining the importance of land reforms in advancing the socio-economic conditions of marginal and small farmers.

5. ABOLITION OF INTERMEDIARIES

- **Questions:**
 - » Discuss the challenges faced in implementing the Zamindari abolition policy in India. How successful was it in its objective of land distribution?
- **Background: The main cause of stagnation in agricultural sector was the exploitation by Zamindars.**
 - » Even before independence it was understood that exploitation of zamindars is the main cause of stagnation in India's agriculture which in turn was the main reason behind stagnation in agricultural growth.
- **So, some states had passed laws to abolish zamindari system, but the primary work related to this was done during the first five year plan.**
- **Outcome:**
 - » Official documents claimed that **intermediaries were completely abolished** by the end of the First Plan excepting a few small pockets in some areas.
 - » It is estimated that in all 173, million acres of land was acquired from the intermediaries and, as a consequence, about **2 crore tenants were brought into direct relationship with the state**.
- **Assessment:**
 - » **Challenges:**
 - **Absence of land records** in the permanently settled areas: Here the land records and administrative machinery had to be built from scratch.
 - **Delays**: Due to delay in making of laws (for e.g. UP Zamindari Abolition act, took 4.5 years) and then due to Zamindar's challenging it in court.
 - **Flaws in legislations:**
 - **"Personal Cultivation"** provision was misused. Zamindars could obtain land for 'personal cultivation' upto a ceiling limit. The zamindars could even evict tenants for the purpose.
 - **"Ceilings were very high"** -> very few zamindars were affected.

- **Transfer of land to family members:** Flaws in the legislation have also enabled them to transfer their land to other members of their families and thus escape the ceiling law.
 - For e.g. in post reform Bihar, there existed estates of 500, 700 or even 1,000 acres and older structure of landowner, occupancy raiyat, non-occupancy raiyat, bataidars etc. continued.
- **Zamindari only changed its 'garb':** The previous zamindars acquired large areas for personal cultivation on which cultivation is done with the help of hired agricultural labor. They are now designated as 'big landowners' and along with rich peasantry, have formed "a new and dominant class of rural capitalist".

» **Positives:**

- Most of the states had passed zamindari abolition law by the end of first five-year plan. This perhaps reflected on the popular sentiments against zamindars and their exploitative practices.
- Exploitation and oppression of tenants and actual tillers of the soil declined steeply and the feudal rural structure crumbled.
- Reforms led to skimming of great absentee landlords.
- Land reforms measures in Kerala (1959) and West Bengal (1967) are particularly significant.
 - In Kerala, the government declared eviction illegal and sharecroppers were granted the right to purchase land. They were not allowed to retain more than 10 acres of land.
 - The United Front Government of West Bengal acted decisively in favour of the bargees and agricultural workers and against landlords and rich farmers.

- **Conclusion: Overall**, while the policy marked an important step towards reducing economic inequality and rural poverty, its implementation was marred by several challenges, and its success was uneven across the country. For the policy to achieve its objectives fully, these challenges needed to be, and still need to be, addressed more effectively.

6. TENANCY REFORM

- **Background:**
 - Before reforms, tenants at will and sub-tenants were in a precarious position.
 - Their very existence dependent on the mercy of landlords and this made them prone to various exploitative practices adopted by latter.
 - According to experts, before green revolution, approximately 50% of agricultural land in India was under one or other form of tenancy.
- **Key Reforms:**
 - i. **Rent Regulation:** In the pre-independent India, exorbitant rent was extracted from tenants. In the country as a whole, the rent varied from 34 to 75%.
 - **Reduction in Rent:** The first five-year plan stated that maximum rent should be fixed at 1/4th or 1/5th of the total produce. Except in Punjab, Haryana, J&K, TN and Andhra

Pradesh, this limit was observed in all the states. Even in these states, it didn't go beyond 40%.

- **Limitations:**

Violation of the law: Because of the strong **socio economic and political hold of the landowners** in the countryside, they have been able to extract considerably more rent from the peasants. For e.g. in Bihar, share croppers are mostly required to pay 50%. In the absence of any security of tenure, the peasants are not willing to confront landlords.

ii. **Security of Tenure:** To protect tenants from ejection and grant them permanent rights in land, legislations have been passed in most of the states.

- » **Legislation for security of tenure had three essential aims:**

- No ejection except as per the provision of the law.
- Land may be resumed by the owner, if at all, for 'personal cultivation' only
- In the event of ejection, tenant is assured of a prescribed minimum area.

- » **Limitations:**

- **Some sharecroppers not covered by this law:** In WB and Uttar Pradesh, sharecroppers were not included in the definition of tenants and thus were not protected by these laws.
- The '**Right of resumption**' combined with flaws in the definition of personal cultivation rendered all tenancies insecure.
- The '**Provision of voluntary surrender**' was also misused.
 - Socio-economic conditions allowed landlords to compel their tenants to give up the tenancies.
- **No (or incomplete) records of tenancy:** This leads to laws related to security of tenure not getting implemented.

iii. **Ownership rights for Tenants:**

- » Some states have also passed law to confer ownership rights to tenants.

- It is estimated that as a result of this, 1.2 crore tenants have acquired ownership right over 6.32 million hectares of land.
 - **West Bengal, Karnataka, and Kerala** have achieved more successes than the other states.
 - In West Bengal, 14 lakh sharecroppers have been recorded under the '**Operation Barga**'.
 - **Operation Barga** was a land reform movement, throughout the rural WB for recording the names of the sharecroppers (Bargadars) while avoiding the time-consuming method of recording through the settlement machinery. It bestowed on the bargadars, the legal protection against eviction by the landlords (jotedars), and entitled them to the due share of the produce.
 - It was launched in 1978 and concluded in mid 1980s.
 - Till date the operational barga recorded the names of approximately 1.5 million bargadars. Since then, it has been marked as one of the most successful land reform programs in India.

- In Kerala, **applications of 24 lakh tenants** for conferment of ownership rights were accepted.
- **Limitations:**
 - » On the whole, the **progress was very unsatisfactory**.
 - » A few states didn't adopt a legislation while in some others implementation has been very poor.
 - » For a long period, tenant didn't exercise their rights to purchase ownership of land they cultivated due to following reasons:
 - Many tenants couldn't afford to pay the purchase price.
 - Many tenants were unwilling to purchase. This reflected the dominant controlling power of the landowner's vis-a-vis the tenants.

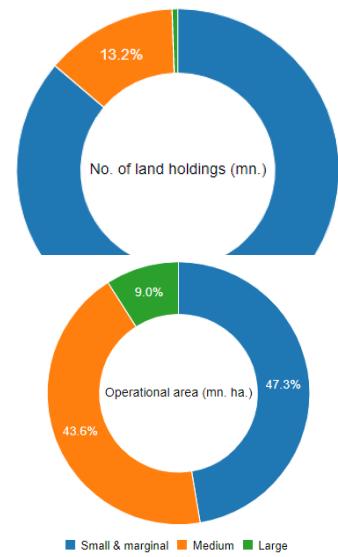
7. CEILING ON AGRICULTURAL HOLDING

- A ceiling on agricultural holdings means **statutory absolute limit** on the amount of land which an individual may hold.
- **Need of Ceiling:**
 - i. **The Social Rationale:** It is socially unjust to allow a small number of people to hold a large part of land and thereby subjugate the interests of millions of laborers to the interest of this handful minority.
 - ii. **Improving the position of poor:**
 - » According to FAO, "Redistribution of only 5% of farmlands in India, coupled with improved access to water, could reduce rural poverty level by 30% under what otherwise would be, so that in India conditions land and water reform would be a key approach.
 - » Various studies have shown that the per capita income of the rural poor has more than doubled, as is their share in total personal incomes.
 - iii. **The Efficiency Factor:** With ownerships, small farms can be more effectively managed in comparison to large farms. Small farms offer more opportunities for employment as they are less capital intensive as compared to large farms.
 - iv. **Inculcating the Spirit of Cooperation:** The land redistribution can be done with a condition that farmers form cooperatives for its cultivation and management. This practice will enable the hitherto landless laborers and petty peasants to learn the techniques of social management and joint cultivation on the one hand, and enable them to realize the benefits of large-scale farming as well.
- **Steps taken to promote ceilings:**
 - » It had two aspects - Ceiling on future acquisition and Ceiling on existing holdings.
 - » **The 2nd Five Year Plan** provided that ceiling should apply to all future acquisitions of land and all existing agricultural land holdings held under 'personal cultivation'.
 - » **Compensation:** The plan said that it should be recovered from persons to whom allotments are made.
 - » The priority should be accorded to tenants displaced as a result of resumption of land for personal cultivation, farmers with uneconomic holdings and landless workers.
- **Limitations:**
 - » The above guidelines haven't been applied uniformly across the state laws.

- » Malafide transfers, Benami properties have reduced the sting out of the ceiling laws and have tended to defeat the aim of these laws.
 - » In some cases, too many exemptions permitted evasion of ceiling on a considerable scale.
- **1972 Conference of Chief Ministers:**
- » To bring uniformity in the different policies regarding imposition of ceilings being pursued by the states, a conference of chief ministers was called in July 1972. Based on the consensus at the conference, a new policy on land ceiling was evolved.
- **Aim of the new policy of land ceiling:**
- i. Lowering the ceiling to 18 acres of wet lands and 54 acres of unirrigated land.
 - ii. The change over to family rather than the individual as the unit for determining land holding - lowered ceiling for a family of five.
 - iii. Fewer exemptions from ceilings
 - iv. Retrospective application of the law for declaring Benami transactions null and void.
 - v. To insulate measures from being challenged in the court, most of the laws were introduced under the 9th schedule of the Constitution.
- **But, even its implementation was poor.** Only around 3 million hectares has been declared surplus so far, which is hardly 2% of net sown area in India.
- » About 30% of the land hasn't been distributed as it is caught up in litigations.
 - » A number of Benami and Clandestine transactions have resulted in illegal possession of significant amount of land above ceiling limits.
 - » The balance of power in rural India is so heavily weighted against the landless and the poor that implementing land ceilings law is difficult.
 - » A new problem also emerged. In certain states like Karnataka, the industry and the large farmers are being given exemption from ceiling laws without seeking the permission of Government of India

8. CURRENT LANDHOLDING SITUATION IN INDIA: AGRI-CENSUS 2015

- **Current Situation of Agriculture Holding In India: Agri-Census 2015**
 - » Small and marginal landholdings (<2 hectare area) constituted **86.21%** of the total landholding, an **increase of 1.2% points** compared to 2010-11.
 - Farmers holding 10 hectares and more account for just **0.57%**.
 - Semi-Medium and Medium: **13.2%**
 - » Decline in average size of landholding from 1.15 hectare to 1.08 hectare.
 - » Average size of farm holding was the **highest in Nagaland** at 5.06 hectares and **lowest in Kerala** at 0.18 hectares.
 - » It is noteworthy that small, marginal and medium landholdings constitute the lion's share of operated area - large landholding account for only **9%** of the total operated area.



- **Causes of Subdivision and Fragmentation:**

- i. **Law of Inheritance:** Land gets equally divided among all the siblings.
- ii. **Increasing Population:** The land under agriculture has increased marginally, but the population has kept on going up.
- iii. **Decline in joint family system**
- iv. **Farmer's Indebtness:** This sometimes leads to farmer selling a part of the land to someone else.
- v. **Psychological Attachment to land:** Even if people migrate to urban areas, they would want that their land in village remain owned by them. Every child want to have a share in father's land and is not willing to accept payment in lieu of land.
- vi. **The Practice of share cropping:** This allows a farmer to manage several fragmented pieces of land.

- **Disadvantages:**

- » **Wastage of land:** Sometimes after division, the land become so small, that it can't be used for agriculture. It has been estimated that in Punjab around 6% of land is wasted on this account.
- » **Difficulty modernization:** Investment on farm equipment, irrigation facilities etc. become very probable. This also contributes to low productivity.
- » **Difficulties in land management:** For a farmer, several small pieces of land fragmented in entire village is less manageable, than one large field located together.
- » **More fragmentation leads to more boundaries** leading to more disputes. This one several occasion hamper the peace in the village.
- » **Disguised unemployment:** Small piece of land fail to provide work for all members of the farmer's family. But they still remain dependent on it, causing disguised unemployment.

- **Efforts towards Consolidation:**

- » **Land Consolidation** is designed to solve the problem of fragmentation of holdings. The method that was adopted was to give one consolidated holding to the farmer equal to the total of the land in different scattered plots under his possession. Initially the program was voluntary, but it was later made compulsory.

- **Critical evaluation of Consolidation Program:**

- » **However, the progress under the initiative have been quite low.** Consolidation has been done only on 1/3rd of the consolidable area of the country. It is a continuous process, but most states have stopped consolidation. Only in Punjab and Haryana the task has been consolidated so far.
- » **Factors:**
 - **Different quality of soil from land to land:** This makes it difficult to convince farmer to accept other piece of land which may be smaller.
 - **Emotional attachment to land:** She doesn't willingly cooperate with consolidation officer.
 - **Most states were engaged in the immediate land reform programs** like abolition of intermediaries, tenancy reform etc and thus consolidation reforms were postponed.
 - **Failure of other aspects of land reform** reduces the scope of land consolidation.
 - **Socio-Economic Factors:** Rich and influential often mange to get fertile and well situated land, whereas the poor and uninfluentiel get inferior lands.

9. COOPERATIVE FARMING

- Cooperative farming has been advocated to solve the problems created by subdivision of holdings. The idea is that farmers having very small holdings should join hands and pool their lands for the purpose of cultivation.
 - Farmers will be able to pool resources, implements and cultivate jointly and thus can reap the benefit of large-scale farming.
- **Arguments in favor of Cooperative farming: Solving the problems created by small uneconomical holdings.**
 - Small holding can be pooled together with this method and joint cultivation on the pooled land enables the members to reap all benefits of large scale farming.
 - Reduce input cost -> Inputs bought in bulk will cost less
 - Modernize -> Big agricultural implements and machinery like tractors, harvesting machines, etc. which small individual farmers can't purchase can now be purchased on a collective basis by the society and can be rented out to individual farmers.
 - Marketable surplus of food grains and industrial raw materials can be obtained more easily from large farms and can be transported to the market on a bulk basis in an easier way. Thus agriculture surplus can be located and transported more easily.
 - It is also easy to collect agricultural data from large scale cooperatives farms instead of subdivided and fragmented small farms. This increases the reliability and authenticity of agricultural data which is a sine qua non of all good agricultural planning.
 - **Social Cohesion:** Cooperative farming will inculcate, the spirit of cooperation among members of the society which can go a long way in inspiring mutual confidence, collective action, joint thinking, and feeling of fraternity and friendship among members.
 - **Foundation for strong democracy** can be laid by such cooperatives.
 - In recent years, there have been a lot of talk about 'public participation in planning' and 'planning from below'. This will remain mere slogans unless and until the spirit of cooperation develops at the village level.
- **Progress:**
 - In the first three plans, there was a push for cooperative farming through various incentives and facilities for the development of these societies like financial assistance, technical assistance, subsidies, preference in allocation of improved supply of seeds etc. However, the progress was extremely low and as of June 1969 there were only 8,160 such societies with 2,20,047 members.
- **Other limitations:**
 - An analysis by planning commission had found that cooperatives were formed mostly by well-to-do farmers to enjoy the benefits of government initiatives. Very few farming cooperatives are true cooperatives formed by small landholders.
 - **Lack of necessary professional skills:**
 - » Inefficient administration and corrupt practices eroded the confidence of members of the society who were soon disillusioned by the experiment of cooperative farming.
 - » Thus, this led to reversal to individual farming. This failure discouraged other peasants also who were either planning to join the existing societies or to form new societies.

10. KEY THINGS WHICH LIMITED THE SUCCESS OF LAND REFORMS

i. Snags in the legislation:

- **Definition of 'Personal Cultivation'** broadly led to large scale ejection of tenants.
- **Limits for retention of land for personal cultivation:** Intermediaries were allowed to retain substantial areas of land for personal cultivation. This enabled zamindars to resume large areas of land for cultivation defeating the entire purpose of abolition of zamindari system.
- **Transfer of land to family members:** To escape the law related to land ceiling there was large-scale transfer of land to family members. For quite some time there was no law in some states to prevent such transfers.
- **Definition of tenant inadequate:**
 - In some states, sharecroppers were kept out.
 - Further, considerable number of tenancies in India are oral and informal and these tenants are not protected under the law.
- **The problem of voluntary surrender:** Due to the dominant position of the landlord/zamindar
- **Inadequacies in ceiling laws:**
 - The list of exemptions were unduly large.
 - A lot of benami and clandestine transaction had taken place by then.

ii. **Lack of Political Will and determination** on the part of authorities

- Given the tardy progress of land reforms, it seems that governments were not interested in the implementation of the legislation enacted. The structure of grassroot democracy and huge influence of landlord class may have been a strong factor.

iii. **Apathy of Bureaucracy:**

- Most of the officials and bureaucrats also came from the landed class and thus they also sympathized with the landed class more. The rich peasant power not only dominated the state government but also the regional and local administration and serves as the principal instrument of land grabbing and as a strong impediment in the implementation of land reforms.

11. LAND LEASING REFORMS NEEDED TODAY

- **Past year Questions**
 - » In view of the declining average size of land holdings in India which has made agriculture non-viable for a majority of farmers, should contract farming and land leasing be promoted in agriculture? Critically evaluate the pros and cons [Mains 2015]
- **Background**
 - » Land leasing laws relating to rural agricultural land in India were overwhelmingly enacted during decades immediately following the independence.
 - Focus on **abolition of Zamindari and Redistribution of Land**.
 - Tenancy and Sub-Tenancy were seen as integral to feudal land arrangements and therefore **discouraged**.
 - » Therefore, state governments brought tenancy law reforms which
 - Focus on transferring ownership rights to tenant.
 - **Prohibited or heavily discouraged leasing** and sub-leasing
 - Imposed ceiling on rent (at 1/4th of the produce)
 - Provided tenant the right to purchase land after specified period of time.
- **Unintended Consequences of above laws**

» **Negative consequence for tenant**

- Contracts became informal and oral i.e. the above laws forced tenant underground. Almost 1/3rd of India's land may be under tenancy but only 10% is under formal mechanism.
- Tenants lost security of tenure

» **Negative Consequence for Owners**

- Felt insecure in leasing the land and thus chose to leave the land fallow. This became increasingly prevalent with landowners and their children seeking non-farm employment.
- As per official records (NSSO, 2012-13), only about 10% of agricultural land is under tenancy, down from 20% in 1953-54.

» **Negative Consequence for Agriculture sector**

- Lack of investment in the land
- Lack of credit availability to tenant farmers

» **Negative consequences for government policies**

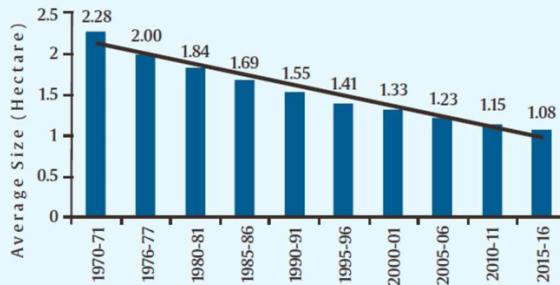
- **Crop Insurance** -> how to ensure that tenant who bears the bulk of the risk of cultivation receives the benefit
- **Disaster Relief** -> How to ensure actual cultivator gets the disaster relief.
- **Direct Benefit Transfer** for e.g. for Fertilizer subsidy
 - Difficulty in identifying real cultivators and therefore intended beneficiary. DBT cannot be satisfactorily implemented.

- **Other benefits which liberal land leasing would have**

- » **Difficulty in land acquisition** under the, 2013 land acquisition law, can be solved. States wishing to facilitate industrialization can benefit from liberal land leasing if they simultaneously liberalize the use of agricultural land for non-agricultural purposes.

- » **Decreasing landholding size** also requires that easy land leasing options should be available.

FIGURE 1: AVERAGE SIZE OF OPERATIONAL HOLDINGS AS PER DIFFERENT AGRICULTURE CENSUS



Source: Agriculture Census, 2015-16 and various issues of NSSO Reports

- **Model Agriculture Land Leasing Act, 2016**

- » The act seeks to permit and facilitate leasing of agricultural land to improve access to land by the landless and marginal farmers.
- » It also enables recognition of farmers cultivating on leased land to enable them to access loans through institutional credit.
- » **Key Provisions**

- Ownership rights protected
- Right of tenant to cultivate the land for the leased period protected
 - Tenant eligible to raise loans without mortgaging the leased in land
 - Entitled for compensation from owner for any improvement investment on land.
- Ban on sub-leasing -> to prevent misuse

- **Way Forward**

- » The introduction of transparent land leasing laws that allow the potential tenant or sharecropper to engage in written contracts with landowner is a win-win reform.
 - Long term investment
 - Landowner would not be apprehensive of losing the land
 - Government will be able to implement its policies efficiently
 - Will ensure availability of land for landless and small and marginal farmers.
- » A potential hurdle to the land leasing reform laws is that landowners may fear that a future populist government may use the written tenancy contract as the basis of transfer of land to tenant and therefore would oppose the reform.
 - This is a genuine fear and may be addressed by give landowners indefeasible titles.
- » **State governments must seriously consider revisiting their leasing (and land use) laws** to determine if they could bring about the simple but powerful changes provided in the Model Agricultural Land Leasing Act, 2016 to enhance productivity and welfare all around.

12. CONTRACT FARMING

- **Example Questions**
 - » "In spite of many advantages associated with contract farming, the practice is not very popular in India" Give reasons. [10 marks, 150 words]
 - » Critically analyze the provisions of the Model Agriculture Produce and Livestock Contract Farming and Services (Promotion and Facilitation) Act, 2018. [15 marks, 250 words]
- **Introduction**
 - » Contract Farming refers to a system of farming, in which bulk purchasers including agro-processing/exporting or trading units enter into a contract with farmer(s), to purchase a specified quantity of any agricultural produce (including livestock and poultry) at pre-agreed prices.
 - » Studies by Food and Agriculture Organization (FAOs) show that contract farming can indeed benefit both parties by increasing efficiency, productivity and farmer's income, while at the same time giving private player a larger say in farming methods, type and quality of produce.
- **Advantages of Contract Farming**
 - » **For Buyers** it ensures quality product availability and price stability.
 - » **For producers** it reduces the risk of fluctuation in market price and demand. Research have shown that contract farmers earn considerably more than non-contract farmers.
 - » **Increases private participation** in agricultural reforms.
 - » Contract farming also **improves the quality of input** as the producer get support from the buyer in the form of technology, pre-harvest and post-harvest support etc.
 - » It **reduces the subsidy burden** on government on procurement.

- **Situation in India**
 - » Despite the above advantages, the Contract farming is not very common in India.
 - » The 2003 model law provided for contract farming, but it suffered from various limitations including APMCs being designated as authority of registration and dispute; provisions for stockholding limits on produce limited the participation by bigger players and finally poor awareness/publicity about contract farming and its benefits among farmers.
 - » **2018 Model Law** tried to bring some changes but wasn't very effective.
 - » **2020 Ordinance and law** - withdrawn in 2021
 - This law tried to bring some simplification and protection for farmers, but had to be withdrawn because of farmer protests.

- **Conclusion**
 - » While contract farming, if implemented wisely, does have the potentials to alleviate the sufferings of India's farmers, improved yields, and greater technology transfer, it is imperative that the state government takes a cautious, research backed approach and implements the model law with modifications suitable for the state.

13. LAND POOLING POLICY

- **Example Question**
 - » "A transparent and well regulated Land Pooling system has the potential to solve the problems associated with the current Land Acquisition Framework" Critically Analyze [15 marks, 250 words]
- **Background**
 - » India is a country with high population density and huge land scarcity. Therefore, land acquisition is slowly becoming more and more difficult and it is hindering developmental activities. Further, the land acquisition system had also become unpopular due to complaints of low compensation and forceful acquisition. The system of land pooling comes as a ray of hope in this scenario to ensure that the developmental activities are not hindered and the original land owners are also satisfied.
- **What is Land Pooling?**
 - » Under Land Pooling Policy, a development agency pools land parcels owned by individuals, a group of owners or a builder. Then it develops the land and returns a part of it to the original owners. In this way, the land is made available for development work and a part of developed land returned to owner is worth more than the original value of the land, thus satisfying the original owners.
- **Advantages of Land Pooling Policy**
 - » **Unlocking huge parcel of land for development** -> Land Acquisition is becoming unattractive for people and this may appear as an alternative and attractive option.
 - This would also contribute to reducing stress on already developed area and may also restrict price escalation in these areas.
 - It thus emerges as an **transformative step for urbanization**.
 - » It also **promotes public-private partnership and trust** -> this is due to wider community participation in the whole process of land pooling, development and return of ownership.

- » **Aggregates small land piece** for bigger projects. This leads to more efficient utilization of land.
- » **Reduced initial cost for development authority** -> As there is no need of buying the land for the developmental projects
- » **Less conflict ridden** as is the case of Land Acquisition due to inadequate compensation, consent, process etc.
- » **Original Owners** will also be benefitted as the land returned to them, though smaller in size, have access to infrastructure and services which increases the value of the land drastically. Further, the landowners are not displaced in the land pooling scenario.

- **Concerns**

- » **Poor System of land records** can be concern here. As participation in land pooling is dependent on the owner having proper land ownership documents.
- » In case of pooling for Amravati even **fertile agricultural land** was also pooled.
- » Unlike land acquisition, the provisions for the **social or environmental impact assessment is absent** in case of land pooling. Therefore, the impact on landless laborers and on environment are generally ignored or very meagre compensation is paid to landless workers.
- » There have been instances of mandatory land pooling. For e.g. in case of Navi Mumbai Airport Land Pooling, the pooling was made mandatory because of the delays in the process.

- **Way Forward**

- » There is a need of a **transparent regulatory frameworks with statutory backing** to ensure that the land pooling process is transparent, consensual and doesn't use agricultural or environmentally sensitive zones. Further, this framework should also provide for mandatory social and environmental impact assessments before the beginning of the developmental work.

- **Conclusion**

- » Land Pooling if done on non-agricultural land (for e.g. in urban villages) and along with social and environmental impact assessments, can emerge as a tool of transformative urban development which is beneficial for all the three parties i.e. the land owners, the private sector and the government. Land owners get better value and better quality of land, private players are able to participate in commercial and developmental process and the government is able to facilitate development.



CURRENT AFFAIRS PROGRAM

PRE-CUM-MAINS 2024

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TABLE OF CONTENTS

1. General Studies – 2	1
1) Sedition	1
2. General Studies – 3	6
1) Economy: Foreign Trade Policy, 2023.....	6
2) Economy: Foreign Trade Policy, 2023 and e-Commerce	8
3) Economy: Foreign Trade Policy, 2023 and Districts as Hub of Exports	9
4) S&T: Space: NAVIC and NVS-01.....	10
A) Basics About SATNAV	10
B) Global Positioning System (GPS)	11
C) BeiDou	11
D) NAVIC (Navigation using Indian Constellation)	12
3. Prelims Facts	15
1) Places in News: Kafue National Park (Zambia)	15
2) Places in news: Nova Kakhovka Reservoirs (DAM):	15
A) Ukraine	16
3) S&T: Defence: ‘Fattah Missile’	18
4) Biodiversity: Black Veined Butterfly.....	18
5) Biodiversity: Mahua (Madhuca Indica)	19

1) SEDITION

- **Why in news?**
 - The 22nd Law Commission has recommended that Section 124A of the Indian Penal Code (IPC) dealing with offence of sedition be retained and that the minimum jail term for the offence be enhanced from three to seven years (June 2023)
- **Example Questions**
 - Discuss the provisions and scope of Section 124A of the Indian Penal Code (IPC) pertaining to sedition. Examine its constitutionality in light of freedom of speech and expression [15 marks, 250 words]
 - In light of the recent report by 22nd Law Commission of India, evaluate the need for legislative reforms or amendments to the sedition law in India [10 marks, 150 words]
- **Intro**
 - **Definition:** Conduct or speech inciting people to rebel against the authority of a state or monarch can be considered as sedition.
 - **Section 124A of IPC** defines sedition as "any action whether by words, signs or visible representation which brings or attempts to bring into hatred or contempt, or excites or attempt to excite disaffection towards the Government established by law in India". The section also contains a clarification to the effect that the word "disaffection" includes disloyalty and all feelings of enmity.
 - Under this section, Sedition is punishable with imprisonment for life.
- **Evolution of Sedition Law from the beginning**
 - Not a part of original IPC enacted in 1860.
 - Added a decade later as fears of possible uprising plagued the colonial authorities.
 - Note: Other laws to suppress dissent at that time -> Dramatic Performance Act, 1876 and the Vernacular Press Act, 1878.
 - **The British India government liberally used this provision** during India's freedom struggle to suppress any kind of dissent.
 - **Constituent Assembly:** An attempt to include sedition as an express ground for limiting speech under Article 19(2) was successfully resisted.
 - The law was in a way reimposed in 1951 through First Constitutional Amendment which added two expressions - "friendly relations with foreign state" and "public order" - as grounds for imposing "reasonable restrictions" on free speech.
 - A **Constitutional Bench of the Supreme Court upheld** the validity of Section 124-A in the celebrated case of **Kedar Nath Singh vs. State of Bihar in 1962** but at the same time **attempted to restrict the scope of its misuse**.
 - The Court upheld the right to comment in strong terms upon the measures or acts of **government** and laid down that that a person can be charged with **sedition only if there is incitement to violence in his speech or writing or an intention or tendency to create disorder or disturbance of law and order**.

- The court said "A citizen has a right to say or write whatever he likes about the Government, or its measures, by way of criticism or comment, so long as he does not incite people to violence against the Government established by law or with the intention of creating public disorder"
- In the **Menaka Gandhi** case of 1978, the Supreme Court held that criticizing and drawing opinion against the government's policies and decisions within a reasonable limit that does not incite people to rebel is consistent with the freedom of speech.
- **Inspite of these Supreme Court verdicts**, the law continues to be misused.
 - NCRB report says 356 cases of sedition under Section 124A of the IPC has been registered and 548 people arrested between 2015-2020, with just six convictions.
- **The supreme court** has to pitch in regularly to protect citizen's freedom of speech being suppressed by the sedition law. For e.g.
 - In March 2021, while hearing a plea to "terminate" the Lok Sabha membership of Dr. Farooq Abdullah and book him for sedition, the court held that voicing dissent against government doesn't amount to sedition.
 - In June 2021, a two-judge bench of the Supreme Court quashed a sedition case registered against journalist and Padma Shri awardee Vinod Dua for his critical remarks against the Prime Minister and Union government in a YouTube telecast.
- **Analysis: Criticism**
 - » Too Broad and vaguely worded definition is used to suppress liberty of citizens and Criminalize dissent.
 - This vagueness was misused to suppress dissent and imprison freedom fighters such as Mahatma Gandhi and Bal Gangadhar Tilak who criticized the policies of the colonial administration.
 - This reduces government accountability as the government is able to ignore its critics and in turn charge them with sedition.
 - » Very strict nature of the law - non-bailable, cognizable and punishment that can extend to life - has a strong chilling effect on free speech and dissent.
 - Note: "**Doctrine of Chilling Effect on Speech** considers the probability of a legal provision causing psychological barriers in the free exercise of the right"
 - Critics of the sedition law argue that this doctrine was not sufficiently developed in 1962 and thus the Kedarnath Singh Judgment should be revised.
 - E.g. After Hathras gang rape case 22 sedition cases were filed. "Vinod Dua" - a journalist was charged with sedition for criticizing governments activities during COVID-19 lockdown.
 - » **Scope of misuse of Law as Political Tool:**
 - Gandhi had said "*Section 124-A under, which I am happily charged, is perhaps the prince among the political sections of the IPC designed to suppress the liberty of citizen*".
 - More than 20 cases were filed under sedition law after the CAA protests.

- » Trial Courts have mostly ignored the 1962 Supreme Court Judgment and have imposed the law even in cases where there was no incitement to violence or attempt towards public disorder.
 - » Sedition is not one of the grounds for reasonable restrictions on free speech provided under Article 19(2).
 - » Law commission of India in a consultation paper, in Aug 2018 observed that berating the country or a particular aspect of it cannot be treated as “sedition” and the charge can only be invoked in cases where the intention is to overthrow the government with violence and illegal means.
 - » UK, which introduced sedition in India, have also abolished it.
 - In fact, in March 2023, even Lahore High Court in Pakistan annulled the offence of 'Sedition' in the Pakistan Penal Code.
 - » Our Criminal law is equipped with other provisions to deal with most of the violations as defined right now under sedition
- **Support of the law**
- » Supreme court has upheld constitutionality of the law. Without sedition, the state would be in jeopardy if the government was subverted.
 - » Law itself might not be problematic, but its implementation is.
 - » Misuse of the law doesn't invalidate it.
 - » Country faces many threats - Terrorism, Naxalism, Enemy states etc. and thus a strong law preventing incitement of violence against state is important to protect unity and integrity of the country.
- **Supreme Court puts the Sedition Law on Hold (May 2022)**
- » A three-judge bench of the Supreme Court has suspended pending criminal trials and court proceedings under Section 124A (sedition) of the IPC till the Centre completes its exercise in re-examining its provisions.
- **22nd Law Commission of India on Section 124A of IPC: Key Recommendations:**
- » The commission recommended that the law should not be repealed but it should be retained with some changes.
 - Why?
 - A necessary legal instrument in the face of threats to India's Internal Security including Maoism, Militancy, secessionist movements etc. The report also quotes NSA Ajit Doval on wars against Invisible Armies, and on a "civil society" that can be subverted, divided and manipulated to hurt the interest of the nation.
 - Allegation of misuse don't automatically justify the repeal of the Section 124A.
 - Further, in the absence of provisions like Section 124A of IPC, any expression that incites violence against the government would invariably be tried under special laws and counter-terror legislation, which contain much more stringent provisions to deal with the accused.
 - While any alleged misuse of section 124A of IPC can be reined in by laying down adequate procedural safeguards, repealing the provisions altogether can have "serious adverse ramifications for the security and integrity of the country", while the subversive forces getting a free hand to further their sinister agenda as a consequence.

- » It has recommended that the **following amendments be made to Section 124A of IPC:**
 - **Include the Kedarnath ruling into the provisions of the law** by adding the words "with the tendency to incite violence or cause public disorder". The report also defines the tendency to incite violence as a "mere inclination to incite violence or cause public disorder rather than proof of actual violence or imminent threat to violence".
 - **Enhancing the imprisonment for sedition** to "remove an oddity"
 - One of the criticisms against the provision is that it **leaves judges with wide discretion on sentencing**.
 - Section **124A has a jail term of up to three years or life imprisonment**. It means either imprisonment for life or imprisonment upto three years only, but nothing in between.
 - The **law commission** has now proposed enhancing the jail term upto seven years or life imprisonment.
 - **To prevent the misuse of the law**, the report suggested including a procedural safeguard that no FIR shall be registered for sedition "unless a police officer, not below the rank of inspector, conducts a preliminary inquiry and on the basis of the report made by the said police officer the Central Government or the State government, as the case may be, grants permission for registering a FIR.
 - Other general suggestions:
 - The police should not use Section 124A to stifle dissent or criticism of the government.
 - The courts should interpret Section 124A narrowly and should not convict a person under this section unless there is clear and convincing evidence that the person has committed the offence.

- **Analysis: Criticism:**

- These recommendations are a step backwards.
 - The Supreme Court in May 2022 had stayed the law and expressed strong reservation and indicated that it could hear arguments in favor of striking down the colonial provision that has proved to be prone to misuse.
 - The report doesn't engage seriously enough with criticism of the sedition provision, including concerns expressed by the Supreme Court.

- **Way forward**

- **Parliament** should do an exhaustive re-examination of the law to determine if it will be appropriate or not to continue the usage.
- **Clarifications given by Supreme Court in Kedarnath case and Law Commission of India should be strictly followed** - "section 124A applies only when there is violence or incitement to violence"

against government". These provisions should be introduced through an amendment to the bill as suggested by 22nd Law Commission of India.

- Simplify the definition to prevent its misuse for curbing dissent and for political reasons.
- Reduce the severity of the law - make it bailable, non-cognizable etc.
- A sign of mature republic is its willingness to stand up to scrutiny by its citizens and accommodate dissent and criticism of the government should not be construed as sedition.

- **Conclusion1 (Supporting the law)**

- The word sedition is extremely nuanced, and the law needs to be applied with caution. It should only be used against serious cases which involves provocation to raise arms against government, demand for separate country etc. But, the legal system needs sedition provision (with some amendments), mostly to act as a deterrent, and on occasion to use against serious offenders.

- **Conclusion2 (Critical of the law)**

- Personal Liberty and Right to Free Speech are hallmarks of liberal democracy and sedition laws and their gross misuse attack the very foundation of these liberties enshrined in the Indian Constitution. The need of the hour requires the judiciary to review the colonial law.
- Even if abolishing of the law is not feasible, it should be toned down and string guidelines should be issued to limit its indiscriminate abuse of the law. This will not only help India's democratic standing but would also safeguard freedom of expression in the country.

1) ECONOMY: FOREIGN TRADE POLICY, 2023

- **Why in news?**
 - » On 31st March 2023, Ministry of Commerce and Industry announced India's Foreign Trade Policy 2023 and it came into force from 1st of April 2023.
- **Example Questions:**
 - » What are the key objectives of India's Foreign Trade Policy, 2023? Highlight some of the challenges to the implementation of this policy. Suggest measures to make this policy more effective in boosting India's exports [15 marks, 250 words]
- **Introduction:**
 - Foreign Trade Policy (FTP) refers to a set of guidelines, regulations and measures formulated by a government to govern its international trade.
- **FTP, 2023** is a policy document which is based on continuity of time tested schemes facilitating exports as well as a document which is **nimble and responsive** to the requirements of trade.
- **The Key Approach** to the policy is based on these **4 pillars**:
 1. Incentive to Remission
 2. Export Promotion through collaboration - Exporters, States, Districts, Indian Missions
 3. Ease of Doing Business, reduction in transaction cost and e-initiatives.
 4. Emerging Areas - E-commerce, Developing Districts as export Hubs and **streamlining SCOMET Policy**.
 - Note: SCOMET stands for Special, Chemicals Organisms, Materials, Equipment, and Technologies (SCOMET) policy.
- **Key Aims and Objectives** of India's FTP, 2023 are:
 - » Boost India's exports to USD 2 trillion by 2030.
 - » Strengthen India's export competitiveness.
 - » Diversify export basket, expand export market, and promote sustainable exports.
 - » Focus on promoting exports from small and medium enterprises (SMEs). For this policy envisages support in the form of access to finance and markets.
 - » Provide incentives for exporters, including duty drawback, export promotion capital goods (EPCG) scheme, and interest subvention schemes.
 - » Encourage collaboration between exporters, states, and districts to promote exports.
 - » Simplify and streamline the process of exporting goods and services:
 - » Focus on emerging areas of export, such as e-commerce, green technology, and defence and aerospace. These are the areas where India has a competitive advantage, and the policy aims to help businesses take advantage of these opportunities.
- **The Policy aims to boost India's exports through several measures:**
 - » Process Re-engineering and Automation (technology enablement) for facilitating exporters.

- » **Expanding the scope of Town of Export Excellence (TEE)** by including Faridabad, Mirzapur, Moradabad and Varanasi in the existing list of 39 towns listed as Towns of Export Excellence (TEE).
 - **Note:** Under this scheme recognised associations of units are provided financial assistance under the Market Access Initiative Scheme on a priority basis, for export promotion projects for marketing, capacity building and technological services, and to visit various trade exhibitions/fairs for exploring more marketing avenues
- » **Promoting Exports from districts** by building partnerships with state government and taking forward the District as Export Hubs initiative to promote exports at the district level.
 - Institutions like State Export Promotion Committee and District Export Promotion Committee will identify export worthy products and services.
 - District specific export action plans will be prepared for each district.
- » A robust export control system in India would provide access of dual use High end goods and technologies to Indian exporters while facilitating exports of controlled items/technologies under **SCOMET** (Special Chemicals, Organisms, Materials, Equipment, and Technologies) from India.
- » **Facilitating E-Commerce Exports** through establishment of e-commerce hubs and other related elements.
 - The consignment wise cap on E-commerce exports through courier has been raised from Rs 5 Lakh to Rs 10 lakh.
 - A comprehensive e-commerce policy addressing export/import ecosystem is planned to be brought soon.
- » **Export Promotion of Capital Goods (EPCG) Scheme** has been rationalized.
 - Prime Minister Mega Integrated Textile Region and Apparel Parks (PM MITRA) scheme has been added as an additional scheme eligible to claim benefits under CSP(Common Service Provider) Scheme of Export Promotion capital Goods Scheme(EPCG)
 - Battery Electric Vehicles (BEV) of all types, Vertical Farming equipment, Wastewater Treatment and Recycling, Rainwater harvesting system and Rainwater Filters, and Green Hydrogen are added to Green Technology products – will now be eligible for reduced Export Obligation requirement under EPCG Scheme.
- » **Introduction of provisions for merchanting trade.**
 - **Note:** Merchanting trade involves shipment of goods from one foreign country to another foreign country without touching Indian ports, involving an Indian intermediary.
- » **Amnesty Scheme** to provide relief to exporters who have been unable to meet their obligations under EPCG and Advance Authorization schemes. This will reduce litigations and foster trust based relationship.

- **Challenges:**

- » **Global Economic Uncertainty:** The global economy is facing a number of challenges, including the COVID-19 pandemic, the Russia-Ukraine war, and rising inflation. These challenges could impact India's exports, as they could lead to lower demand for Indian goods and service.
 - » **Competition** from other emerging economies : Countries like China, Vietnam etc are also competing to increase its export base and may become a hurdle in India's achievement of its export targets
 - » **Domestic challenges** such as infrastructure bottleneck, regulatory hurdles, lack of skilled workforce and high cost of logistics may also become a hindrance to India's exports.
- **Way Forward:**
- » **Increased government support** to exporters in the form of access to finance and market.
 - » **Improvement in infrastructure** such as roads, railways, airways etc for easier and faster export of goods and services.
 - » **Streamlined regulations** related to customs and taxation.
 - » **Increased investment in R&D** for development of innovative products and services fulfilling the global demands.
 - » **Promoting Brand India** in global market. This will attract foreign buyers and increase demand for Indian goods and services.
- **Conclusion1:**
- » Overall, the Foreign Trade Policy 2023 is a comprehensive and ambitious document that has the potential to boost India's exports and promote economic growth. Though, it faces some challenges, but with strong political will, and collaboration with various stakeholders, these challenges could be overcome.
- **Conclusion2:**
- » The new FTP is a shift from an incentive based approach and creates an enabling ecosystem for exporters, which is a move in line with India's vision of becoming 'Atmanirbhar' (self-reliant).

2) ECONOMY: FOREIGN TRADE POLICY, 2023 AND E-COMMERCE

Question: "The Foreign Trade Policy, 2023 approaches digitally enabled cross-border trade in an inclusive manner and seeks to make small players part of India's exports" Elaborate [10 marks, 150 words]

- **Introduction:**
- » India's e-commerce market is one of the largest in the world. It has been made possible due to increase penetration of smart phones, internet and digital payment systems. However, when it comes to e-commerce exports, it accounts for only a very small fraction of India's total exports.
 - » But, FTP, 2023 looks to change this and increase India's e-commerce exports by enabling vendors to access the international markets.
- **Key provisions related to e-commerce in FTP, 2023**
- » The new section on 'Promoting Cross Border Trade in Digital Economy' gives a fillip to e-commerce exports in the following ways:
 - Extending all FTP benefits to e-commerce exports
 - Increasing the value limit for exports through couriers to INR1,000,000 per consignment

- Promoting e-commerce through the **postal routes**: Government aims to operationalize '**Dak Niryat Kendras**' to "work on a hub and spoke model with Foreign Post Offices (FPOs) to facilitate cross border e-commerce and to enable artisans, craftsmen and MEMEs in the hinterland to reach international market.
- The policy also proposed to create E-Commerce Export Hubs (ECEHs), which would act as a centre for favourable business infrastructure and facilities for cross border e-commerce activities. These hubs would provide the necessary infrastructure for exports, and also connect to and leverage the services of the nearest logistics hubs.
- **Handholding and outreach schemes** to small players on how to use e-commerce platforms effectively.

- **Conclusion:**

- E-commerce platforms for exports can serve as a democratized marketplace that allows small vendors, MSMEs, and local artisans to access international market and retain higher profit margins. This will not only boost India's exports but will also lead to inclusive growth and development.

3) ECONOMY: FOREIGN TRADE POLICY, 2023 AND DISTRICTS AS HUB OF EXPORTS

Ques: Discuss the role of Foreign Trade Policy 2023 in galvanizing districts of the country to become export hubs [10 marks, 150 words]

- The Foreign Trade Policy, 2023 was launched with the goal of boosting exports to the USD 2 trillion by 2030. Towards achieving this goal, one of the sections of the FTP aims to galvanize districts of the country to become export hubs.
- It is being done in the following ways:
 - **Identifying products and services** with export potential in the district
 - The policy proposes to do so by creating District Export Promotion Committees (DEPC) and creating District Export Action Plans for each district.
 - The interventions at the district level can generate awareness and help small vendors to access bigger markets.
 - Further, steps such as promotion of exports through e-commerce and promotion of exports from MSME will also contribute to development of small towns and districts as export hubs.
 - Lastly, the FTP has declared four new 'Towns of Export Excellence' (TEE)[Faridabad-Apparel, Moradabad-Handicraft, Mirzapur - Handmade carpet and Dari, Varanasi - Handloom and handicraft] [in addition to existing 39 TEEs] with the objective of moving up the value chain and tapping into new markets.
- These initiatives are thus in sync with the spirit of '**Local goes Global**' and '**Vocal for Local**'. But to make these initiative successful, it is important to focus upon:
 - Improving export infrastructure and regulations in every district and town.
 - Studying global quality standards and bringing Indian standards in sync with global standards

- Take a few more points for way forward from the main FTP Article.

4) S&T: SPACE: NAVIC AND NVS-01

- Why in news recently?
 - ISRO's GSLV-F12 successfully places navigation satellite NVS-01 into intended orbit (May 2023)
- Example Questions
 - What do you understand by 'Standard Positioning Systems' and 'Precision Positioning Systems' in the GPS era? Discuss the advantages India perceives from its ambitious IRNSS program employing just seven satellites [Mains 2015, 12.5 marks, 200 words]
 - Why is Indian Regional Navigational Satellite System (IRNSS) needed? How does it help in navigation? [Mains 2018, 10 marks, 150 words]
 - What is satellite navigation? Discuss the key economic and social uses of Satellite navigation. [10 marks, 150 words]

A) BASICS ABOUT SATNAV

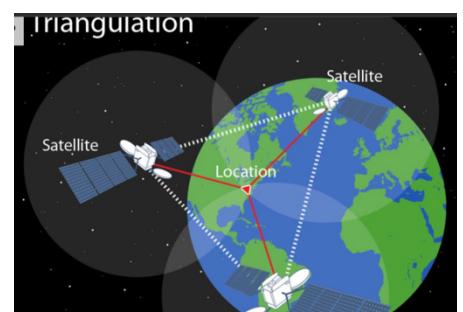
- A satellite navigation (SATNAV) system is a technology that allows users to determine their precise location, velocity, and time information anywhere on or near Earth's surface.
- It uses a network of satellite in space and provide accurate positioning data.
- Currently, there are four global satellite-based navigation system – the American GPS, the Russian GLOASS (GLObalnaya NAvgatsionnaya Sputnikovaya Sistema), the European Galileo and the Chinese BeiDou.
- India has a regional system called NavIC and Japan has Quasi Zenith.

- Methods used in SATNAV: Triangulation and Trilateration

Triangulation: Satnav systems use a technique called triangulation to determine the precise location of a receiver on the Earth's surface.

It is a geometric method that uses the angles formed by lines connecting the receiver to multiple satellites to determine the receiver's position.

By measuring the time it takes for signals to travel from multiple satellites to the receiver, the system can calculate the receiver's position based on the intersection of the satellite signals



Trilateration: GPS receiver use the method of trilateration. Trilateration involves measuring the distance between your GPS receiver (e.g. a smartphone) and multiple satellite in the network. Each GPS satellite broadcasts a signal that includes a timestamp and information about its location. Our GPS receiver picks up these signals and use the timestamp to calculate the distance between itself and each satellite.

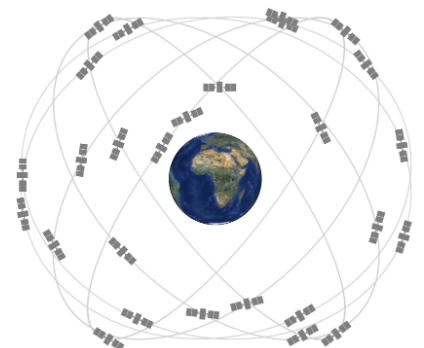
Using the distance from at least four satellites and their known positions, your GPS receiver performs calculations to determine your precise location on earth.

[Please note that GPS doesn't use triangulation (which measure angles), they really don't use angles at all].

- **Accuracy:** They generally provide high levels of positioning accuracy (within a few meters), depending on the quality of receiver and the number of satellites in view. However, various factors such as signal obstruction, atmospheric conditions, and receiver limitations can affect the accuracy.
- **Applications: Navigation purposes** -> helping users find their way while driving, hiking, or boating. It is also used in aviation, surveying, geolocation-based services, precision agriculture, and even in some outdoor recreational activities. It can be used for vehicle tracking, fleet management, precise timing etc.

B) GLOBAL POSITIONING SYSTEM (GPS)

- The best-known satnav system, GPS, uses 24 active satellites (including backups). Day and night, 365 days a year, they whiz around earth once every 12 hours on orbital plane inclined 55 degrees to the equator.
- Wherever you are on earth, you are in sight of at least half a dozen of them, but **you need signals from 3 or 4 satellites** to determine your position with an accuracy of just a few meters.
- **How GPS Finds your location?**
 - It uses **Trilateration**
- **GPS Constellation arrangement**
 - » GPS constellation fly in medium earth orbit (MEO) at an altitude of approx. 20,200 kms. Each circle orbits the earth twice a day.
 - » The satellites are arranged in six equally placed orbital planes surrounding the earth. Each plain contains four slots occupied by baseline satellites. This 24-slot arrangement ensures users can view at least four satellites from virtually any point on the planet.



C) BEIDOU

- **Details**
 - China initiated Beidou in 1994 with first BeiDou satellite launched in 2000.
 - **Second generation BeiDou (BDS-2)** provided coverage to Asia Pacific region starting in 2012.
 - **Third generation BeiDou (BDS-3)** satellite deployment started in 2015 and it started providing navigation services in 2018 to countries taking part in BRI. In 2020, the system has been completed and it can now provide global services. With this they have joined United States' GPS and Russia's GLONASS in providing global PNT services, with Europe's Galileo to follow. These are all compatible and interoperable, meaning users can draw services from all of those to improve accuracy.
- **Satellite Constellation**

- **24 satellites in Medium Earth Orbit** (around 21,500 kms above the earth) provide the positioning, navigation, and timing (PNT) services. These satellites use rubidium and hydrogen atomic clocks for highly-accurate timing that allows precise measurement of speed and location.
- **Satellites in geosynchronous Orbit** (including Geo-stationary orbit) help BeiDou provide short messaging service through which 120-character messages can be sent to other BeiDou receivers.

- **Plans of Expansion:**
 - In Nov 2022, China outlined plans to further expand the global reach of its home grown BeiDou satellite navigation system.
 - a. **Pakistan** in 2014 became the first foreign country to set up a BeiDou network.
 - b. **BeiDou** has set up a first of three Continuously Operating Reference Stations (CORS) for its network in Thailand in 2013, to serve as a hub for ASEAN.

D) NAVIC (NAVIGATION USING INDIAN CONSTELLATION)

- Indian Regional Navigation Satellite System (IRNSS) (also called Navigation Using Indian Constellation (NAVIC)), is a regional satnav system developed by ISRO. It aims to provide reliable position, navigation and timing (PNT) services over India and its neighbourhood, upto 1500 km from its boundary. In addition it is also capable of broadcasting messages. This can be used for broadcasting safety-of-life alerts in areas with poor or no communication, particularly in Ocean.

- **Need of IRNSS** when services like GPS are easily available.
 - The access to foreign controlled global navigation satellite systems is not guaranteed in hostile situations, as happened to Indian military depending on American GPS during **Kargil War**.

- **NAVIC provides two types of services:**
 - » **Standard Positioning Service** (Open for Civilian Use)
 - » **Restricted Services** (Encrypted one, for authorized users (military))

- **Components of IRNSS System:**
 - » Space segments consists of **7 satellites, 3 satellites in GEO stationary orbit (GEO) and 4 satellites in GEO synchronous orbit(GSO)** with inclination of **29 degree** to the equatorial plane.
 - » All the satellites will always be visible in the Indian region.



- » **First of the 2nd generation satellite – NVS-01** was successfully launched in May 2023
 - ISRO's **GSLV F12** (GSLV-MK-II mission) successfully places navigation satellite NVS-01 into intended orbit.
 - **About GSLV F12:**
 - » It is the 15th flight of India's GSLV and the 9th flight with indigenous cryo stage.
- **About NVS-01:**
 - » **Heavier:** It weighs 2232 kg and has been placed in geosynchronous orbit (older IRNSS satellites weighed 1,425 kg)
 - » **Indigenous Atomic Clock:** For the first time, the satellite carries an indigenous atomic clock. The space qualified Rubidium atomic clock has been indigenously developed by Space Application Centre – Ahmedabad.
 - » **L1 signals for better use in wearable devices:** The second generation satellites have send signals in a third frequency, L1, besides the L5 and S frequency signals that the existing satellites provide. This will increase operability with other satellite based navigation systems. L1 frequency is the most commonly used in the GPS and will increase the use of NavIC in wearable devices which use low power signal frequency chip.
 - » **Longer Mission Life** of 12 years (earlier NavIC satellites have a mission life of 10 years).
- **Criticism of NaVIC:**
 - **Delay in developing user receiver:** A 2018 report by the CAG of India has said that even though the cabinet cleared funding of Rs 200 crore to develop user receivers in 2006, work on the project started only in March 2017, by which time seven launches of NavIC was already done.
- **Current Situation (June 2023)**
 - The receivers have now been deployed, and NavIC is in use for projects like public safety, power grid synchronization, real-time train information system, and fishermen's safety.

- Other upcoming initiatives (such as) common alert protocol based emergency warning, time dissemination, geodetic network, unmanned aerial vehicles are in the process of adopting NavIC system.
- Some cell phone chipsets build by Qualcomm, MediaTek integrated NavIC receivers in 2019. Some example phones which are NavIC enabled include Redmi Note 9, realme 6, the OnePlus Nord etc.

- **Way Forward:**

- **Promoting the Use of IRNSS:**
 - **NavIC** chip -> affordable
 - **Spreading awareness** -> Positional accuracy better than 20 m and timing accuracy better than 50 ns (20);
 - **Make compulsory for** phones marketing in India: Mobile phones haven't been made compatible to process its signals.
 - **Government apps** -> start using NavIC for various purpose.
 - HEIs -> Promote use in Labs, among students etc.
- **Fast track** the plans for making NavIC global
- The next generation NVS series of satellites will make the NavIC more versatile and promote ease of use.

3. PRELIMS FACTS

1) PLACES IN NEWS: KAFUE NATIONAL PARK (ZAMBIA)

Kafue National Park: Lion and Leopard populations have begun rebounding in Africa's **third** largest national park - **Zambia's Kafue National Park (KNP)** -after fifty years of poaching, according to a new report from **Panthera**, the global wild cat conservation organizations, and partners.

Factors:

1. **Counter Poaching Operations:** Game changing conservation technologies like **SMART** (Spatial Monitoring and Reporting Tool) and **EarthRanger** were employed in these operations.
2. **Effective Prosecution**
3. Distribution of **synthetic 'heritage Furs'** replacing garments made of authentic leopard and lions skin

Other details about KNP: KNP sits within the **Kavango Zambezi Transfrontier Conservation Area (KAZA)**, the largest terrestrial conservation landscape in the world spanning five countries (**Angola, Botswana, Namibia, Zambia, and Zimbabwe**)



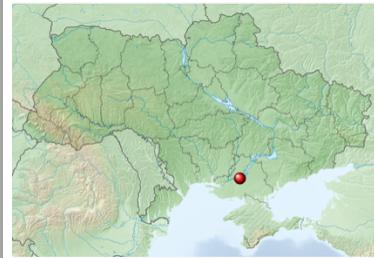
2) PLACES IN NEWS: NOVA KAKHOVKA RESERVOIRS (DAM):

Nova Kakhovka Reservoir (DAM):

The Kakhovka Dam was a dam on the **Dnieper River** (also known as Dnipro) in **Kherson Oblast**, Ukraine. It is a **soviet era** dam and was **destroyed** in June 2023.

This breach has **unleashed flood water in the war zone**. Both, Ukraine and Russia have conflicting accounts on who destroyed it.

This Dam is part of **Kakhovka** hydro-electric power plant. It supplies water to **Crimean Peninsula**, which Russia annexed in 2014, and to the **Zaporizhzhia nuclear power plant**, which is also under Russia control.



Location of Kakhovka Dam in Ukraine

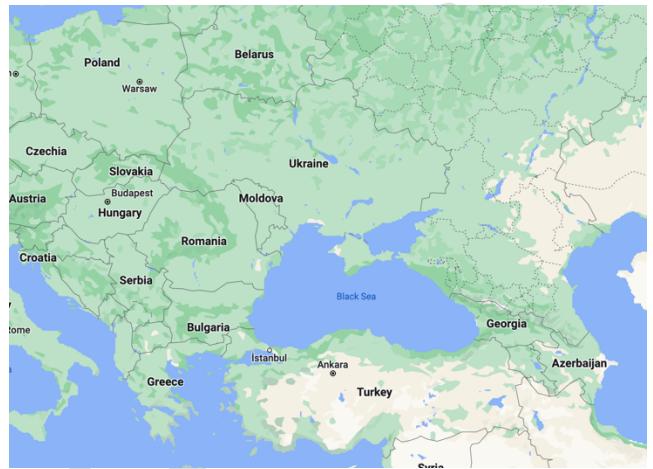


The Zaporizhzhia Nuclear Power Plant is the largest nuclear power plant of Europe. It gets its cooling water from Kakhovka Reservoir. It is located on the southern side, now under Russia control.

A) UKRAINE

Geographical Details

- Ukraine is a country in Eastern Europe. It is the second largest country in Europe after Russia.
- **Neighbours:** It shares its borders with Hungary, Slovakia, Poland to the West, Belarus to North, Russia to North, Northeast and East and Moldova and Romania to the South.
 - **Trick:** Hungry, Slow, Polar, Bear of Russia are Roaming in Moldova.
- **Coastline:** the country has coastline along the sea of Azov and Black Sea.



Recent Political Events:

- Ukraine gained its independence in 1991 after dissolution of Soviet Union. Ukraine declared itself a neutral state, forming limited partnership with both Russia and NATO.
- In 2014, Kremlin leaning Ukrainian President Viktor Yanukovych rejected an association with the European Union (EU) in favor of close ties with Moscow. This resulted in a series of protests across Ukraine, ending with Yanukovych's removal from power the same year.
- Mass protests and demonstrations known as the Euromaidan erupted, escalating into the Revolution of Dignity that led to the establishment of new government. These events led to Russia annexing Crimea and a war in Donbas against Russian backed separatists, culminating in Russian invasion of Ukraine in 2022.

Donbas Region

The Donetsk and Luhansk region of Ukraine is collectively called the Donbas.

Strategic significance of Donbas region: Donbas can act as a corridor between Russia and Crimea (and by extension, the strategically significant port of Sevastopol).

The population of this region is more Pro-Russia and thus a war has been going on since 2014 against Russia-backed separatists in the region.



On 21st Feb 2022, Russia officially recognized the DPR (Donetsk People's Republic) and LPR (Luhansk People's Republic) and on 24th Feb launched a full-scale invasion of Ukraine.

Kherson

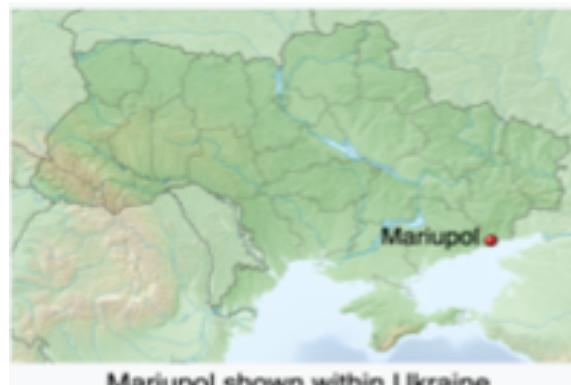
It is a port city of Ukraine that serves as the administrative centre of Kherson Oblast. It is located on the black sea and on the Dnieper River.

Kherson's administrative centre is Kherson City. It was occupied by Russia from March 2022 to Nov 2022, when the Ukrainian forces recaptured it. In June 2023, the city was flooded following the destruction of the nearby Kakhovka Dam.

Mariupol

It is a city of the north coast of the Sea of Azov at the mouth of Kalmius river. While internationally recognized as in Ukraine, the city is under the de facto administration of the Donetsk People's Republic.

During the 2022 Russian invasion of Ukraine, the city was besieged and severely damaged in which it received the title of Hero City of Ukraine. On 16th May 2022, Ukrainian troops in Azovstal Steel Plant surrendered to Russian forces and were evacuated to Russian held territory in the Donetsk People's Republic, as Russia secured complete control of the city.



Mariupol shown within Ukraine

3) S&T: DEFENCE: 'FATTAH MISSILE'

Why in news?

- Iran has claimed that it has created a hypersonic missile capable of traveling at 15 times the speed of sound (June 2024)

Fattah is an Iranian hypersonic medium-range ballistic missile developed by the Islamic Revolutionary Guard Corps and unveiled in 2023.

It is Iran's first hypersonic ballistic missile. According to Iran, its high maneuverability and speed allows it to defeat all missile defence systems.



Range: 1,400 kms and **terminal speed** of Mach 13 to Mach 15.

Significance:

It is the first hypersonic missile of Iran and is also believed to be first such missile in the middle east.

Its capabilities could pose a challenge to regional and global missile defense system.

Note: Hypersonic weapons are the weapons which fly at speeds in excess of Mach 5, or five times the speed of sound.

4) BIODIVERSITY: BLACK VEINED BUTTERFLY

- Why in news?

- » Re-emergence of 'extinct' black veined butterfly in England likely due to unscientific release (June 2023: Source - DTE)

About the Black Veined White (*Aporia crataegi*):

It is a large butterfly that became extinct from British Isles in 1925. It was always considered a rarity in the British Isles but on the continent, it is often very common.

In June 2022, the butterfly was spotted in London. These sightings are the result of unofficial release and is unlikely that the butterfly will survive in the wild to breed. It is not known who did this or why.



5) BIODIVERSITY: MAHUA (MADHUCA INDICA)

- Mahua is a medium sized tropical deciduous tree found largely in central, southern and north Indian plains and forests. They are also found in Nepal, Myanmar, and Sri Lanka.
- **Uses:**
 - Mahua flowers, fruits, and leaves are edible and used as vegetables in India and other Southern Asian Countries.
 - » **The sweet, fleshy flower** are eaten fresh or dried, powdered and cooked with flour, used as a sweetener or fermented to make alcohol. This liquor is popular across India.
 - It is also an oil plant, whose seeds yield between 35 and 47% oil. This oil is used for making soaps and candles. It also has a potential use in bio diesel production. Though, it is used as edible oil by tribals, WHO recommends against it as it contains aflatoxin, a toxin component. The processing of oil can get rid of aflatoxin and makes it edible.
 - **Cocoa Butter Extender:** It is prepared from Mahua seed oil and is a prized product. It can be used for making chocolate and other confectionaries. Experts feel that this product has the scope of altering socio-economic conditions of tribals in India.
 - **Timber:** The tree is also used for its hard, strong, dense and reddish timber.
 - **Traditional Medicines** also use some mahua components.
- **Tribal women from Odisha's Kandhamal District** have been using mahua flowers to prepare various delicious varieties of food (Source: DTE, June 2023)
 - Around 120 tribal women members of the state's Van Dhan Vikas Kendras prepare laddus, cakes, jam, toffees, pickles, squash, pakodas, and biscuits using dry mahua flowers and supply them in local markets.
 - The women started preparing these items after attending a training held at the Krishi Vigyan Kendra, Nandurbar, Maharashtra, in Feb 2023





CURRENT AFFAIRS PROGRAM

PRE-CUM-MAINS 2024

JUNE 2023- BOOKLET-2

TABLE OF CONTENTS

1. General Studies-1	1
1) Geography: El-Nino and Monsoon	1
2. General Studies-2	5
1) Social Justice: Homosexuality	5
2) Same Sex Marriage	8
3. General Studies-3	10
1) Syllabus: Issues related to Direct and Indirect Farm Subsidies and Minimum Support Price (MSP	10
A) Government's Subsidy Expenditure.....	10
B) MSP	10
2) Fertilizer Subsidy	14
A) Nutrient Based Subsidy (NBS) Scheme, 2010.....	15
B) Urea Based Subsidy.....	15
C) Impact of Fertilizer Subsidy Policies in India	16
D) Some steps that have been taken to make UREA sector efficient.....	17
E) Steps that further needs to be taken/Way forward	18
3) Nano-Fertilizers	18
4. Prelims Facts	20
1) Places in news: SVALBARD.....	20
2) S&T: Space	20
A) Svalbard Mission of 1997	21

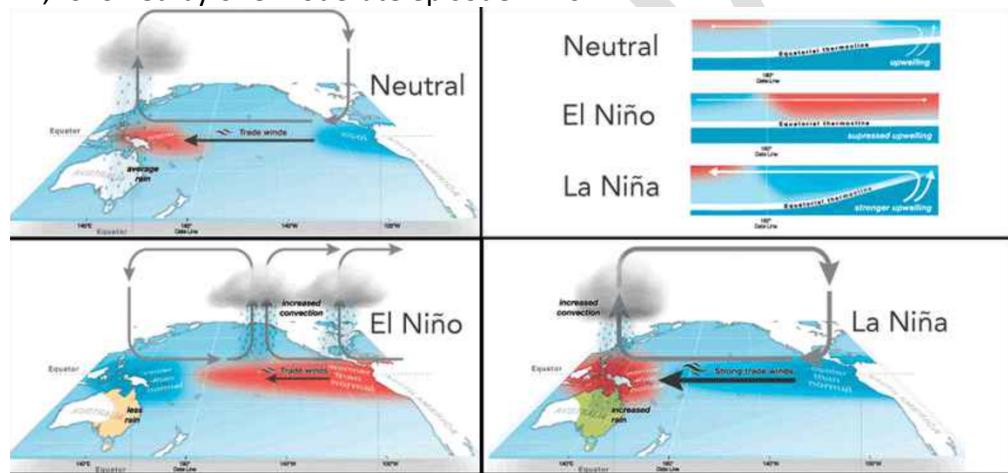
1. GENERAL STUDIES-1

1) GEOGRAPHY: EL-NINO AND MONSOON

- Why in news?
 - » According to the National Oceanic and Atmospheric Administration (NOAA), El-Nino has arrived (June 2023)
- Example Questions
 - » Discuss the mechanism behind occurrence of El-Nino and its counterpart La-Nina. How do they effect Monsoon season in India [15 marks 250 words]
 - » Discuss the different ways in which El-Nino situation is detected in the Pacific Ocean. How does the phenomenon of El-Nino Southern Oscillation impact Monsoon rains in India (10 marks 150 words)
- Understanding El-Nino Southern Oscillation (ENSO)
 - » EL-Nino Southern oscillation, also known as ENSO is a periodic fluctuation in the sea-surface temperature (El-Nino) and the air pressure of the overlying atmosphere (Southern Oscillation) across the **equatorial pacific ocean**. It is a recurring climatic pattern which has impact on temperature and precipitation across the globe.
 - » This scientific phenomenon occurs in **3 phases**: El-Nino Phase, the La Nina phase, and the Neutral Phase.
 - **The El-Nino Phase**
 - During El-Nino, the trade winds weaken or even reverse:
 - Instead of blowing from the east (South America) to West (Indonesia), they could turn into westerlies. As the wind blows from West to East, they cause the masses of warm water to move into the central and eastern equatorial pacific ocean. This leads to increased rainfall along the Western Latin America, the Caribbean and the US Gulf Coast, while depriving SE Asia, Australia and India of rainfall.
 - The strength of trade wind depletes and it is not able to take warm water to the Australian Coast.
 - This reduces the pressure difference between Eastern Pacific and Western Pacific.
 - This phase is characterized by severe drought in Indonesia, Australia (Western Pacific) and heavy rainfalls in the Eastern Pacific (i.e. the west coast of the Equatorial South America)
 - **The neutral phase (Normal Condition) of ENSO** involves sea surface temperature in the tropical pacific ocean that are closer to average.
 - The **trade winds** blow easterly across the surface near the equator.
 - **Warm water accumulates** in the Western Pacific (East Coast of Australia) creating low pressure there and high pressure in the Eastern Pacific (near the Peruvian Coast).
 - This phase is characterized by heavy rains on the East Coast of Australia and lack of rainfall on the Peruvian coast.

» The La-Nina Phase

- It is opposing phase to El-Nino.
- It basically refers to abnormal cooling of the central and eastern pacific ocean waters off the coast of Ecuador and Peru. Such cooling (SSTs falling 0.5 degree Celsius or more below a 30-year average for at least five successive three months period) is a result of strong trade winds blowing west along the equator (strong easterly trade winds), taking warm water from South America towards Asia. The warming of western equatorial pacific, then, leads to increased evaporation and concentrated cloud formation activity around that region, whose affect percolate to India as well. It also leads to decreased rainfall in tropical pacific.
- For e.g. the bountiful rainfall during 2019-22 has been significantly attributed to La Nina.
 - The latest La-Nina event was one of the longest ever, lasting from July-September 2020 to Dec-Feb 2022-23. And it brought copious rainfall to India.
 - This was also the case with two previous strong La Ninas in 2007-08 and 2010-11, followed by one moderate episode in 2011-12.

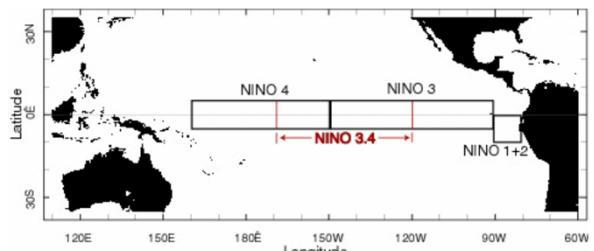


- **Discovery of El-Nino and La-Nina**
 - » El Nino Phenomenon was first noticed by the scientists in the 1920s, though local population in Peru and Ecuador were aware of the periodic warming much earlier.
 - » The La Niña phenomenon, on the other hand, was discovered only in the 1980s.
- **Reasons behind Oscillation** (i.e. El-Nino and La-Nina)
 - » **Not fully understood.**
 - » But the two components of ENSO - Sea Surface Temperature (SST) and Atmospheric Pressure are strongly related.
 - The strengthening and weakening of the trade winds is a function of changes in the pressure gradient of the atmosphere over the tropical Pacific. Ironically, the warming of the sea surface works to decrease the atmospheric pressure above it by transferring more heat to the atmosphere and making it more buoyant. So, in summary, the pressure gradient affects the sea surface temperatures, and the sea surface temperatures affect the pressure gradient.

- How is El-Nino situation predicted?

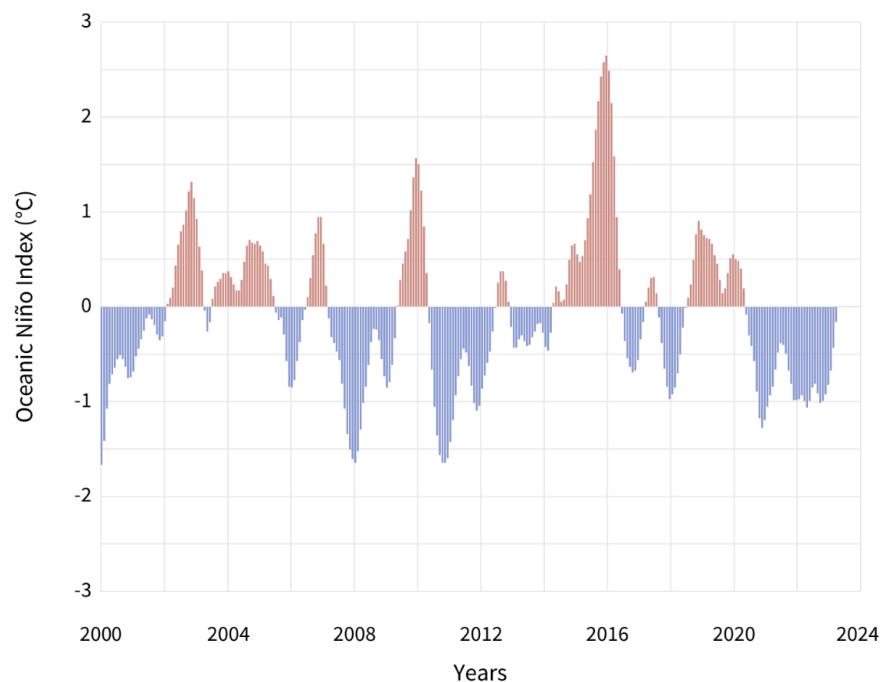
A. The Ocean Part of ENSO is measured by **Oceanic Nino Index (ONI)**.

- Monitoring of ENSO primarily focuses on Sea Surface Temperature (SST) anomalies in the 4 geographical regions of the equatorial pacific.
- The **Nino 3.4 region** refers to central and equatorial pacific while Nino 3 is the adjoining far-east pacific.
- During an **El-Nino**, the Nino 3.4 region gets relatively warmer (by atleast 0.5 degree Celsius)
- These are averaged over five, three-month sessions on a trot to arrive at the **Oceanic Nino Index (ONI)**.
- During a La-Nina it gets relatively cooler (by at least 0.5 degree Celsius)



Niño Regions

OCEANIC NIÑO INDEX (ONI)



Fluctuations in sea-surface temperatures in the eastern equatorial Pacific Ocean, as represented by Oceanic Nino Index (ONI), since 2000. (Image Credit: NOAA, US)

- **Thermal expansion** of warming water in the eastern part of the basin measurably raises sea level in these regions, and this change in sea level can be measured by satellite sensors. Thereby, variations in sea level are good indicators of the presence of an El-Nino.

B. The Atmospheric part is monitored through **Southern Oscillation Index, or SOI**.

- Southern Oscillation Index (SOI) is calculated on the basis of the atmospheric pressure difference between Tahiti (Southern Pacific Ocean) and Darwin (Australia).

- **Negative phase of SOI** represents below-normal air pressure at Tahiti and above-normal air pressure at Darwin. It corresponds to warm waters across the eastern tropical pacific typical of **El-Nino**.
- **Positive phase of SOI** coincides with cold ocean waters across the eastern tropical pacific typical of **La Nina episodes**.

- ENSO and Climate

- » In general, El Nino has warming effect on the planet, while La Nina tends to cool it down. The warmest years in a decade are usually the El Nino years.
 - The warmest ever year on record, 2016, was part of one of the longest and strongest El Nino episodes ever, dubbed the Godzilla El Nino.

All but one drought year in India was an El Nino year.



	Drought Intensity	El Nino Intensity
1957-58	Major	Strong
1965-66	Major	Strong
1966-67	Major	No El Nino
1972-73	Major	Strong
1976-77	Moderate	Weak
1979-80	Major	Weak
1986-87	Moderate	Moderate
1987-88	Major	Strong
1991-92	Major	Moderate
2002-03	Moderate	Weak
2004-05	Moderate	Moderate
2014-15	Moderate	Weak
2015-16	Moderate	Very Strong
2018-19	Moderate	Weak

- Accurate Prediction of El-Nino provide valuable information for managing its impacts on vulnerable regions:

- Agriculture and Food Security: Based on the expected changes in rainfall due to El-Nino farmers can adjust their crop choices, planting schedule and irrigation options.
- Water Resource Management:** Early prediction of El-Nino enable water resource managers to optimize reservoir storage and allocations.
- Disaster Preparedness:** Steps can be taken to deal with disasters like drought or heatwaves in vulnerable regions.

- Impact of El-Nino in India

- » El-Nino has been generally known to **suppress monsoon rainfall** in India.
 - Practically, all drought years in India since Independence - marked by large declines in food grains production or monsoon failures - have witnessed El-Nino events of varying intensity. The sole exception was 1966-67, where drought took place without El-Nino.
 - Please note that this doesn't mean the all El-Nino years have been drought years.

- Conclusion1

- Though El-Nino and La-Nina are naturally occurring climate events, there **impacts in recent years have been exacerbated** by extreme weather events.
- With a good disaster management strategy, India needs to remain prepared for these adverse weather phenomena.

2. GENERAL STUDIES-2

1) SOCIAL JUSTICE: HOMOSEXUALITY

- Example Questions
 - » "The SC verdict in Navtej Singh Johar v. Union of India is a step in the right direction but will not be enough to ensure protection of fundamental rights for sexual minorities" Discuss [15 marks, 250 words]
 - » "In striking down section 377, the Supreme Court has recognized the Constitution's extraordinary transformative power" Elaborate [10 marks, 150 words]
- Introduction
 - » The sexual orientation characterized by romantic or sexual desire for, or sexual attraction towards member of the same sex is called Homosexuality (Homophilia).
 - The term 'gay' is used to refer to homosexual persons of either gender, although it is mostly used to refer to males.
 - In women, romantic sexual desire for other women is also called 'lesbianism'.
- Legal Provisions in India
 - » **Section 377 of IPC** punished voluntary carnal intercourse against the order of nature with any man, women or animal with imprisonment for life or for a term of upto 10 years.
 - Supreme Court in its 2018 judgment in **Navtej Singh Johar vs. Union of India** has said that section 377 insofar as it prohibits 'any consensual sexual relationship' is unconstitutional.
- History of important court ruling on the issue of Homosexuality:
 - » The issue of Section 377 being violative of fundamental rights was first raised by NGO, NAAZ Foundation, and AIDS Bedhhav Virodha Andolan (ABVA), in the Delhi High Court in 2001. But the petitions were dismissed by the court.
 - » Eight years, later in 2009, Delhi High Court in **Naz Foundation vs. Government of NCT of Delhi (2009)** declared that the Section (377), insofar as it criminalizes consensual sexual acts of adults in private, is violative of article 14, 15, 19 and 21 of the Constitution.
 - The court also held that "constitutional morality must outweigh the argument of public morality, even if it be the majoritarian view".
 - » However, the Naz Foundation judgment was overturned by Supreme Court in 2013 in **Suresh Kumar Koushal vs. Naz Foundation**
- Supreme Court Judgment in **Navtej Singh Johar vs Union of India** have reversed the Koushal judgment and has de-criminalized homosexuality. The key reasons given by the SC are:
 - a. **Sexual orientation is natural** and people have no control over it.
 - It is controlled by neurological and biological factors. CJI said that "what nature gives is natural and the natural identity of an individual should be treated to be absolutely essential to his being".

- Research shows that sexual orientation is decided very early, possibly even before birth, and that homosexuality is found in about 10% of the population, a figure that is largely constant across the cultures.
 - Justice Chandrachud also added that 'homosexuality has been documented in almost 15,00 species'.
 - b. Section 377 violates LGBTs' **Right to Equality** under article 14 of the constitution and **Prohibition of Discrimination** under article 15 of the constitution and is thus irrational, arbitrary and incomprehensible.
 - c. It also violates **Right to Freedom** by punishing freedom of choice of individuals.
 - d. **Violates Right to Life**
 - Right to Privacy as part of Right to Life applies fully to LGBT community.
 - Punishment under Section 377 made the LGBT a closeted community, destroyed the identity of members and breached their dignity - All part of Right to Life.
 - Self-determination lies at the core of the concept of identity.
 - e. **Section 377 leads to harassment of LGBT community**
 - Section 377 has become a weapon in the hands of the police and majority community to harass those who have alternative sex orientation. Therefore it assumes the character of unreasonableness.
 - After the 2013 judgment, a large number of cases have come up where gays were blackmailed by acquaintance and the police is in connivance with each other.
 - f. Benefit of **presumption of constitutionality of a statute can't be extended to a pre-constitutional law like 377** that was not enacted by popular legislature.
 - g. The court has rules that consensual sex between adults is neither harmful nor contagious in society.
 - h. **Constitutional morality is more important than Social Morality** (majoritarian consensus): Social morality or what the majority of society thinks cannot be used to violate the right of even one single individual.
 - CJI Mishra had made it clear by saying "We don't settle constitutional issues by referendum. We don't follow majoritarian morality, but follow constitutional morality".
 - The judges have unanimously said that freedom of choice can't be subjected to majoritarian perceptions. The constitution is not just for majority, the fundamental rights are guaranteed to "any person" and "any citizen" and the sustenance of these rights doesn't require majoritarian sanction.
 - i. Judiciary plays an important role in making constitution a "**living document**" through dynamic and purposive interpretations.
 - The constitution must transform society for better - at the heart of **transformative constitutionalism** lies a pledge to change the Indian society so as to embrace the ideals of justice, liberty, equality and fraternity.
- The Court also added that **society owes an apology to LGBTQ community**.
- **Other arguments Supporting Homosexuality / decriminalizing homosexuality.**
- i. **Homosexuality is not against India's tradition and culture.**
 - Our mythology refers to the existence of homosexuality.
 - There are reference to homosexuality in Valimiki's Ramayan.

- There are many instances of men turning into women and so on in Mahabharata too.(e.g. Shikhandi)
 - Erotic paintings and sculptures in ancient temples depict homosexual impulses of at least certain sections of Indian society.
 - ii. **Forced Heterosexuality Affects family life**
 - Homosexuals when forced to live life of a heterosexual have to get married and live with someone to whom they are not attracted. This ruins the life of not only the homosexual but the person with whom s/he got married.
 - iii. **Even Britishers have changed their law**
 - IPC which was drafted by Britishers criminalize homosexuality.
 - The English law was reformed in Britain by sexual offences Act, 1967, which decriminalized homosexuality and acts of sodomy between consenting adults.
 - iv. **Prevented raising awareness over the issue**
 - Homosexuality is already considered a social taboo and it being illegal further made it difficult to spread awareness about it and thus prevent harassment of homosexual people.
 - v. **International Image of a liberal, inclusive, democratic country**
 - Decriminalization of homosexuality has also enhanced India's international image of being a country of diversity, of inclusion and or equal protection for all.
- **Way Forward:** Supreme court judgement has merely decriminalized homosexuality but has not altered civil laws on it. Further court judgments or laws cannot remove social prejudice on their own. Discrimination still persists at workplace, in renting houses, and in the form of stigmatization which is more intense in rural areas. Therefore, we need to work towards:
- » **Bringing change in social attitude:** A change in social attitude and mentality needs to take place. This would require a lot of proactive efforts from government, civil society organizations, educational institutions etc. in the form of Information, Education and Communication Programs.
 - Homosexuals at leadership roles need to come up openly and confront the discriminatory attitude against them. This will help in changing the social perception
 - » **Ensuring Administrative Protection**
 - Government needs to ensure that homosexuals who are making their identity public are not harassed or discriminated in any way.
 - » **Legal Reforms:** Civil laws have to be brought in consonance with the SC verdict. The amendments need to provide for
 - Legalizing same sex marriage
 - Allowing same sex couples to adopt a child
 - **Ban Conversion Therapy**
 - » **Judiciary** also needs to proactively protect fundamental rights of homosexuals, at least, till the time when social attitude and legal protections are enhanced.
 - An example would be Kerala High Court's June 2022 judgment where it sanctioned a lesbian couple to live together after they were coercively separated by their parents.

- **Conclusion**
 - » The Navtej Singh Johar judgment widens the ambit of individual autonomy and decisional privacy. But the verdict is only the first step towards ensuring right to life, liberty and dignity of LGBT community. We still need to go a long way towards changing social attitude and ending all forms of discriminatory laws against the LGBT community.

2) SAME SEX MARRIAGE

- **Why in news?**
 - » The Constitutional Bench of the Supreme Court has reserved its verdict on the batch of petition seeking legal recognition of same-sex marriages after a hearing that lasted 10 days (May 2023)
- **Quote: "For the time they are a-changing": Bob Dylan**
- **Introduction:**
 - » In Navtej Singh Johar case, Supreme Court decriminalized homosexuality. But, gay marriages still don't have legal recognition in India. This may change soon. In a landmark case, a group of 18 same-sex Indian couples have petitioned the country's Supreme Court to legalize same-sex marriage.
- **Petitions**
 - » The petitions argued that marriage brings with it several rights, privileges, and obligations that are "bestowed and protected by law". The Delhi Commission for Protection of Child Rights (DCPCR) also advocated for recognition of marriage, filing an intervention application to assist the court on the impact of such marriages on children.
- **Respondents Opposing the petition:**
 - » The Central Government, the National Commission for the Protection of Child Rights, and a body of Islamic Scholars called the Jamiat-Ulama-i-Hind, opposed the petitions.
- **Argument Supporting Same Sex Marriage**
 - » The right to marry for non-heterosexual couple is implicit in Article 14 (Equality), 15 (Non-Discrimination), 16 (Equality of Opportunities in public employment), 19 (Freedom of Speech), and 21 (Right to Life). This is specially true after the SC ruling in 'Navtej Singh Johar vs. Union of India' and 'KS Puttaswamy verdict'.
 - » In Navtej Singh Johar verdict, Justice Chandrachud held that members of LGBT community are entitled, as all citizens, to a full range of constitutional rights, including liberties protected by the Constitution.
 - Being able to marry a partner would allow homosexuals to a host of rights currently reserved for heterosexual married couples - including right to jointly adopt children, own property together or nominate one another as a surrogate decision maker in a medical emergency, right to inheritance, maintenance and tax benefits.
 - » Since Navtej Singh Johar Judgment, several high court verdicts have ruled in favor of same sex couples having the right to live together.
 - In Madhu Bala vs State of Uttarakhand (2020), the high court of Uttarakhand held that right of a same sex couple to live together is a constitutional and human right.

- In **Vanitaben Damjibhai Solanki vs State of Gujarat** (2020), the Gujarat High Court ordered police protection for two women police constables in a relationship.
 - In **S Sushma v Commissioner of Police** (2021), the court protects the couple in relationship and makes sure that both sets of parents are taken along in this journey.
 - » **Supreme Court's recognition of same sex marriage will contribute to society's acceptance towards homosexuality.**
 - » A study titled '*The Anticipated Impact of LGBTQIA+ Marriage Equality Legislation on Indian Society and Mental Health*' among Indians has found that legalization of such unions will have a "positive impact on mental health of LGBTQIA+ individuals".
 - » There are 25 countries where same sex marriage is legalized. These countries have seen no harm to their culture and no deterioration of the legitimacy of traditional marriage in any place where same sex marriage is lawful.
- **How the law can be changed?**
- » Personal law can be interpreted by court to legalize same sex marriages.
 - » Government can add a provision defining LGBT culture in personal laws and allow for same sex marriages.
 - » Special Marriage Act, 1954 can be amended to bring in provisions for same sex marriage.
- **Arguments of people opposing same sex marriage:**
- » They argue that same sex marriage is afront to Indian customs and is an urban elitist concept.
 - » The government is also arguing that if Supreme court legalizes same sex marriage, it would mean a virtual judicial rewriting of an entire branch of law and court must refrain from passing such omnibus orders. Proper authority for this should be the legislature.
 - » Some don't consider it as normal because they can't replicate babies.
- **Conclusion:**
- » The LGBTQIA+ community is gazing upon the Supreme Court with a profound sense of optimism, anticipating the bestowal of their long-awaited constitutional rights, which have been withheld from them throughout the ages.

3. GENERAL STUDIES-3

1) SYLLABUS: ISSUES RELATED TO DIRECT AND INDIRECT FARM SUBSIDIES AND MINIMUM SUPPORT PRICE (MSP)

A) GOVERNMENT'S SUBSIDY EXPENDITURE

- For FY23, government has spent Rs 5,32,446 crore on subsidy.
 - This includes Food Subsidy (Rs 2.8 lakh crores), Fertilizer Subsidy (Rs 2.1 lakh crores), and Petroleum subsidy (Rs 30,756 crore).
- It was the 2nd highest ever after the 7.06 lakh crores of FY 20-21.
- But, in 2020-21, the spike in subsidy was on account of the finance ministry making a one-time provision to clear all dues to the FCI and fertilizer companies.
 - The centre in previous years was not providing fully for subsidies, arising from these entities selling grain and fertilizers at below cost to PDS consumers and farmers respectively.
- **Key Reasons for Rise in Subsidy Burden:**
 - **Covid-19 Pandemic:** The lockdown led to launch of various initiatives like Pradhan Mantri Garib Kalyan Anna Yojana.
 - **Russia-Ukraine War:**
 - » This led to surge in global prices of petroleum and fertilizers.
 - Government had to keep farmers and consumer insulated from this price rise which led to rise in subsidy burden.

B) MSP

- **Why in news?**
 - » Government has announced the Minimum Support Price (MSP) for this year's summer (Kharif) season crops, hiking the prices between 5-10% from last season, to ensure remunerative prices to growers for their produce and to encourage crop diversification (June 2023)
 - **Reactions:**
 - A section of farmer representatives have expressed unhappiness over what they term as a 'meagre' hike in MSP, defeating the government's intent of securing a "remunerative price".
 - Agriculture domain experts believe that an increase in MSP may give a slight respite to growers, but argue that in the absence of any dependable or assured market mechanism of procurement-purchase for crop on the MSP in most parts of the country, Crop Diversification will not be encouraged.
- **Example Questions**
 - i. What do you mean by Minimum Support Price (MSP)? How will MSP rescue farmers from the low income trap? [Mains 2018, 10 marks, 150 words]
- **Introduction**

- » **What is MSP:** It is the minimum price set by the Government at which farmers can expect to sell their produce for the season. When market prices fall below the announced MSPs, procurement agencies step in to procure the crop and ‘support’ the prices.
- » **Beginning:** The Minimum Support Prices (MSP) were announced by the Government of India for the first time in 1966-67 for Wheat in the wake of the Green Revolution and extended harvest, to save the farmers from depleting profits.

Prelims	How is MSP decided and Who takes final decision.
	<ul style="list-style-type: none"> ▪ The <u>Cabinet Committee of Economic Affairs (CCEA)</u> announces <u>MSP</u> for various crops at the beginning of each sowing season based on the <u>recommendations of the Commission for Agricultural Costs and Prices (CACP)</u>. ▪ The CACP takes into account <u>demand and supply</u>, the cost of production (A2 + FL method) and <u>price trends</u> in the market, inter-crop parity, implication for MSP on consumers, <u>a minimum of 50% as the margin over cost of production</u>; etc. ▪ The CACP calculates three types of costs — A2, A2+FL and C2 — for each mandated crop for different states. The lowest of these costs is A2, which is the <u>actual paid-out cost incurred by a farmer</u>. Next is <u>A2+FL</u>, the actual paid-out cost plus imputed value of family labour. The highest of the three costs is C2, <u>defined as ‘Comprehensive Cost including Rental Value of Own Land</u> (net of land revenue and interest on value of own fixed capital assets (excluding land))

- » MSP is announced for 22 mandated crops and FRP is announced for sugarcane (**total 23 crops**)

Prelims	Crops Covered under MSP:
	<ul style="list-style-type: none"> - MSP is announced for 22 mandated crops and FRP for Sugarcane. (Total 23 crops) <ul style="list-style-type: none"> ▫ Mandated Crops are: 14 crops for Kharif season, 6 Rabi crops (except Toria) and 2 crash crops (Copra and Raw Jute). ▫ In addition MSP for <u>Toria</u> and <u>De husked coconut</u> are fixed on the basis of MSP for <u>rapeseed/mustard</u> and <u>Copra</u>. - Note: <u>Coffee, tea</u> etc are not covered under MSP. - 7 Cereals, 8 oilseeds, 5 pulses, 5 cash crops - Copra, Raw cotton, Raw Jute, Virginia Flu cured (VFC) tobacco, Sugarcane. - Note: For Sugarcane <u>Fair and Remunerative Prices (FRP)</u> is announced that has to be paid by sugar mill owners.

Kharif Crops	Rabi Crops
1. Paddy	15. Wheat
2. Jowar	16. Barley
3. Bajra	17. Gram
4. Maize	18. Masur/lentil

	5. Ragi	19. Rapeseed/mustard
	6. Arhar (Tur)	20. Safflower
	7. Moong	21. Toria (an oilseed similar to rapeseed)
	8. Urad	Other Crops
	9. Cotton	22. Copra / Dehusked Cotton
	10. Groundnut	23. VFC Tobacco
	11. Sunflower seed	24. Raw Jute
	12. Soyabean black	25. Sugarcane(FRP)
	13. Sesamum	
	14. Nigerseed	

- **Need of MSP/ Rationale Behind MSP**
 - » Protecting farmers from price volatility
 - » Incentivizing farmers to grow crops in short supply
 - » MSP also ensures easy procurement for food security schemes
- From FY19 the MSP has been **pegged at more than 50% of cost of production for most of the Kharif and Rabi crops**. This is another step towards ensuring **income inclusiveness**.
 - » Accordingly, the Government has been increasing the MSP for all 22 Kharif, Rabi and Commercial crops with a margin of at least 50% over the all-India weighted average cost of production since the agricultural year 2018-19.
- **Various Mechanisms under MSP to procure crops and ensure remunerative prices for farmers (Before PM-AASHA)**
 1. **For wheat and paddy** -> **Open Ended Procurement by FCI**
 2. **Coarse Grains** -> **Purchased by state government** with permission of central government, **upto the extent it is required** in their Target Public Distribution System (TPDS).
 3. **Price Support Scheme (PSS)** - for oil seeds, pulses and cotton - at the request of concerned states
 4. **Market Intervention Scheme (MIS)** for perishable horticulture commodities - at the request of states - when there is excess supply or low prices.
- **Some shortcomings in MSP Procurement Program**
 - » **Procurement is limited to few crops, few geographies and few farmers** -> only wheat and rice under open procurement -> Punjab, Haryana, Coastal Andhra benefitted a lot -> mostly big farmer benefitted
 - » There has been delays in establishment of procurement centre.
 - » Lack of awareness about MSP among large section of farmers. This leads to they getting exploited at the hands of commission agent.

- » **Inadequate MSP** (MSP calculation is not based on A2 + FL + C2 which was recommended by MS Swaminathan committee). It uses A2 + FL method.
- **Pradhan Mantri Annadata Aay Sanrakshan Abhiyan (PM-AASHA):**
 - » The scheme is aimed at increasing the MSP procurement of pulses, oilseeds, COPRA etc. This is expected to ensure remunerative price to farmers.
 - » **Three components of PM AASHA - Price Support Scheme; Price Deficiency and Payment Scheme; and Private Procurement & Stockist Scheme**
 - Note: For Oilseeds, the states will be allowed to choose between the PSS or two other schemes.
 - » **Note: AASHA is complementing (not replacing) complementing other schemes**
 - Other existing schemes of Department of Food and Public Distribution (DFPD) for procurement of paddy, wheat and nutri-cereals/coarse grains and of Ministry of Textile for Cotton and Jute will be continued for providing MSP to farmers to these crops.
 - » **What was expected out of PM-AASHA:**
 - Better remuneration for farmers; reduced storage and procurement requirement for government; increased private participation -> more investment in storage etc; improved food security
- **But, PM-AASHA has also not been able to increase MSP procurement a lot due to following reasons:**
 - **Budgetary support for PM-AASHA** has been too minimal (around Rs 15,000 crore in the first year)
 - **A number of factors preventing PM-AASHA to be inclusive:**
 - » **Agri-Marketing reforms** are incomplete: Poorly functioning APMCs with cartelization, lack of transparency which causes price distortion.
 - The three farm laws which were expected to reform agri-marketing in India had to be withdrawn due to farmers' protest.
 - » **Poor infrastructure:** This has led to farmers remaining out of MSP regime, remaining out of MSP regime.
 - To increase procurement of pulses, oilseeds etc., a large infrastructure improvement is required at state level. This infrastructure is absent or very poor at state level.
 - » Further, **ineffective supply chain management**, has rendered the whole scheme trivial.
 - For e.g. NAFED has a stock of 4 million tonnes of pulse and oilseeds, but their distribution policy is non-existent.
 - **State Financial condition** may not be strong enough for the program.
- **Other Criticism of MSP mechanism in general**
 - **MSPs causes market distortion** -> this negative impacts free market economy and investment in the sector.
 - **Cropping pattern** is affected and farmers tend to grow high MSP crops rather than the most suitable crop for the region.
 - **Excess fertilizer and water guzzling crops** makes agriculture unsustainable.
 - **Higher inflation due to higher MSP pressure** also has to be considered while announcing MSP for the food crops.
 - **Cost Plus Pricing** is risky as it ignores the demand side, i.e. demand-supply, domestic and international price trends, terms of trade, inter-crop price parity etc.

- Leads to less focus on non-price factors like technology, inputs, services, institutions and infrastructure
 - High fiscal burden on government
- Bigger stock exceeds the stock holding norms of FCI
- WTO' AOA issues (discussed with WTO issues separately)

- Way forward

- There is a need of **correction in the way MSP is provided.**
 - Land rentals and capital depreciation needs to be kept in mind.
- In order for our **procurement policy to be really inclusive**, government will need to focus upon improving the procurement infrastructure in rural, remote and backward areas. There is also a need to fast track the reform process of APMCs to end cartelization and promote transparency.
- Steps towards **wooing private investments** needs to be enhanced. Crop mandis can ensure more competition and thus better output for farmers.
- Further, FCI and NAFED will have to **strengthen the supply chain mechanism** to focus more on efficient distribution of the procured food items.
- At the same time we should remember that **procurement schemes can only be a temporary solution**. For lasting impact we need other structural changes. Farming has to be made profitable by reducing production cost and improving returns.

In summary, there has to be a **Comprehensive 'Production, process and market' approach** through higher investments on market infrastructure, processing, value addition and agri-business and diversification along with farmer's welfare initiative.

2) FERTILIZER SUBSIDY

- Why in news?
 - » CACP recommends Centre to bring urea under NBS regime to check overuse (June 2023)
- Introduction
 - » A fertilizer is any organic or inorganic, natural or synthetic material added to soil to supply one or more plant nutrients essentially to the growth of plants.
 - » These fertilizers provide **six macro nutrients** and **8 micro-nutrients** to plants for well balanced growth:
 - i. **6 macronutrients:** nitrogen(N), phosphorus(P), potassium(K), Calcium (Ca), magnesium (Mg), and sulphur(S). They are consumed by plants in larger quantities and make the bulk of fertilizers.
 - ii. **8 Micronutrients:** Boron (B), Chlorine (Cl), Copper (Cu), iron (Fe), manganese (Mn), Molybdenum(Mo), Zinc (Zn) and Nickel (Ni).
 - » Fertilizer are an important input for agriculture and have played a major role in increasing farm productivity since green revolution.
 - » But Indian farmers have often faced difficulties due to shortage of fertilizers in past. To ensure easy availability of fertilizers, government has **various subsidy schemes**. But not all fertilizers are sold at a controlled price.

- » In India, Urea is the only controlled fertilizer, which is sold at statutory notified uniform price. The Phosphatic and Potash fertilizers are under a decontrolled regime and are sold at indicative maximum retail prices (MRPs).

A) NUTRIENT BASED SUBSIDY (NBS) SCHEME, 2010

- Key provisions of NBS
 - **Fixed subsidy based on nutrient:**
 - » Government provides a fixed amount of subsidy based on the nutrient content (both macro and micro (boron, zinc etc.)) (per kg) of fertilizers (unlike the earlier product-based subsidy scheme) to the fertilizer companies.
 - » For e.g. for RABI 2022 (from 01/10/2022 to 31/03/2023) - Subsidy rate was decided as follows:
 - **N (Rs 98.02/kg) P (Rs 66.93/Kg), K (Rs 23.65/Kg) and S (Rs 6.12/kg)**
 - **MRP to be fixed by fertilizer companies** on the basis of demand and supply but after incorporating the subsidy element.
 - Rate of subsidy is determined by various factors such as international prices, exchange rate, inventory levels etc.
 - The NBS scheme currently covers 21 grades of different phosphatic and potassic (P&K) fertilizers including DAP (diammonium phosphate), MOP (Murate of Potash) and other NPK complex fertilizers.
 - **UREA has been kept outside the coverage of the NBS scheme.**
- **Key Aim** -> Reduced Subsidy Burden; New specialized variety of fertilizers; Balanced application; Improved farm output; promote indigenous fertilizer industry.
- **Hasn't been as affective** -> Government's subsidy burden still very high -> UREA kept out of NBS, so farmers shifted to UREA -> Balanced Nutrient Goal also missed.
- **Subsidy burden** has also kept on going up.

B) UREA BASED SUBSIDY

- **Introduction:**
 - To ensure affordable access to fertilizers to farmers, UREA is made available at statutorily **controlled price**, which at present is Rs 5378 per MT (exclusive of Central/State Tax and other charges towards neem coating).
 - The difference between the delivered cost of fertilizers at farm gate and MRP payable by farmers is given as subsidy to the fertilizer manufacturer/importer by GoI.
- **Issue of Diversion**
 - Being super-subsidized, urea is always prone to diversion for non-agricultural use - as a binder by plywood/particle board makers, cheap protein source for animal feed manufacturers or adulterant by milk vendors - apart from being smuggled to Nepal and Bangladesh.
- From 2018, the government announced the **implementation of DBT** for disbursement of fertilizer subsidy.

- Now the subsidy transfer only happens after the actual sales to farmers by retailers. Retailers have a point of sale (PoS) machine linked to e-Urvark DBT Portal. Fertilizer buyers (farmers) are required to furnish Aadhar or KCC number.
- **Advantages**
 - Prevents diversion and plug the leakages (because Aadhar is used)
 - Timely payment of Urea subsidy to urea manufacturing companies.
 - Adequate availability of UREA to farmers at adequate prices.
- But the diversion still continues at the retail level.
- Various steps being proposed to deal with this problem:
 - **Plans for Direct Cash Transfer to Farmers:**
 - Ceiling might be put on farmers based on the size of their land.
 - The subsidy may be directly transferred to farmer's e-wallet which could be made available along with farmer's Rupay Kisan Card.
 - In a study by NITI Aayog in 2019, farmers prefer DBT to fertilizer companies, rather than Direct Cash Transfer to Farmers as they are worried that buying fertilizers at market price would be an extra burden.
 - Government is trying to resolve this concern by developing a DCT mechanism where fertilizer subsidy will be paid in advance.
- **Plans to cap the total number of subsidized fertilizer bags that any person can buy during an entire Kharif and Rabi Cropping season:**
 - This is expected to end even retail-level diversion and purchases by large buyers masquerading as farmers.

C) IMPACT OF FERTILIZER SUBSIDY POLICIES IN INDIA

- **Positive Impact:** Fertilizer subsidy policies have had positive impact in terms of increasing fertilizer consumption and hence leading to an increase in overall Agri-production.
- **But it has failed in the goals of increasing domestic production** (and has thus increased import dependency) and promoting balanced use of nutrients by farmers. It has also led to diversion of UREA for other industries and exports to neighboring countries.
- **Why domestic industry couldn't be promoted:**
 - **Lack of raw material for potassic and phosphatic fertilizers:** India completely lacks any commercially exploitable source of Potash and the entire demand for MOP is met through import. In the Phosphatic sector (for DAP etc.), there is limited availability of raw material like Sulphur and rock phosphates and hence, a bulk of raw material is imported. Even the **Urea sector** is dependent on imported fuel sources like crude oil and now, even gas.
 - **Low investment in fertilizer sector** over the years.
 - **Inefficient Fertilizer manufacturer companies** - Since they get subsidy based on the cost of production (rather than fixed subsidy for all manufacturers on the basis of per unit production).
- **Increased dependency on Urea has been harmful**
 - In India, the ideal ratio of NPK fertilizers use is considered as **4:2:1**. However, in most regions it is skewed against the ratio with a propensity to use larger quantities of N (urea) as it is cheaper.

- It has caused serious problems:
 - i. Widespread deficiency of secondary and micro-nutrients.
 - Among these, the deficiency of zinc has to be specifically mentioned as zinc deficiency in food causes problems like stunting.
 - ii. **Fertilizer response and efficiency** has continuously declined over decades mainly due to imbalanced use of nutrients.
 - iii. Environmental damages
 - Part of over-used Nitrogen is lost as NH₃, N₂, NO_x gases which adversely affect environment.
 - Part of Nitrogen leaches down as NO₃ and contaminates the ground water resources. It has been found to cause methemoglobinemia or the Blue baby syndrome.
 - iv. **Limits diversification of crops**
 - Specialized fruits, vegetables require special non-UREA fertilizers, which are not easily available at affordable prices. This prevents diversification of agriculture.
- **Diversion of UREA** -> smuggling to neighboring Nepal, Diversion to Industries
- **Huge Fiscal Burden on Government**
 - A burden of more than Rs 2 Lakh crore only because of fertilizer subsidy.

D) SOME STEPS THAT HAVE BEEN TAKEN TO MAKE UREA SECTOR EFFICIENT.

- i. **GAS Price Pooling**
 - Earlier, different urea plants got gas at different prices, so their cost of production differed.
 - Therefore, in 2015 government has approved a major policy intervention. Under this policy the **domestic gas is pooled with imported LNG gas** to provide uniform natural gas to all the Urea manufacturing plants for the production of Urea.
 - **Cost of UREA at pooled price will be less than the price of imported urea.** This will help in increasing the production. This will augment indigenous production capacity.
- ii. **Neem Coating of UREA**
 - Reduces rate of dissolution in soil -> slowly absorbed by plants
 - Reduces diversion to industry
 - Neem has other advantages for crops -> insecticidal and pesticidal properties
 - UREA can't be used in synthetic milk now
- iii. **New Urea Policy** to increase the productivity, efficiency and indigenous production
- iv. **Introduction of 45 kg Urea Bag** (from earlier 50 kg) -> aimed at cutting demand
- vi. **Nano Urea**
 - Government has notified the **specification of Nano nitrogen** under Fertilizer Control Order, 1985.
- vii. **One Nation One Fertilizer Scheme**

- It aims to ensure timely supply of fertilizers as well as eliminate the dilemma of farmers in choosing one of the many brands available in the market.

viii. **Pradhan Mantri Krishi Samriddhi Kendra (PMKSK)**

- It has been decided to convert the existing village/block/sub-district/taluk and district level fertilizer retail shop into Model Fertilizer Retail Shops. These shops will act as "**One Stop Shop**" for all the agriculture related inputs and services.

ix. **PM PRANAM (Proposed)**

- Aimed at reducing the use of chemical fertilizers and thus reducing the subsidy burden.

E) STEPS THAT FURTHER NEEDS TO BE TAKEN/WAY FORWARD

i. **Work towards self-reliance and reducing dependency on imports.**

- Tie-up with gulf countries to set up plants
 - Gas prices for UREA plants in India is 3 times higher than in gulf countries. So we should set up joint ventures in countries where these prices are low.

ii. **Correcting Price Signals and Decontrolling the Fertilizer sector -> More investment and more competition.**

- The Commission on Agriculture costs and Prices (CACP) has recommended the centre to bring urea under NBS regime.

iii. **Direct Cash Transfer to Farmers and ensure progressive subsidies.**

iv. **Improve fertilizer efficiency -> Expand the soil health testing facilities and Issue of soil health cards**

v. **Digitization of land records**

- The process of was launched in 2008 but has not gathered momentum.
- Without setting right the land records, it will be impossible to transfer the subsidy to beneficiaries or to issue soil health cards.

vi. **Ensuring timely reach of subsidy to farmers**

- Last, but not the least, in the drive for increased efficiency and productivity, we should not forget the question of equity and inclusiveness, for 85% of our operational holdings belong to small and marginal farmers and smaller farmers tend to use fertilizers more intensely.

vii. **Develop Alternative sources of nutrition for agriculture** - Shift towards non-chemical form of fertilizers -> scope to use large biomass of plants which is wasted today;

- **Conclusion:**

- These steps will go a long way in enhancing the productivity of agriculture, mitigating climate change, providing an alternative to chemical fertilizers and balancing the fiscal impact of fertilizer subsidy on the Union Budgets in the years to come.

3) NANO-FERTILIZERS

- **Why in news?**

- Union Home Minister Amit Shah launched IFFCO's liquid nano Di-Ammonia Phosphate (DAP) (April 2023)

- Nano Urea fast-tracked for approval despite incomplete trials (Sep 2022)
- **Question:**
- “The Nano-Fertilizer technology can change the contours of not just Indian agriculture but also the economy” Critically analyze [10 marks, 150 words]
- **Introduction:**
- India has become the first country in the world to have developed and roll out nano-fertilizers.
 - » So far, it has launched nano-versions of two fertilizers – Urea and Diammonium Phosphate (DAMP).
 - » While nano-Urea has been made available to farmers since late 2021, nano-DAP was launched in April 2023.
 - The Indian Farmers Fertilizer Cooperative Limited (IFFCO), which had developed the variants using propriety technology, claims that Nano-UREA and Nano-DAP have several advantages over their conventional granular counterparts.
- **More Details:**
- Both Nano-Urea and Nano-DAP come in liquid form.
 - IFFCO claims that a 500 ml bottle of nano-urea can replace at least a 45 kg bag of granular urea and a bottle of 500 ml nano-DAP can replace a 500 kg bag of granular DAP.
- **Advantages:** The Parliamentary Standing Committee on Chemicals and Fertilizers (2022-23), headed by Shashi Tharoor have enumerated several advantages of nano-fertilizers in its March 2023 report:
- **Soil Health:** Nano-UREA can address the imbalanced and excessive used of conventional urea in the country, which accounts for around 82% of nitrogenous fertilizers applied to majority of the crops.
 - It costs lesser than subsidized conventional fertilizer thus reducing the cost for farmers.
 - They also result in better productivity and higher income for farmers.
 - » The PSC report notes that it has average 8% higher crop yield.
 - Experts also believe that these nano-fertilizers will lead to reduced import dependency of fertilizers and save forex reserves.
 - It will also contribute to reduced fiscal burden of government because of reduced fertilizer subsidy cost.
- **Limitations:**
- **Doubts about Yield gain:** DTE has reported interviews of several farmers who had to resort back to traditional fertilizers after, nano-fertilizers didn't give good results.
 - **Labour cost for spraying fertilizer** is increasing the overall input cost for farmers.
 - **Complaints** about farmers being forced to buy Nano-Urea.
 - **Issue of Evaluation/Trial:** ICAR has given results of field trial based on a year (two seasons) of experiments in its affiliated labs. This was an exception as ICAR normally tests a new fertilizer for 2 years (or three seasons) before giving go ahead to a new fertilizer.
- **Conclusions:** Nanotechnology could play a crucial role in promoting sustainable agriculture in India and nano-urea is an example of that. At the same time, it should be ensured that any new technology-based product is properly evaluated in its efficacy, environmental impact and economic impact on farmers.

4. PRELIMS FACTS

1) PLACES IN NEWS: SVALBARD

SVALBARD (also known as Spitsbergen)

- It is a Norwegian archipelago in the Arctic Ocean. North of mainland Europe, it is about midway between the northern coast of Norway and the North Pole. The islands of the group range from 74 degree to 81-degree N.
- The largest island is Spitsbergen.
- **Flora and Fauna:** The flora has adapted to take advantage of the long period of midnight sun to compensate polar nights. Many seabirds use Svalbard as a breeding ground, and it is home to polar bears, reindeer, the Arctic fox.
- **Svalbard Global Seed Vault** is a seedbank to store seeds from as many of the world's crop varieties and their botanical wild relatives as possible. It is a cooperation between the government of Norway and the Global Crop Diversity Trust, the vault is cut into rock near Longyearbyen, keeping it at a natural – 6 degree C and refrigerating the seeds to -18 degree C. It is also referred as Earth's dooms day vault.
- **IndARC:** It is India's first underwater moored observatory in the Arctic region. It was deployed in 2014 at Kongsfjorden fjord, Svalbard, Norway. It is focused on studying arctic climate



2) S&T: SPACE

- **Why in news?**
 - Norwegian Ambassador Han Jacob Frydenlund's visit to ISRO's headquarters (June 2023)
- In June 2023, Norwegian Ambassador Frydenlund, accompanied by officials of Kongsberg Satellite service (KSAT), called on ISRO Chairman S. Somanath in Bengaluru, ISRO. The meeting concluded with a mutual agreement on the importance of maintaining a continued partnership and fostering increased engagements between India and Norway.

- It also offered an occasion to recall the 'Svalbard mission' of 1997.

A) SVALBARD MISSION OF 1997

- On Nov 20, 1997, a Rohini RH-300 Mk-II sounding rocket rose to the skies from Svalbard, Norway, operationalizing a new rocket launching range.
- ISRO bagged the Norway mission after its commercial arm Antrix Corporation won a global tender floated by the Norwegian space agency.
- The RH-300 MK-II was given a new name by the NSC (Norwegian Space Centre): **Ibjorn-1**, which translates literally as 'Polar Bear-1'.



CURRENT AFFAIRS PROGRAM

PRE-CUM-MAINS 2024

JUNE 2023- BOOKLET-3

TABLE OF CONTENTS

1. General Studies-1	2
1) Geography: Heat Waves	2
A) Prelims Understanding: What is Heat Stroke?	4
2) Geography: Urban Heat Island (UHI) Effect	4
3) Geography: Cyclones	6
A) Why tropical cyclones don't originate on western coast of S America, Africa and Australia.....	8
B) How are cyclones originating in Indian Ocean named?	8
C) Cyclone Color Coding	9
D) Cyclone Biparjoy (June 2023).....	9
E) Excellent Work of Disaster Management:	10
F) Why are tropical cyclones becoming more dangerous?	10
G) Way Forward:.....	10
2. General Studies-2	11
1) Social Justice: LGBTQIA+.....	11
2) The transgender Persons (Protection of Rights) Act, 2019.....	13
3) Prelims: Intersex Inclusive Progress Pride Flag	15
3. General Studies-3	17
1) Environment: Miyawaki Forests	17
4. Prelims Facts	19
1) Places in News: Lake Victoria.....	19
2) Places: Venetian Grand Canal	20
3) Culture: Gandhi Peace Prize, 2021	20
4) Science: Cocaine	21
5) Science: Space and Astronomy: Star BetelGeuse.....	21
6) Anthropology: Did Homo Naledi made rock art and buried their dead?	22
A) Evolution of Humans.....	22
B) Homo Naledi	23

7)	Biodiversity: Himalayan Brown Bear (<i>Ursus Arctos Isabellinus</i>)	23
8)	Biodiversity: Orchids of Darjeeling Hills and DOab are facing threats	24
9)	Defence: INS Kirpan.....	26

LevelupIAS

1) GEOGRAPHY: HEAT WAVES

- **Why in news?**
 - Many Heat wave deaths in Uttar Pradesh and Bihar (June 2023)
 - Earlier in April 2023, **13 people died from apparent heatstroke** while attending a government award function in an open space in Navi Mumbai. This is possibly the **biggest ever heatwave-related death toll from a single event in the country** and brings back to spotlight on potential risks from heatwaves, whose intensity and frequency is expected to rise because of climate change.
- **Example Questions**
 - What are heat waves? Suggest a strategy to reduce India's vulnerability to heatwaves. [15 marks, 250 words]
 - With a focus on the Oct 2019 guidelines from the National Disaster Management Authority (NDMA), discuss the mechanisms for preparedness to deal with Heat Waves in India. [15 marks, 250 words]
 - Heatwaves can pose economic challenges to various sectors. Evaluate the economic consequences of heatwaves on industries such as agriculture, tourism, and energy, and suggest some measures to minimize their adverse effects [15 marks, 250 words]
- **Definition**
 - A heat wave is a **period of abnormally high temperatures, more than the normal maximum temperature** that occurs during the **summer season** usually in the north-western parts of India. In India, heat waves **typically occur between March and June**, and in some rare cases extend till July.
 - **Indian Meteorological Department (IMD)** has given following criteria for heat waves.
 - **Maximum Temperature of at least 40 degree Celsius for Plains, 37 degrees Celsius for coastal regions** and atleast **30 degree Celsius for hilly regions**.
 - Following conditions are used declare heat waves:
 - a. **Based on Departure from Normal**
 - **Heat Wave:** Departure from normal is 4.5 degree to 6.4 degree.
 - **Severe Heat Wave:** Departure from normal is > 6.4 degree.
 - b. **Based on Actual Maximum Temperature (for plains only)**
 - **Heat Wave:** When actual maximum temperature \geq 45 degree Celsius
 - **Severe Heat Wave:** When actual maximum temperature \geq 47 degree Celsius.
- **Increasing cases of Heat Waves in India:** According to Lancet Report, India faced **60 million heatwave exposure events** in 2016, a rise from 40 million exposures in 2012. Similarly, the **average length of heat waves** in India ranged from **3-4 days**, which is more than double of **global average of 0.8 - 1.8 days**. The key factors responsible for this are:
 - **Climate change -> higher temperatures**
 - According to a report by UNICEF "*The Coldest year of the Rest of Their Lives*" - **nearly every child will face frequent heatwaves by 2050**.
 - **Sparser Pre-Monsoon shower and Delayed Monsoon**
 - This weather pattern coupled with **El-Nino effect**, which often increases temperature in Asia, combine to create the record high temperatures.

- The **Loo (hot and dry winds)** originating from **Pakistan and Northwest India**, has also contributed to increasing temperature in India.
 - **Urbanization and its problems like Urban Heat Island (UHI) Effect** exacerbates the problem of heat wave in many parts of our country.
 - **Decreasing Tree Covers** -> concrete jungles, land heats up more.

- **Impact of Heatwaves**
 - **Health Impacts**
 - The heat waves are associated with increased rate of heat stress and heat stroke, worsening heart failures and acute kidney injury from dehydration.
 - Children, elderlyies and those with pre-existing morbidities are particularly vulnerable.
 - According the NDMA, more than 24,000 people have died in India due to heat waves between 1992-2015.

 - **Economic Loss**
 - According to Lancet, the output of workforce in India declined by 7%, equivalent to 75 billion labor hours every year.

 - **Worsening of air pollution problems** -> increased electricity use -> more fuel burned.

- **Steps Taken So Far**
 - The **IMD** has regularly issued heat wave warnings in different parts of the country to make people aware of the worsening situation.

 - The **NDMA** has suggested things like covering of head, cross-ventilating rooms and sleeping under a slightly wet sheet.

- **NDMA's revised guidelines for prevention and management of Heat Waves in India (Oct 2019)**
 - **Aim/Objective**
 - The guideline aims to provide framework for developing Heat Action Plans for implementation, inter-agency coordination and impact evaluation of heat wave response activities in cities/towns.

 - **Developing a Heat-wave Plans**
 - Generating heat wave risk and vulnerability map and mapping hotspots for developing a strategic mitigation action plan.
 - Identifying **Vulnerable Population** - elderlyes, pregnant women, chronic disease patient, resident of a particular type of housing, certain type of occupations etc.
 - Identification and Evaluation of factors leading to disproportionate increase in temperature in the city.

 - Reducing Temperature in the cities through vertical gardens, small parks with water fountains etc.
 - Coordinate with Research institutions for better built environment.
 - Government budget should allocate funds for R&D in this field
 - Curb Future UHI manifestation by incorporating findings from the built environment assessment
 - Adhere to city building codes.
 - Preparedness at the local level for health eventualities.
 - Health care system capacity building
 - Collaboration with private and Non-Government and Civil Society

- Establish Early Warning System and Communication Systems
 - Developing inter-agency response plan and coordination in the field.

- **Other Steps that can be taken:**
 - **Preparedness:** Already discussed with NDMA guidelines
 - **Response:**
 - Ensuring quick advanced communication and guidelines during heatwave condition.
 - Drinking water supply should be increased along the roadside during heatwave conditions
 - Health facilities should respond with all the relevant facilities.
 - **Other steps:**
 - **Reviewing the existing occupational health standards, labor laws, and sector regulation** for worker's safety.
 - **Special focus on farm laborers** as the agricultural sector was more vulnerable compared to the industrial and service sectors because workers there were more likely to be exposed to heat.
 - Increased work on amenities like increased access to drinking water, indoor ventilation, healthcare, regular work breaks, and protection against wage loss.
 - **Promoting more greenery throughout the city** especially on both sides of the roads to ensure cooler roads.
 - **Making communities more aware and resilient** to after effects of the heatwaves.
 - Internationally, the **global community** should work towards achieving the climate change mitigation goals by working towards Paris Climate targets and making the NDCs more ambitious.

A) PRELIMS UNDERSTANDING: WHAT IS HEAT STROKE?

- A heat stroke happens when the ambient temperature is so high that the body's cooling mechanism (sweating) is not able to bring down the temperature of the core. The body temperature may shoot upto 40-degree C. In these situations there is severe imbalance of salts such as sodium and potassium in the body.
- The high core temperature coupled with salt imbalances disrupts the organs, leading to host of symptoms.
 - It can affect the brain, making a person foggy, drowsy, and in severe cases may also lead to a person going into a coma.
 - It can also lead to kidney and liver damage as well.
- A cascade of such symptoms may also lead to death due to heat stroke.
- **What should be done during such situations:**
 - In severe cases, the aim is to bring down the core temperature of the body fast. This can be done by pouring cold water over the person, making them drink cold drinks, and giving them electrolytes to balance salt levels.
 - **Visit hospitals quickly** if they are exhibiting symptoms like high body temperature, but no sweat, feeling drowsy, vomiting, not passing urine, and not breathing properly.
- **How to prevent heat stroke?**
 - Don't go out between 12 noon - 3 pm. Avoid strenuous activities during this period.
 - If you have stepped out, ensure that you are drinking water even if you don't feel thirsty. Drink other hydrating fluids, like Lassi, lemon water, buttermilk, or ORS that can maintain electrolytes levels.
 - Don't consume coffee, tea, and carbonated drinks as they by dehydrate you further.
 - Wear light weight, light-colored, loose, and porous cotton clothes.

2) GEOGRAPHY: URBAN HEAT ISLAND (UHI) EFFECT

- **Probable Questions?**
 - i. What is Urban Heat Island? What are the key factors responsible for the phenomena. [150 words, 10 marks]
 - ii. "Urban Heat Island effect is accentuated by rapid urbanization". Elaborate. Suggest some measures to deal with the phenomena. [200 words, 12.5 marks]
- **Introduction**
 - UHI is an urban area which is significantly warmer than the surrounding rural areas.
 - The temperature difference is more stark during the day hours and night. Weak winds reduces the heat transfer and makes this phenomena more apparent.
- **Causes**
 - The main cause of UHI effect is the modification of land surfaces.
 - Extensive concrete and asphalt surfaces, which absorb and retain heat from sun. These materials have low albedo (reflectivity) and high heat capacity, leading to absorption and storage of solar radiation.
 - Unscientific Urban Planning and Layout may also be responsible for UHI effect. Density of buildings, street patterns, and the arrangements of tall structures may affect the air flow and restrict the dissipation of heat.
 - Decreased vegetation cover and reduction in agri fields: Vegetation help in regulating temperature by a process of evatranspiration. In the absence of vegetation, this cooling effect reduces.
 - Decrease in water bodies (like lakes and ponds) over the years reduce the cooling effect during summers.
 - Increasing population also increase the human generated heat through refrigerators, ACs etc.
- **Harmful Impacts**
 - UHI increases the probability of long duration heat waves and it also exacerbates the impact of heat waves.
 - It leads to increased energy consumption. This is due to greater demand for cooling in hot weather conditions
 - Elevated Emissions of Air Pollutants and Greenhouse Gases
 - Increased energy consumption leads to more greenhouse gas emissions as more fossils will be burned for the energy.
 - Fossil fuels also produce other harmful pollutants such as Sulphur dioxide, Nitrogen oxides, Particulate Matter, Carbon monoxide etc.
 - The pollutants further result in formation of ground level ozone, acid rains etc.
 - Ozone is formed when NO_x reacts with Volatile Organic Compounds in presence of sunlight. If environment becomes hotter, more ground level ozone will be formed.
 - It also decreases water quality as warmer waters put stress on the ecosystem.
 - Storm water which gets warm will affect the nearby ponds, lakes and rivers too.
 - **Infrastructure Damage:** The excessive heat in urban areas can cause damage to infrastructure, particularly roads, pavements and buildings.
 - Some experts believe that it may be contributing to global warming.
- **Some positive impacts**
 - Lengthening the plant growing season in very cold regions.
- **How Urban Heat Island effect can be mitigated?**
 - **Proper Urban Planning** - keep UHI effect in mind, while planning urban development.

- Lower building height, aligning streets against the sun's path (i.e. in north-south direction) could prevent new layouts from heating up.
 - Focus on energy efficient buildings which will ensure insulation, high-performance windows etc.
 - Create monitoring systems to automatically identify UHIs.
 - **Green Infrastructure**
 - It includes Green Roofs (Roof partially or completely covered by vegetation)
 - Painting house in light colors
 - Promoting urban forestry (For e.g. use Miyawaki method)
 - **Protect Water Bodies and Permeable Surface:**
 - This will ensure high soil moisture and proper cooling of cities.
 - **Community Engagement and Education**
 - Promoting behavioral changes like reducing energy consumption, planting more trees, etc.
 - **Collaborative governance:**
 - Promote collaboration between various stakeholders like state government, local bodies, NGOs etc.
- **Conclusion:**
- These measures can not only help mitigate UHI effect, but can also improve urban resilience, enhance public health and create sustainable and livable cities.

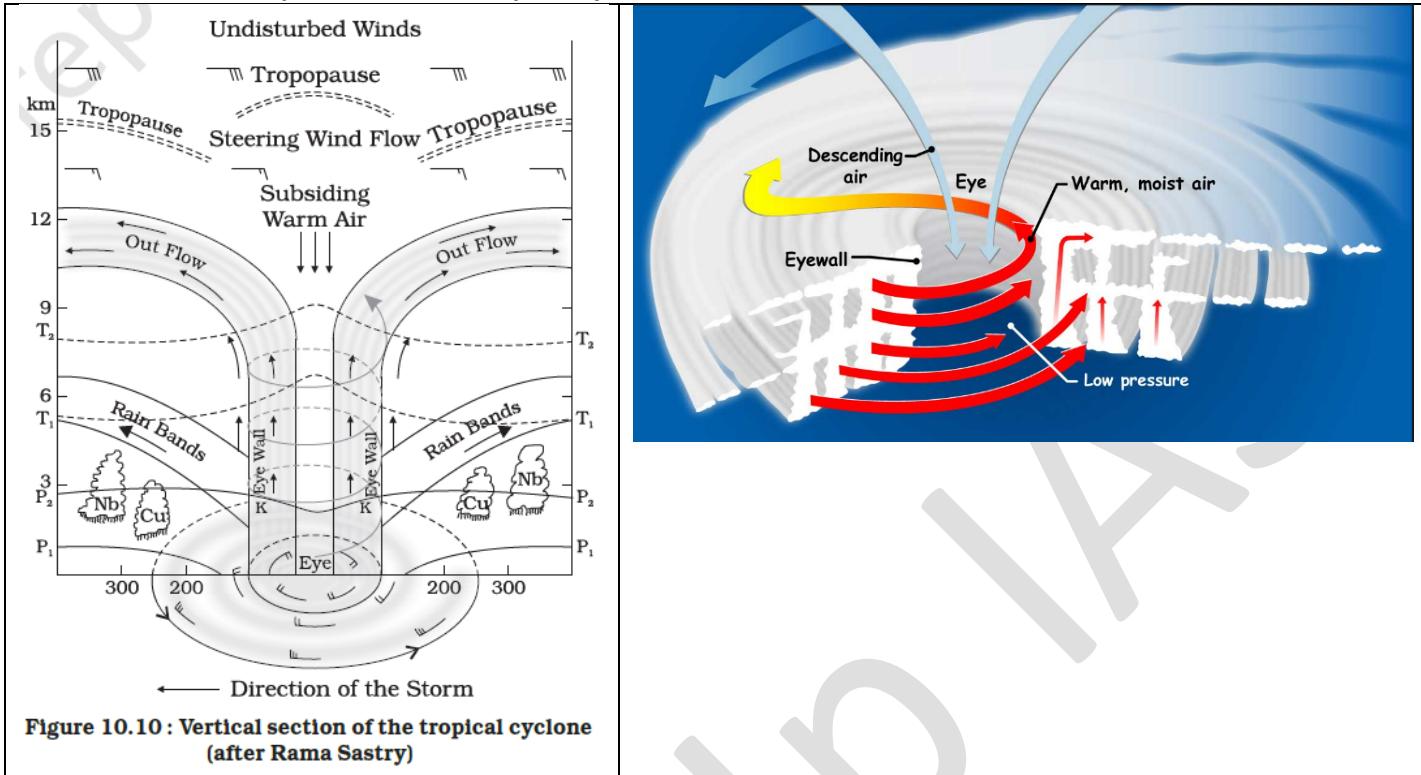
3) GEOGRAPHY: CYCLONES

- **Syllabus:** Important Geophysical phenomena such as earthquakes, Tsunami, Volcanic activity, **cyclone** etc., geographical features and their location - changes in critical geographical features (including waterbodies and icecaps) and in flora and fauna and the effects of such changes
- **Why in news?**
 - **Cyclone Biparjoy** (June 2023)
- **Example Questions**
 - Tropical Cyclones are largely confined to South China Sea, Bay of Bengal and Gulf of Mexico. Why? [12.5 marks, 200 words] [Mains 2014]
 - The recent Cyclone on the coast of India was called "Phailin". How are the tropical cyclones named across the world? [Mains 2013] [10 marks, 150 words]
 - Why is east coast of India more prone to tropical cyclones compared to west coast of India? [10 marks, 150 words]
 - Discuss the conditions required for the formation of a tropical cyclone [10 marks, 150 words]
- **Introduction**
 - Tropical cyclone is a violent storm system characterized by a low pressure centre, strong winds and heavy rainfall. They originate over oceans in tropical areas and move to coastal areas bringing about large scale destruction. It is one of the most devastating natural calamities.

Prelims	Different names
	<ul style="list-style-type: none"> ▪ Cyclones - Indian Ocean region ▪ Hurricane - Atlantic / East Pacific ▪ Typhoons - West Pacific and South China Sea

- **How does a cyclone originate and intensify?**
 - Tropical cyclones originate over warm tropical oceans.
 - **The condition favorable for the formation and intensification of tropical storms are**
 - a. Large Sea surface with temperature higher than 26.5 degree celsius to a depth of atleast 50 meters below the surface.
 - b. Presence of the Coriolis force (A distance of atleast 500 km from equator) (as Coriolis force is zero at equator)
 - c. Small variation in the vertical wind speed (low wind shear i.e. there is not too much change in wind direction and strength at different levels)
 - d. Pre-existing weak low-pressure area or low-level cyclonic circulation
 - e. Upper divergence above the sea level system
 - f. If ITCZ is away from Equator, the tropical cyclone are intensified because of warm air masses converging at ITCZ.
- **Process of formation of a tropical cyclone**
 - Warmer ocean surface (generally late summers) -> Low pressure center on water bodies -> winds from surrounding region are attracted towards this region -> while rising up they release the latent heat which acts as an energy for tropical cyclone.
- **Process of intensification of storm**
 - The energy that intensifies the storm, comes from the condensation process in the towering cumulonimbus clouds, surrounding the center of the storm. With the continuous supply of moisture from the sea, the storm is further strengthened.
- **Various stages in formation of a tropical cyclone**
 - **Tropical Depression** (wind speed < 62km/h) -> **Tropical Storm** (wind speed > 62 km/h) -> **Cyclone** (Wind speed >= 119 km/h) -> **Super Cyclone** (wind speed >= 320 km/h)
- **Tropical Cyclone Structure**
 - Because the converging wind spiral inward towards the central low pressure area, the wind rotate in a counterclockwise direction around the central low in the northern hemisphere (clockwise in the southern hemisphere). As these winds spiral inward they draw in the thunderclouds around the storm, creating the spiral rain bands that are clearly visible on satellite images of the storm.
 - As the winds converge toward the central core, they spiral upwards, sending warm moist air upwards. As this air rises, it cools and releases its latent heat into the atmosphere to add further energy to the storm.
 - The winds spiraling around this central core create the eye of the tropical cyclone and eventually spread out at high altitudes. Eventually, cool air above the eye begins to sink into the central core. This dry descending air within the eye gives the core a clear, cloud free sky, with little to no wind. The wind is coming inwards towards the center from all direction. This convergence causes the air to sink in the eye. This sinking creates a warmer environment and the clouds evaporate leaving a clear area in the centre.
- **Dissipation**
 - Since the main source of energy for the storm is the heat contained in the warm tropical and subtropical oceans, if the storm moves over the land, it is cut off from its source of heat and will rapidly dissipate.
- **Other terms**
 - **Land fall:** It refers to the centre of a storm - or its eye - moving over land from the sea.

- A Schematic representation of tropical Cyclone



- Useful Video:

- <https://youtu.be/UKL9NIxLIIE> (Formation of a Tropical Cyclone)

A) WHY TROPICAL CYCLONES DON'T ORIGINATE ON WESTERN COAST OF S AMERICA, AFRICA AND AUSTRALIA

- Cold Ocean Currents -> don't let shifting of ITCZ -> warm air don't converge here.

B) HOW ARE CYCLONES ORIGINATING IN INDIAN OCEAN NAMED?

- The system of naming of Atlantic cyclones (hurricanes), is a fairly old practice, but giving names to cyclones that originate in the northern Indian Ocean and affect South Asian countries began only at the turn of this century.
- Currently, the Cyclones worldwide are named by 9 regions - North Atlantic, Eastern North Pacific, Central North Pacific, Western North Pacific, North Indian Ocean, South West Indian Ocean, Australian, South Pacific, and South Atlantic.
- The system of naming cyclones was finalized at a meeting of World Meteorological Organization (WMO) and the United Nation Economic and Social Commission for Asia and the Pacific (ESCAP) in 2000, and the first cyclone was named in 2004.

- Eight north Indian ocean countries, namely Thailand, Myanmar, Bangladesh, India, SriLanka, Pakistan, Maldives, and Oman were asked to contribute names so that a combined list could be compiled. Each country gave 8 names and a combined list of 64 names were prepared by the Regional Tropical Cyclone Committee.
 - One name from each country is picked in an order to name the cyclones.
 - The Cyclones in North Indian Ocean basin are named by Indian Meteorological Department and the first tropical cyclone was named in 2004 as Onil (given by Bangladesh).
 - This list exhausted with Cyclone Amphan in 2020.

The latest list of tropical cyclone names was adopted by the WMO/ United Nations Economic and Social Commission for Asia and the Pacific (WMO/ESCAP) panel countries in April 2020 for naming of tropical cyclones over north-Indian ocean, including Bay of Bengal and Arabian Sea.

- The 13 panel countries - Thailand, Myanmar, Bangladesh, India, Sri Lanka, Maldives, Pakistan, Iran, Yemen, Oman, UAE, Qatar and Saudi Arabia - have submitted a list of 13 names each [total 169]
- Why Name a Cyclone: Ease of Communication
 - Remembering cyclones or discussing their impacts, or warning people about them, becomes easier with a name.
 - Giving a name to a cyclone makes it easier to spread the word.

C) CYCLONE COLOR CODING

- IMD has its own color-coding system for warning and information regarding cyclones. It is used to signify the intensity of the situation and the warning associated with it. The main objective of the color coded system is to alert people of hazardous weather conditions which have potential to damage properties and lives.
 - Green: All is well - no adverse weather conditions
 - Yellow: It asks the 'guards to be updated' to handle the bad weather that can last for days, with a warning of affecting daily activities.
 - Orange: "Be Prepared" - It can be warning for extreme damage to communication disruptions that can lead to power cuts, road and railway blockade.
 - Red: It is the highest level of warming that notifies the authorities to take action. This is a case in which there is a threat to life with the worst weather conditions.

D) CYCLONE BIPARJOY (JUNE 2023)

- Some unique aspects about Biparjoy:
 - It was a slow cyclone. It developed into a cyclonic storm on 6th June 2023 and made a landfall on June 15. The 10 day life period, during which it developed into a very severe cyclonic storm and then an extremely severe cyclonic storm, was longer than the average but not the longest. One of the reasons for its longer stay on the sea was its relatively slow speed.
 - Cyclones in the Arabian Sea typically progress with a speed of 12-14 km per hour. Biparjoy, through most of its life, moved at a speed of 5-7 km an hour while covering a distance of nearly 1200 km to Gujarat.
 - Reason: Biparjoy was sandwiched between two anti-cyclonic systems. One of them had the effect of aiding its northwards movement, while the other was sort of pulling it back. The combined effect was that it moved relatively slow.

- **Impact:** The slow speed meant that even after reaching land, the cyclone remained close enough to the sea to draw moisture and sustain itself. This allowed it to penetrate much deeper in land (till Ajmer, Rajasthan)
- It was a **recurring tracks cyclone**.
 - The influence of these anticyclonic systems also made its trajectory wobble. We call it recurring tracks cyclone. The trajectory of such cyclones tends to change directions frequently.
 - Therefore, it was only from 11th June, it was concluded that cyclone is hitting Gujarat coast (earlier it was presumed to be hitting Karachi)

E) EXCELLENT WORK OF DISASTER MANAGEMENT:

- **Excellent Forecasting:** Management of recent Cyclone Biparjoy indicates that India has successfully planned and executed integrated forecast systems and computational infrastructure to reduce cyclone mortality by nearly 90% (when compared to the first decade of 21st century).
 - **Early warning** (4 days in advance before landfall) gave enough time for administration to prepare.
 - **Note:** A cyclone in 1998, that stuck Gujarat, reportedly killed nearly, 3,000 people, and it can be safely said that India has moved beyond that era.

F) WHY ARE TROPICAL CYCLONES BECOMING MORE DANGEROUS?

- **Climate Change -> Marine Heatwaves**
 - Ocean absorbs most of the access heat in the atmosphere, it is leading to oceans warming up globally causing marine heatwaves.
- **Warming of oceans** is leading to other challenges like increased intensity of cyclones, rising sea levels, and changing weather patterns globally.
 - For e.g., a new study has suggested that warm subsurface waters in the Bay of Bengal has likely helped fuel the 2020 Amphan super cyclone.

G) WAY FORWARD:

- With climate change, be prepared for stronger cyclones.
- Coastal Regulation Zone Rules should be followed in letter and spirit.
 - Further, it should also specify that only those structures, which are capable of withstanding these cyclones are built in these regions.
- The dwelling of rural, coastal inhabitants must be strengthened.
- Increase green cover like Mangroves which act as natural shield and improve resilience of coastal areas.
- Forecasting should continue to improve.
 - There should also be focus on maximizing skills of the forecasts of cyclone intensities, lifespans, speeds, and tracks.
 - India's academic climate community should build teams to work with IMD to advance understanding of cyclone processes and to improve cyclone predictions.

1) SOCIAL JUSTICE: LGBTQIA+

- **Example Questions**
 - "Legal provisions alone will not be able ensure equal rights for Transgenders, social attitude towards them needs to change" Discuss [15 marks, 250 words]
- **Introduction**
 - **LGBTQIA++** is an inclusive term that includes people of all genders and sexualities, such as lesbian, gay, bisexual, transgender, questioning, queer, intersex, asexual, pansexual, and allies.
 - **LGB** (Lesbian, Gay, Bisexual)
 - **Who are Transgenders?**
 - People who have a gender identity or expression that differs/doesn't conform to the social expectations for their assigned sex. They are sometimes called transsexual if they desire medical assistance to transition from one sex to another.
 - Transgenders also include people who are not exclusively masculine or feminine (people who are genderqueer/non-binary).
 - **Intersex** - Individuals who don't fit into specific gender norms of woman or man; can also be used for those with reproductive anatomy that isn't biologically typical.
 - **Questioning** - when a person is exploring their sexuality, gender identity and gender expression
 - **Queer** - An inclusive term or as a unique celebration of not molding to social norms
 - **Asexual** - used for those who don't feel sexual attraction to either sex or that don't feel romantic attraction in the typical way.
- **Population:** Estimated transgender population > 4,90,000 (2011 census)
 - But the transgender activists estimate the population to be 5-6 times more.
 - In the United States 0.3% people identify themselves as transgender indicating that our census numbers are big under-estimation.
 - It further shows that people in India still have to hide their identity as transgender.
 - **Nodal Ministry :** Ministry of Social Justice and Empowerment.
- **Problems faced by Transgenders:**
 - Discrimination in Family
 - Family gives up the child; higher rate of domestic violence; Orthodox mindset considers birth of transsexual as ill omen.
 - social stigma.
 - discrimination in all walks of life (Education, Health, Work, Access to Public Facilities; Denial of residence);
 - lack of self-determination (mis categorization as males or females);
 - police harassment.
 - insensitive laws (provisions for transgenders missing);
 - For e.g.
 - personal marriage laws don't legalize homosexual marriages.
 - Laws related to adoptions (The Hindu Adoption and Maintenance Act, 1956 (HAMA), and Juvenile Justice Act (JJA) - both laws - don't mention anything about adoption by homosexual couples.

- sexual harassment;
 - Lack of understanding in society -> makes them feel isolated, lonely and may cause mental health issues.
- **Important steps taken for their welfare so far**
 - i. **Supreme Court Judgment in 2014: National Legal Service Authority vs. Union of India**
 - Declared Transgender people to be a 'third gender'.
 - Affirmed that fundamental rights granted under Constitution of India will be equally applicable to transgender people
 - Gave them right to self-identification of their gender as male, female or third gender.
 - The court also recognized transgender people as **socially and economically backward classes** and hence should be granted reservation in educational institutions and jobs.
 - i. **Steps taken by various state governments**
 - Some states like Bihar have already provided them reservations as OBCs.
 - The state of Kerala had become the first state to announce the policy for transgenders in 2015. It has recently announced reservation in Higher educational institutions for transgenders.
 - States like **TN, Rajasthan, and Chhattisgarh** have also allowed hiring of transgenders in police forces.
 - iii. **Transgender Persons (Protection of Rights) Act, 2019**
 - iv. **Transgenders Persons (Protection of Rights) Rules, 2020**
 - v. **National Council for Transgender Persons constituted (Aug 2020)**
 - vi. **National Medical Commission declared conversion therapy a 'professional misconduct'** and empowered the State Medical Councils to take disciplinary action if the guideline is breached.
 - Earlier, Madras High Court had directed NMC to issue an official notification listing conversion therapy as a wrong, under the Indian Medical Council (Professional Conduct, Etiquettes and Ethics).
 - vii. **Shelter Homes - 'Garima Greha' (July 2021)**
 - Shelter Homes - 'Garima Greha' for Transgenders: MoSJ&E has initiated 12 pilot shelter homes and provided financial assistance to community based organizations (CBOs) for setting up of shelter homes 'Garima Greha' for Transgender Persons. (July 2021)
 - These pilot shelter homes are in States of Maharashtra, Delhi, West Bengal, Rajasthan, Bihar, Chhattisgarh, Tamil Nadu and Odisha.
 - The main aim of these shelter homes is to provide safe and secure shelter to Transgender persons in need. These shelter homes would provide basic amenities like food, medical care, recreational facilities and also conduct capacity-building/skill development programmes for Transgender persons.
 - viii. **National Portal for Transgender Persons**
 - The portal provides for the **procedure for identification certificates issued by the District Magistrate**. It is functional in all districts of the country.
 - The portal was launched in Nov 2020.
 - As of June 2021, i.e. within 6 months of its launch, the portal has issued 1,557 certificates.
 - x. **IWEI - India Workplace Equality Index (Dec 2020)**
 - It is touted as the country's first comprehensive benchmarking tool for employers to measure their progress on LGBT+ inclusion at the workplace.

- It was launched in Dec 2020 by **non-profit Keshav Suri Foundation** (founder Hotelier-activist Keshav Suri) partnered with **Pride Circle, Stonewall UK** and **FICCI**, to bring the IWEI to India Inc.
 - The index **measures 9 areas**: policies and benefits, employee lifecycle, employee network group, allies and role models, senior leadership, monitoring, procurement, community engagement and additional work.
 - **Standard Chartered Bank** has been named as a 'Gold Employer' in the Indian Workplace Equality Index 2021 for its LGBT+ inclusion.
- **Steps that further needs to be taken**
 - i. **Proper estimation**
 - ii. **Sensitization and Awareness to deal with stigmatization**
 - Inclusion of third gender in school books
 - Information, Education and Communication Programs
 - iii. **Ending all forms of discrimination, coming up with welfare schemes etc.**
 - Effectively enforce the 2019 act
 - iv. **Reservation in educational institutions and jobs**
 - This will help in dealing with poor literacy rate and employment situation
 - v. **Special focus on their health needs**
 - Community had been demanding mental health counselling support and free gender transition surgery facilities in government hospitals.
 - vi. **Rehabilitation**
 - A large number of them are involved in flesh trade. There should be a plan to rehabilitate them in various other sectors
 - vii. **Transgender Welfare board in all states** should be made mandatory.
 - This will provide an institutional set up to look after the welfare of the transgender community.
 - viii. **Reforming Personal Laws** to make them more inclusive.

2) THE TRANSGENDER PERSONS (PROTECTION OF RIGHTS) ACT, 2019

- **Main Provisions**
 - i. **Definition of Transgenders:**
 - A person whose gender doesn't match the gender assigned at birth. It includes trans-men and trans-women, persons with inter-sex variations, gender queers, and persons with social cultural identities such as Kinnar and Hijra.
 - **Intersex variations** is defined to mean a person who at birth shows variations in his or her primary sexual characteristics, external genitalia, chromosomes, or hormones from the normative standard of male or female body.
 - ii. **Prohibition Against Discrimination:** The act prohibits the discrimination against a transgender person, including denial of services or unfair treatment in relation to, Education, Health, Employment, access to or enjoyment of goods, facilities, opportunities available to public; Right to movement Right to reside, rent, own or otherwise occupy property, Opportunity to hold public or private office;
 - iii. Every transgender person shall have **right to reside** and be included in the household.
 - If the immediate family is unable to care for transgender persons, the person may be placed in a rehabilitation centre, on the orders of a competent court.

- iv. **Health Care:**
 - The government must take steps to provide health facilities to transgender person including separate HIV surveillance center, sex reassignment surgeries, etc.
 - The government shall review medical curriculum to address health issues of transgender persons, and provide comprehensive medical insurance scheme for them.
- v. **Certificate of identity:** A transgender person may make an application to the District Magistrate for a certificate of identity, indicating the **gender as 'transgender'**. A revised certificate may be obtained only if individual undergoes surgery to change their gender either to male or a female.
- vi. **Welfare measures by government**
 - The act directs central and state governments to take measures to ensure the full participation of transgender persons in society.
 - Government must also take steps for their rescue and rehabilitation, vocational training and self-employment, create schemes which are transgender sensitive, and promote participation in cultural activities.
- vii. **Offences and penalties:** -> Forced labour; denial of public space; removal from household, village; physical, sexual, verbal abuse etc.; These offences will attract imprisonment between six months and two years, and a fine.
- viii. **National Council for Transgenders persons (NCT)**
 - The National Council of Transgender persons will consist of
 1. Union Minister for Social Justice (Chairperson)
 2. Minister of State for Social Justice (Vice-Chairperson)
 3. Secretary of Ministry of Social Justice
 4. One representative from ministries including health, home affairs and human resource development
 5. Representatives from other ministries, NITI Aayog and the NHRC.
 6. Five members from transgender community and five experts from NGOs.
 - The council will advise the central government on the formulation and monitoring or policies, legislation and projects with respect to trans gender person.

- Analysis

- **Positives**
 - The act is in spirit with International Conventions, particularly the Universal Declaration of Human Rights, 1948, the International Covenant on Civil and Political Rights, 1966, and the Yogyakarta Principles 2006.
 - It recognizes gender identity as non-binary. Through this act the government has evolved a mechanism for social, economic and educational empowerment of the transgenders.
 - The act will benefit a large number of transgenders persons, mitigate the stigma, discrimination and abuse against this marginalized section and bring them into mainstream of society.
 - It will lead to greater inclusiveness and would make transgender persons as productive member of society.
 - The bill will bring greater accountability on the part of the central government and state government/ union territories administrators for issues concerning transgender persons.
- **Negatives/Limitations/Shortcomings**
 - i. **Principle of Self Determination/ Self Identification missing**
 - NALSA verdict had suggested that anyone who didn't identify with the gender assigned to them by birth could choose to identify as transgender without needing a physical

- examination and certification, the new bill undoes this possibility both in spirit and in practice.
- In fact, the parliamentary standing committee on the bill, which submitted its report in July 2017 have called for many modifications including the change in definition to ensure conformity with the international definition and providing right to self-identification.
 - In the current act, there are no avenues open either for appeal in the event a magistrate refuses to hand out such a certificate.
- ii. **Doesn't suggest changes in other laws**
 - Certain criminal and personal laws currently only recognize the genders of 'man' and 'women'. It has not been defined how such laws will be applicable to transgender persons.
 - iii. **National or State Commissions: No provision** for national or state commission for transgenders
 - NCT, lack the power of commission, which is statutory in nature
 - iv. **Transgender Rights Court: No provision for transgender right courts**
 - v. **Reservation: Silent on any kind of reservation** for transgender persons in education system
 - vi. **Lack of clear grievance redressal mechanism and insufficient punishment**
 - The act is ambiguous about the methods individuals must follow to seek justice, limits the jail sentences that the offender may receive to just two years.
 - vii. **Only covers transgender** (protection may be needed by Intersex, Queer, lesbians, gays, bisexuals etc. as well)
- **Parliamentary standing committee on the bill submitted its report in July 2017 and suggested following changes.**
 - a. Self-identification to bring conformity to international definition
 - b. Providing transgender persons with medical benefits
 - c. Providing quotas in government college and jobs
 - d. Recognize the rights of transgenders person to partnerships and marriages
 - **This has become more crucial after decriminalization of homosexuality by Supreme Court.**
 - **Conclusion1**
 - With various judicial and legal efforts, NALSA Judgment, Transgender Persons (Protection of Rights) Act, 2019 etc., the environment for transgender persons is changing in the country. But, still we need to go a long way in creating a society completely inclusive of LGBTI++ community.
 - **Conclusion2**
 - We need to emulate Kerala Model throughout the country. This state, in last 12 years have turned from a society which was very discriminatory against transgenders to a society which is very inclusive towards transgenders. All this is a result of strong political will where politicians and administrators have acted to reform social attitudes.

3) PRELIMS: INTERSEX INCLUSIVE PROGRESS PRIDE FLAG

- Why in news?

The month of June is recognized as the Pride Month all across the world. While many organization still use the older rainbow pride flag (a simple red to violet rainbow) in their events, the new variation is increasingly accepted as a more inclusive representation of the LGBTQIA+ community (June 2023)

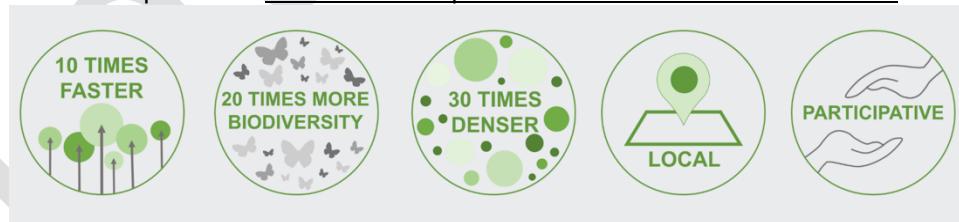


- A Pride flag essentially represents the pride associated with LGBTQIA+ social movement. For centuries people belonging to the community have had to fight for basic rights in countries across the world. The struggle continues in many countries. Uganda, for instance, recently passed a law criminalizing the LGBTQIA+ community.
- History of Pride Flag:
 - The simple rainbow pride flag, designed by Baker, made its debut in 1978 at the San Francisco Gay Freedom Parade. The new flag is based on this very flag.
 - In 2018, American Graphic Designer Daniel Quasar redesigned the flag to include the colors of the transgender flag, blue, light pink, and white. Quasar added the transgender colors along with black and brown color (representing the people in color) in a chevron shape to represent forward movement.
 - The most recent version of the flag is designed by Valentino Vecchietti in 2021 as an inter-sex inclusive Pride flag. A purple circle over a yellow triangle was included in the chevron part of the pride flag. This is a reference to the Intersex pride flag.
 - Why is it called inter-sex inclusive Progress Pride Flag:
 - The intersex has been largely been under-represented within broader queer narratives.
 - According to UN, intersex people are born with sex characteristics (including genitals, gonads, and chromosome pattern) that don't fit typical binary notions of the male or female bodies.
 - In 2021, Intersex Equality Rights (UK) decided to adapt the Pride Progress flag design to incorporate intersex flag, creating the new inter-sex pride flag. Intersex equality rights activists did the redesigning. The colors yellow and purple are used in the intersex flag as a counterpoint to blue and pink which are traditionally seen as gendered colors.

- What do colors of the new flag signify?
 - Red - Life
 - Orange - Healing
 - Yellow - New Ideas
 - Green - Prosperity
 - Blue - Serenity
 - Violet - Spirit
 - Chevron Part:
 - Black and Brown = People of color
 - White, blue and pink = Trans people
 - Yellow with purple circle = Intersex People

1) ENVIRONMENT: MIYAWAKI FORESTS

- **Why in news?**
 - PM Modi talks Miyawaki forests in Mann ki Baat (June 2023: Source - IE)
- **Practice Questions:**
 - Discuss the Miyawaki method of afforestation and its significance in the context of ecological restoration and climate mitigation [10 marks, 150 words]
 - Critically analyze the advantages and limitations of the Miyawaki method compared to traditional afforestation approach. Discuss its potential application and suitability in different regions of India. [15 marks, 250 words]
- **What is Miyawaki Forest?**
 - Miyawaki Forests (also known as Miyawaki method or Miyawaki technique), refer to a unique approach to afforestation and ecological restoration developed by Japanese Botanist Dr Akira Miyawaki. He is a recipient of the 2006 Blue Planet Prize, which is the equivalent of a Nobel prize in ecology.
 - This method aims to create dense, fast growing forests in a short period of time, typically 20-30 years, by emulating the natural growth process of the forests.
- **Details of the method and its advantages:**
 - The method take its inspiration directly from process and diversity in nature: 15 to 30 different species of trees and shrubs are planted together. This plant community works very well together, and is perfectly adapted to local weather conditions.
 - The habitat thus created get more complex over time and attract much more biodiversity. Vegetation becomes much denser than conventional plantations, and it has the structure of a mature natural forest.
 - For e.g. a Kerala based teacher, Raafi Ramnath, has used this method to transform a barren land into a mini forest called Vidyavanam by planting more than a 100 varieties of trees.
 - It is a multistorey structure, where different levels of vegetation appear. The forest thus structured delivers many benefits in the form of ecosystem services.
 - **Faster Recovery:** It would take 200 years to let a forest recover on its own. But with the Miyawaki method a similar result is achieved in 20 years.
 - The technique works worldwide irrespective of soil and climatic conditions.



- **Some challenges and limitations**
 - **Regular Maintenance** requirement: Regular watering, weeding, and pest control can be labor intensive and time consuming
 - **Seed availability** for various kinds of diverse seed is a challenge.
 - **High Initial investment** - Cost of acquiring and preparing land, procuring diverse range of seeds/saplings, and ongoing maintenance expense.
 - **Lack of Long term Data**: Since Miyawaki method is only a few decades old, how sustainable these trees would be over longer period is not very well known.

- **Conclusion:**

- It is important to consider these advantages and limitations when assessing the suitability and feasibility of the Miyawaki method in different contexts. The specific ecological, social, and economic factors of an area should be taken into account for successful implementation and effective decision-making

4. PRELIMS FACTS

1) PLACES IN NEWS: LAKE VICTORIA

- Why in news?

- More robust measures needed to minimize disaster impact in Lake Victoria Basin: Study (June 2023: Source - DTE)

It is the 2nd largest fresh water lake in the world in terms of surface area (after Lake Superior).

It has its boundaries in 3 east African countries (Uganda(45%), Kenya (6%) and Tanzania (49%)). It occupies a shallow depression in Africa.

It is largest lake of Africa.

Source of water for lake Victoria: Mostly rainfall (80%) and thousands of small streams. The Kagera river is the largest river flowing into the lake, with a mouth on lake's western shore.

Lake Victoria is drained solely by the Nile River near Jinja, Uganda, on the lake's northern shore

Mingingo Island

It is a very small island (barely 1/4th of an hectare large) in Lake Victoria.

It is claimed by both Uganda and Kenya and the dispute has continued for a decade now.

The island is a rounded, rocky outcrop which has become densely populated over the last 1 decade.

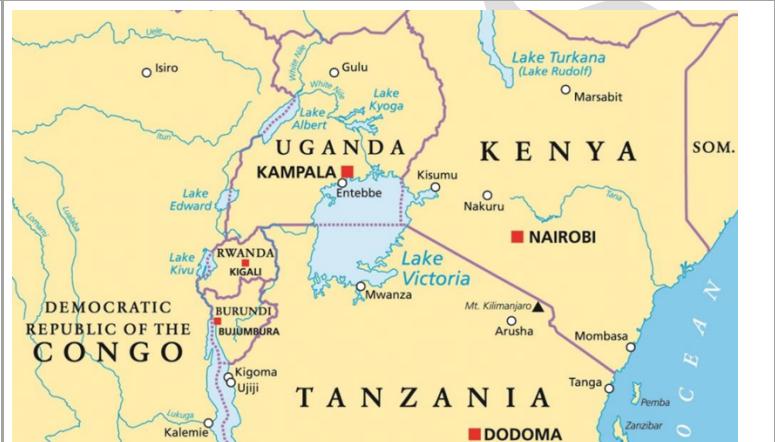
The surroundings of the island is very rich in fishes and is a fisherman's paradise.

Climate Change threatening Lake Victoria Basin (June 2023)

- A new scientific report published in the journal Nature shows significant precipitation changes and increasing extreme climate events in the near future of the already sensitive region, affecting both its large human populations as well as endemic biodiversity.

Note: Country's forming part of Lake Victoria Basin:

1. Uganda
2. Kenya



Note:

Lake Superior is the world's largest fresh water lake by surface area, third largest by volume, and the deepest, largest and coldest of the Great Lakes of North America.

Lake Baikal (located in Russia in the southern region of Siberia), is the largest freshwater lake by both volume and depth (1741 m). It contains 20% of the world's fresh water. It hides its vast waters under a relatively small surface area.

3. Tanzania
4. Rwanda
5. Burundi

Each of this country contributes water to the lake through various rivers, streams, and direct rainfall.

2) PLACES: VENETIAN GRAND CANAL

Venice: It is a city in north-eastern Italy and is the capital of Veneto region. It is built of 118 small islands. That are separated by expanses of open water and by canals.

Venetian Grand Canal:

It is a channel in Venice, Italy. It forms one of the major water traffic corridors in the city.

One end of the canal leads into lagoon near the Santa Lucia Railway Station and the other end leads into the basin at **San Marco**; in between, it makes a large reverse-S shape through the central districts of Venice.

Why in news?

Venetian canal had turned green. Initially known one was able to give a reason. But in June 2023, authorities found that the test samples of the water confirmed the canal's bright new hue was caused by **fluorescein**, a chemical often used to find leaks during underwater construction. The official are investigating how the chemical got into the canal.



3) CULTURE: GANDHI PEACE PRIZE, 2021

- Gandhi peace price is an annual award instituted by Gol in 1995, on the occasion of 125th Birth Anniversary of Mahatma Gandhi as a tribute to the ideals espoused by Mahatma Gandhi.
- Who can get this award?
 - This award is open to all persons, irrespective of nationality, race, language, caste, creed, or gender.
 - The award carries an amount of Rs 1 crore, a citation, a plaque, and an exquisite traditional handicraft/handloom item.
- Past Awardees include ISRO, RK Mission, Grameen Bank of Bangladesh, Vivekananda Kendra, Akshay Patra, Sulabh International.
 - It has also been awarded to luminaries like Nelson Mandela, Dr Julius Nyerere (Former President of Tanzania) etc.
 - Recent awardees include Sultan Qaboos Bin Said Al Said, Oman (2019) and Bangabandhu Sheikh Mujibur Rehman (2020), Bangladesh.

- The Jury headed by the PM Modi, after due deliberation on 18th June 2023 unanimously decided to select **Gita Press**, Gorakhpur as the recipient of the Gandhi Peace Prize for the year 2021, in recognition of its outstanding contribution towards social, economic, and political transformation through non-violent and other Gandhian methods.
- **More About Geeta Press:**
 - Established in 1923, it is one of the world's largest publishers, having published 41.7 crore books in 14 languages, including 16.21 crore Shrimad Bhagvad Gita. The institution has never relied on advertisement in its publications, for revenue generations.

4) SCIENCE: COCAINE

- **Why in news?**
 - "Black Cocaine" worth Rs 32 crores seized at Ahmedabad International Airport (June 2023: Source - PIB)
- **About Cocaine:**
 - It is powerfully **addictive stimulant drug** made from the leaves of the coca plant native to South America. Although healthcare providers may use it for valid medical purpose, such as local anesthesia for some surgeries, recreational cocaine is illegal.
 - As a **street drug**, it looks like a fine, white, crystal powder.
 - **How does cocaine affect the brain?**
 - It increases levels of the natural chemical messenger dopamine in brain circuits related to the control of movement and reward.
 - **Short term effects:**
 - Extreme happiness/ mental alertness/ hypersensitivity to sight, sound, and touch/ Irritability/ Paranoia - extreme and unreasonable distrust of others.
- **About Black Cocaine:**
 - It is a designer drug wherein cocaine is mixed with charcoal and other chemicals to give it black rubbery appearance to camouflage and to evade detection by Canines and field testing kit. This modus operandi to smuggle cocaine is unique and this is the first instance of seizure of "Black Cocaine" by Directorate of Revenue Intelligence (DRI)

5) SCIENCE: SPACE AND ASTRONOMY: STAR BETELGEUSE

- It is one of the brightest and largest known stars in the Milky Way Galaxy. It is located 700 light years away from Earth. It is part of the Orion constellation and is visible to the naked eye in the night sky.
- **Some Key features:**
 - It is a **Red Supergiant** – Thus it is in the last stage in the life cycle of star.
 - **Very Large:** If placed at the center of our solar system, it would extend out to asteroid belt.
 - **Future Supernova:** It is expected to explode as a supernova within the next 100,000 years – a blink of an eye on a cosmic time scale. This explosion will be a spectacular event, potentially visible from Earth even during the day, and the star will outshine the entire galaxy for weeks of months.
- In late 2019, astronomers around the world grew giddy with excitement, because they saw the **Betelgeuse star get fainter than ever before**. There was some speculation that this might be death rattle before the end.

- It was understood that in 2019, Betelgeuse likely underwent an enormous surface mass ejection (SME). An SME happens when a star expels large amount of plasma and magnetic flux into the surrounding space. It is suspected that Betelgeuse lost a large part of its surface material.
- What is remarkable is that Betelgeuse ejected 400 billion times more mass than a typical event on other stars. This is multiple times the mass of Moon, pushed out at incredible speed.

Understanding lifecycle of a star:

- 1) Small or Medium Star (mass less than 8 times the mass of sun):
 - Star -> Red Giant -> White Dwarf (with planetary supernova) -> Black Dwarf
- 2) **Large Stars** (mass more than 8 times the mass of sun)
 - Star -> dying stage (iron core) -> supernova explosion -> Neutron Star -> Black Hole (not all neutron stars will become black hole)

6) ANTHROPOLOGY: DID HOMO NALEDI MADE ROCK ART AND BURIED THEIR DEAD?

A) EVOLUTION OF HUMANS

- The earliest known hominids (man-like species) were members of the ***Australopithecus genus***. They lived roughly between 4.4 and 1.8 MYA and perhaps lived only in Africa (remains have not been found anywhere else so far).
 - ***Ardipithecus*** (or *Australopithecus ramidus*) is the earliest sample of this genus and seems to have evolved from some common ancestor of the hominid and pongid apelines in sub-Saharan Africa about 4.4 MYA.
 - So far, we don't have any evidence to show if *Australopithecus* made any tools. They may have used naturally available material as tools.
- **About Homo Genus:** This is the genus to which humans belong. Like modern humans, other species in the group had large brains and used tools.
- **Homo Habilis:**
 - The earliest known (from fossil evidence so far) representative of '***Homo***' genus is ***Homo habilis*** (hand using man) who was found in Kenya and Tanzania about **2.8 MYA**.
 - The **earliest stone** tool have been found at **Hadar in Ethiopia** and have been dated about 2.5 MYA.
 - These tools were used to scrape flesh from carcasses of animals killed by carnivores, and crack open long bones for their marrow content.
 - These 'first humans', thus became scavengers on animal left-overs. The most probably exploited a time window around mid-day when the carnivores were resting (hyenas arrived nocturnally to devour the leftovers). Walking upright freed their arms to carry bones away to be processed in safe sites to augment the plant-based dietary staples.
 - **Losing of body hairs:** To facilitate mid-day movements -> fur-covered animals will soon overheat.
- **Homo Erectus** (fully erect posture) appeared in east Africa around 1.7 MYA. From here, the species spread to various parts of Africa, Asia and Europe.
 - They are the earliest known humans to have possessed modern human like body proportion with relatively elongated legs and shorter arms.
 - These early humans were efficient hunters.
 - A division of labor came about. Men Hunted; women gathered plants.

- **Homo Neanderthalis** (lived between 400,000 - 40,000 years ago) in Europe and Southwestern to Central Asia.
 - The Neanderthals, *Homo neanderthalensis* or *Homo Sapiens Neanderthalensis*, is an extinct species or subspecies of archaic humans that lived until about 40,000 years ago.
 - They are known from many fossils. The species was first located in 1856 in the Neander Valley of the present day Germany, identified from fossils which were 1,30,00 years old.
 - Whether Neanderthals got merged into *Homo Sapiens* or whether they became extinct remains a mystery. They are the closest extinct human relatives
- **Homo Denisovans:**
 - The **Denisovans** shared a common ancestor with Neanderthals until their population diverged 380,000 to 470,000 years ago. This was much later than the split between modern humans and Neanderthals/Denisovans, which occurred between 5,50,000 and 7,60,000 years ago.
 - ‘**Hominin Denisova**’ was discovered by Swedish Paleo geneticist Svante Paabo, the winner of 2022 Nobel Prize in Medicine.
 - In 2012, Paabo and his team sequenced the DNA of a well-preserved fragment of the bone that was 40,000 years old and found in 2008 in the Denisova Cave in southern Siberia. The result was astounding they had come across an entirely novel hominin, distinct from Neanderthals and even more from modern humans.
 - In the same cave, palaeontologists later discovered the fossil of a girl who was part Neanderthal and part Denisovan, proving that these two species interbred.
 - Little is known about what the Denisovans looked like because they have left few fossilized traces of their time on Earth other than fragments found in Siberia and a jawbone discovered on the Tibetan Plateau in 2019.
- **Homo Sapiens** appeared for the first time around 5,00,000 years ago.
 - From around 130,000 years ago, there is evidence of Homo Sapiens neanderthalis (Neanderthals) in various parts of western and central Asia and in Europe. Whether Neanderthals got merged into Homo Sapiens or whether they became extinct remains a mystery.
- **Anatomically modern humans**, known as *Homo sapiens*, seem to have appeared in Africa between 1,95,000 and 1,50,000 and eventually replaced all other Homo Sapiens.
- **Note:** Evolution is not a neat unilinear process. There are overlap and co-existence of species

B) HOMO NALEDI

Major new research claims smaller brained Homo naledi made rock art and buried the dead. But the evidence is lacking (June 2023: Source - TH)

- Homo Naledi were the short stature, small-brained, ancient cousins who are thought to have lived in Southern Africa between 335,000 and 241,000 years ago.
- They were first discovered in 2013 in South Africa's rising star cave system.
- Rising Star cave system is an exceptional resource for exploring the origins of our species.
- New studies claim that Homo Naledi intentionally buried their dead (a sophisticated practice we generally associate with homo sapiens) and made rock art, which suggests advanced cognitive abilities.
- But these findings have been challenged by several archaeologists

7) BIODIVERSITY: HIMALAYAN BROWN BEAR (URSUS ARCTOS ISABELLINUS)

- **Why in news?**
 - An Himalayan brown bear (*Ursus arctos isabellinus*) as captured by J&K Wildlife Department on May 13, 2023, at Rajwara in the North Kashmir district of Handwara, days after it was found wrecking graveyards, reportedly in search of human cadavers to eat (June 2023: Source - DTE)

It is the largest animal in Himalayas and is usually reddish brown in color. They inhabit altitudes ranging from 2,000 to 2,500 metres, predominantly above the tree line.

It also shows sexual dimorphism (Males (1.5 - 2.2m), Females (1.37 - 1.83m)).

Distribution: Nepal, Pakistan, and Northern India. In Hemis National Park, Great Himalayan National Park, Nanda Devi Park -> this may be seen as the giant mammal walking upright.

IUCN Status: CR

Please note that IUCN status of Brown bear is LC (due to its wide distribution). But the Himalayan subspecies is CR.

Updates:

Human encroachment in wildlife has led to bears straying more often into human-dominated areas. Several incidents from various villages of J&K such as Behnipora, Budshungi, and Shatiam have been reported, where more than one bear may have entered.

Key reasons: Insufficient food in their habitats;



8) BIODIVERSITY: ORCHIDS OF DARJEELING HILLS AND DOAB ARE FACING THREATS

- **What are orchids?**
 - They are a diverse and widespread group of flowering plants, with blooms that are often colorful and often fragrant commonly known as the **Orchid** family. They belong to the family **Orchidaceae**, which is one of the largest family of flowering plants with possibly over 27,000 species and more than 800 genera.
 - **Habitats:** Orchids can be found in nearly every habitat, but most orchid species are tropical.
- **The Botanical survey of India**, in 2019 came up with the first comprehensive census of orchids in India putting the total number of orchid species to 1256.
 - **Orchids can be classified** in three types:

- » **Epiphytic:** (Plants growing on another plants including those growing on rock boulders and often termed lithophyte).
- » **Terrestrial:** (Plants growing on land and climbers)
- » **Mycoheterotrophy:** (Plants that derive nutrients from mycorrhizal fungi that are attached to the roots of a vascular plants).
- » In India, of all orchids 757 are epiphytic, 447 are terrestrial, and 43 are mycoheterotrophy.
- **State wise distribution:**
 - » **Arunachal Pradesh** (612 species); Sikkim (560 species) and West Bengal (with Darjeeling Himalayas having high species concentration) with 479 species.

- Orchids of North Bengal are facing threats (June 2023)

- The wild orchids of Darjeeling Hills and Dooars are facing threats due to habitat loss (mostly due to deforestation).
- **The most endangered** are the epiphytic orchids - the type that grows on another plant/tree merely for physical support. Please note that they are not parasitic and use trees only for support.
- Orchids are also natural gauges of air quality because they don't grow in polluted air
- **Applications:**
- The Oraon and Kharia tribal communities use wild orchids to treat range of diseases - cut and fractures, skin diseases, aches and pains.

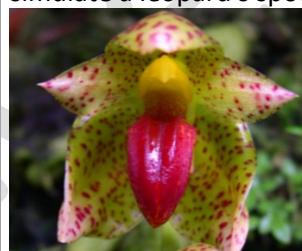


Some Important species of Orchids:

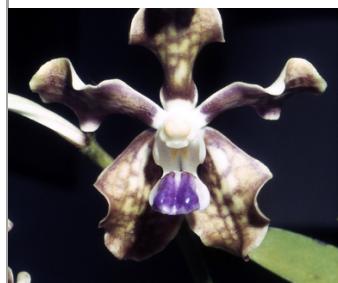
The Dendrobium aphyllum carries pinkish violet, fragrant flowers;



The Bulbophyllum leopardinum, with its pale green and spotted red flowers simulate a leopard's spots;



Vanda Tessellate is greenish with a striking blue purple lip



Dendrobium transparens



Aerides Maculosa - Foxrush Orchid



9) DEFENCE: INS KIRPAN

- **Why in news?**
 - India gifts missile Corvette INS Kirpan to Vietnam (June 2023)
- **Details:**
 - INS Kirpan is a Khukri class missile corvette displacing 1,350 tonnes and was commissioned into the navy on Jan 12, 1991.
 - The ship is fitted with a medium range gun, 30 mm close range guns, chaff launchers, and surface to surface missiles, enabling it to perform a wide variety of roles, including coastal and offshore patrol, coastal security, anti-piracy, HADR operations etc.
- **Gift to Vietnam**
 - India gifted indigenously built in service missile corvette INS Kirpan to Vietnam to enhance that country's Naval capabilities.



TARGET PRELIMS 2024

CURRENT AFFAIRS PROGRAM

BOOKLET-1, S&T-1

SPACE AND ASTRONOMY

1. TABLE OF CONTENTS

1. <i>Table of Contents</i>	0
1. <i>Some Basics About Satellite Orbits</i>	3
1) Orbit:	3
2) Types of Orbits: 1. Circular (LEO, MEO, GSO) 2. Elliptical Orbits	4
A) Low Earth Orbit (Circular Orbit)	4
B) Medium Earth Orbit	5
C) Geosynchronous Orbit and Geostationary Orbit	5
3) Highly Elliptical Satellite Orbits	7
4) Transfer Orbits	7
a) Geostationary Transfer Orbit	7
5) Some other basics (Class Discussion)	7
2. <i>Timeline: India in Space, through the Years</i>	8
3. <i>ISRO Launchers (Operational)</i>	11
1) PSLV (Polar Satellite Launch Vehicle)	11
A) Solid Fuel Engine vs Liquid Fuel Engine (Extra Gyan)	12
B) PSLV C-58	13
C) PSLV C-57/ Aditya-L1 Mission (Sep 2023)	14
D) PSLV-C56 / DS-SAR Mission (July 2023)	14
E) PSLV C-55/TeLEOS-2 Mission (April 2023)	14
2) GSLV (Geosynchronous Satellite Launch Vehicle)	15
A) Launch Vehicle Mark 3 (LMV3 or GSLV Mark 3)	15
B) India's Journey towards developing its own cryogenic engine	16
4) Sounding Rockets	17
4. <i>Other Engines and related projects in News</i>	18
1) ISRO's Next-Gen Launch Vehicle (NGLV) may assume PSLV's Role	18

2)	Semi-cryogenic Engine (Under development)	18
3)	Differences between Cryogenic Engine and Semi-Cryogenic Engine.....	18
4)	Reusable Rockets: Revolutionizing Access to Outer Space	19
5)	Low-Cost Small Satellite Launcher (SSLV)	19
5.	<i>ISRO Satellites.....</i>	21
1)	Basics	21
2)	Communication Satellites.....	21
A)	Communication satellites of India / ISRO	21
B)	Recent ExAmples of Communication Satellites	22
3)	Earth Observation Satellites (Photography, Imaging and Scientific Surveying).....	22
4)	Satellite Navigation (SAT – NAV)	23
A)	Basics About SATNAV.....	23
B)	Global Positioning System (GPS)	23
C)	BeiDou.....	24
D)	GAGAN and GEMINI (class discussion).....	25
E)	NAVIC (Navigation using Indian Constellation).....	25
5)	Satellites to study the Sun: ADITYA L1.....	26
6.	<i>Other Important Projects of ISRO</i>	29
1)	Project NETRA	29
2)	Mission Shakti.....	29
3)	Gaganyaan	29
4)	XPOSAT (X-RAY Polarimeter Satellite)	29
A)	Understanding Polarization – Class Discussion.....	31
B)	Understanding Polarized Glasses.....	31
5)	NASA-ISRO Synthetic APerture Radar (NISAR) Imaging Satellite	31
7.	<i>NASA's Interplanetary Mission.....</i>	32
1)	Mars Orbiter Mission	32
2)	Venus: Shukrayaan-1.....	32
3)	Chandrayaan 3.0 (LVM3-M4) Mission.....	33
A)	Understanding the different phases and path taken by Chandrayaan	33
B)	Components of Chandrayaan 3.0:	33
C)	Landing was the most complicated part here:.....	34
D)	Where did Lander Land?.....	35
E)	Rover:.....	35
E)	Comparing Chandrayaan-1, Chandrayaan-2 and Chandrayaan-3.....	35
D)	Chandrayaan 3 Propulsion Module Retraces Steps to Earth Orbit: Why it matters? (Dec 2023)	36
E)	Significance of Going to Moon:.....	36
8.	<i>Other Important Projects of ISRO</i>	36
1)	India's Own Space Station: Plans	36
8.	<i>International Collaboration in News.....</i>	37

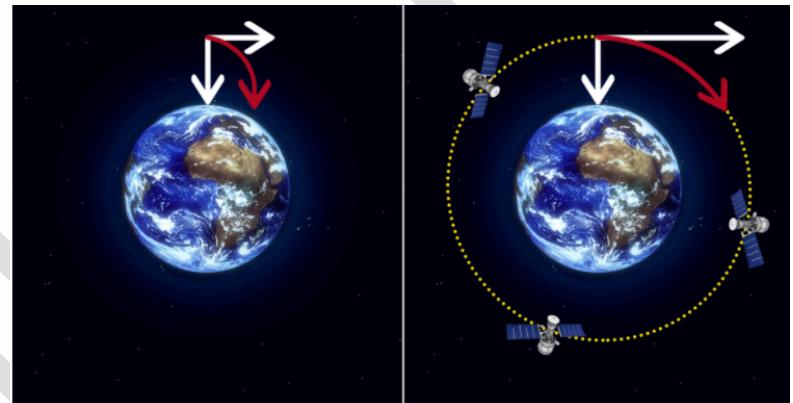
1)	ISRO – nOrway	37
A)	Svalbard Mission of 1997	37
9.	Important Telescopes in news recently.....	37
1)	Various Telescopes at Devasthal	37
2)	India's first Dark Sky ReservE.....	38
a)	The Indian Astronomical Observatory (IAO)	40
10.	Space Infrastructure in India.....	40
A)	Vikram Sarabhai Space Centre (VSSC):	41
B)	UR Rao Satellite Centre (URSC)	41
C)	Satish Dhawan Space Centre (SDSC)-SHAR	41
D)	Liquid Propulsion Systems Centre (LPSC).....	41
E)	Space Application Centre (SAC)	41
F)	Human Space FLight Centre (HSFC)	41
G)	National Remote Sensing Centre	42
H)	ISRO Propulsion Complex (IPRC)	42
I)	ISRO Telemetry, Tracking and Command Network (ISTRAC)	42
J)	Master Control Facility (MCF)	42
K)	ISRO INtential Systems UNIT (IISU).....	42
L)	Laboratory for Electro Optics Systems (LEOS)	42
M)	Indian Institute of Remote Sensing (IIRS)	43
N)	Development and Educational Communication Unit (DECU)	43
O)	National atmospheric Research Laboratory	43
P)	NORTHEASTERN-Space Applications Centre (NE-SAC).....	43
Q)	Indian Institute of Space Science and Technology	43
R)	Antrix Corporation Limited (ACL).....	43
11.	Important Personalities.....	43
A)	Dr Vikram Sarabhai (12 th Aug 1919 – 30 th Dec 1971).....	44
B)	S Somnath	44
12.	Commercialization and Privatization in Space Sector.....	44
A)	Prarambh Mission	44
2)	New Institutions.....	45
b)	New Space India Limited (NSIL)	45
B)	In-Space (Indian National Space Promotion and Authorization Centre).....	46

1. SOME BASICS ABOUT SATELLITE ORBITS

1) ORBIT:

- An orbit is the curved path that an object in space (such as a planet, moon, star etc.) takes around another object due to gravity.
 - Objects of similar mass orbit each other with neither object at the centre, whilst small objects orbit around large objects. In our Solar system, earth revolves around sun, Moon revolves around earth.
- **Satellite Orbits:** The path that satellite takes to revolve around a planet due to force of gravity is called satellite orbit.

- **Gravity and Speed of Satellite in an orbit**



- **How are satellites placed in Orbit – Circular vs Elliptical Orbit** - Detailed Class Discussion

- **Orbital Velocity – Circular vs Elliptical**

- For a circular orbit, it is always the same.
- However, in the case of an elliptical one this is not the case as the speed changes dependent upon the position in the orbit. It reaches the maximum when it is closest to the earth and it has to combat the greatest gravitational pull, and it is at its lowest speed when it is furthest away.

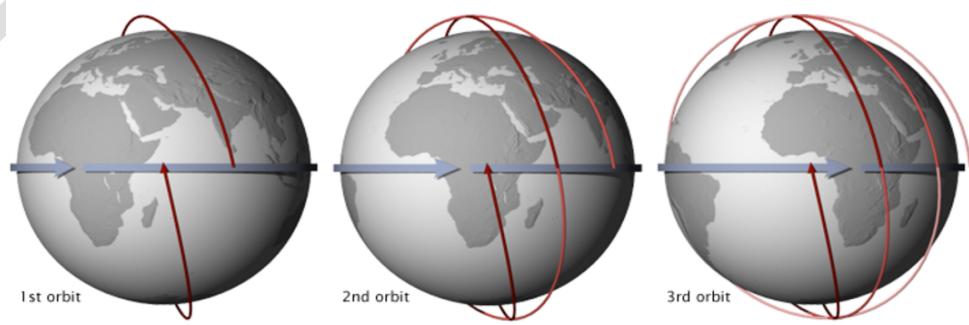
2) TYPES OF ORBITS: 1. CIRCULAR (LEO, MEO, GSO) 2. ELLIPTICAL ORBITS

A) LOW EARTH ORBIT (CIRCULAR ORBIT)

- A low earth orbit is an orbit around earth with an altitude between 160 kilometers and 2000 Kilometers. Objects below approximately 160 Kilometers will experience very rapid orbit decay and altitude loss.
- It is used for vast majority of satellites.
 - Most satellites
 - All human space flights (except manner lunar flight of the Apollo program);
 - All space stations.
- **Main Characteristics**
 - **Low orbital period**
 - **Satellites closer to earth** -> better visibility -> earth observation/remote sensing satellites.
 - **Easier placement of satellite in orbit**
 - **Lower latency in communication** -> less round-trip time.
 - **Satellites face lower radiations** when compared to satellites at higher altitudes.
- **Applications**
 - **Earth Monitoring Satellites**
 - As they are able to see the surface of the earth more clearly
 - **Communication satellites**
 - Especially the satellite phones
 - **International Space Station** is at a height of 400 km.

SUN SYNCHRONOUS ORBIT (CIRCULAR OR ALMOST CIRCULAR) (POLAR ORBIT)

- **Satellites in Polar Orbit** usually travel past Earth from north to south rather than from west to east, passing roughly over Earth's pole. They don't have to pass the north pole or south pole precisely. Even a deviation within 20 to 30 degrees is still classed as polar orbit.
- **Sun Synchronous Orbit** is a kind of Polar Orbit. In this orbit, satellites are synchronized to always be in the same fixed position relative to the Sun. This means that the satellite always visits the same spot at the same local time. In this orbit, whenever and wherever the satellite crosses the equator, the local solar time on the ground is always the same.



- A sun synchronous combines altitude and inclination in such a way that an object on that orbit will appear to orbit in the same position, from the perspective of the sun, during its orbit around the earth. In other words, it orbits in such a way that **it precesses once a year**. The surface illumination angle will nearly be same every time.
- Typical sun-synchronous orbits are about **600-800 Km in altitude**, with periods in the 96-100-minute range, and inclination of around 98 degrees.
- Possible only around oblate planets like Earth, Mars etc. The extra mass around the equator makes the precess possible. But Venus is too spherical to have a Sun Synchronous Satellite orbit.

□ Significance of Sun-Synchronous Orbit

- SSPO keeps the angle of sunlight on the surface of the earth as consistent as possible, though the angle will change from season to season. This consistency allows scientists to compare images from the same season over several years without worrying about too much extreme changes.
- **Kinds of satellite put in Sun-Synchronous orbit:** Imaging, Spy and weather satellites (e.g. Cartosat-2 series)

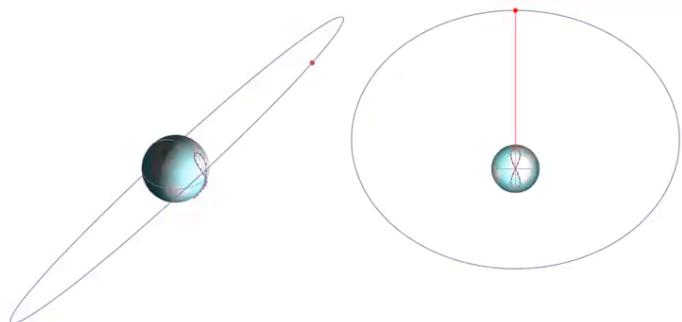
B) MEDIUM EARTH ORBIT

- **Height:** 2000 km to 3,5786 kms
- Satellite speed is lower (compared to LEO)
- **Orbital Period** range from 2 to 24 hours.
- **Most common use** of satellite in this orbit is for navigation, communication, and geodetic/space environment science.
- **Most common altitude** is approximately **20,200 km**, which yields an orbital period of 12 hours as used for examples by GPS.
- **E.g:**
 - GPS Satellites Fly in Medium earth orbit at an altitude of approximately 20,200 km.
 - Galileo (the satnav system of Europe) is also located in MEO.

C) GEOSYNCHRONOUS ORBIT AND GEOSTATIONARY ORBIT

GEO-SYNCHRONOUS ORBIT

- It is a satellite orbit around the earth with an **orbital period that matches Earth's rotation period on its axis** (i.e., orbital period is 23 hours 56 minutes and 4 seconds), irrespective of inclination.
 - » A person on a point on Earth, will see a satellite in this orbit in the same place in the sky at the same time of the day, every day.



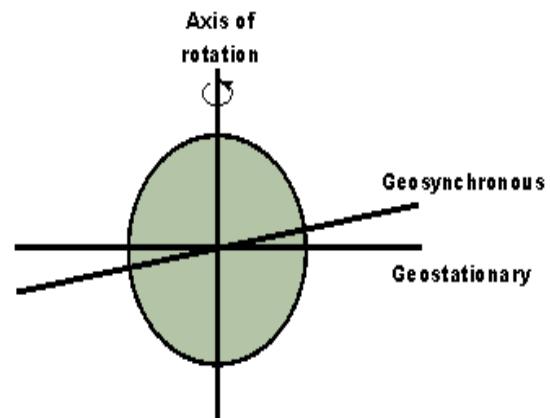
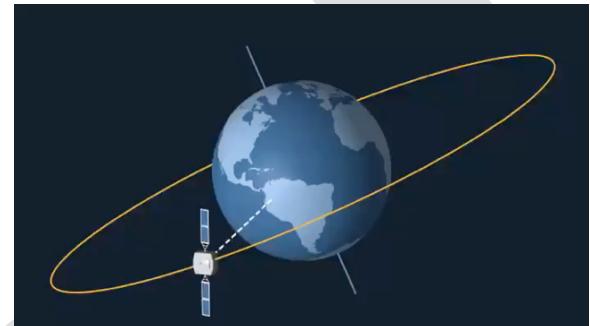
- » Over the course of a day, the object's position in the sky traces out a path, typically in a figure-8 form, whose precise characteristics depend on the orbit's inclination and eccentricity.

- Requirements:

- » **Circular Orbit of Height 35786 km**. At this height an orbital period of satellite is equal to earth's rotation period.
- » **Direction of revolution** of satellite should be same as direction of rotation of earth.

GEO-STATIONARY - A SPECIAL CASE OF GEOSYNCHRONOUS

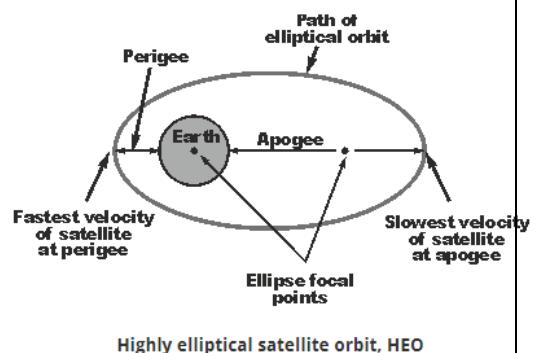
- A Geostationary Orbit is a particular type of Geosynchronous orbit, the distinction being that while an object in Geosynchronous orbit returns to the same point in the sky at the same time each day, an object in geostationary orbit never leaves that position.
- **Requirements for a satellite to be geostationary?**
 - Geosynchronous requirements
 - The equatorial plane of earth must be coplanar with the orbital plane of the satellite revolution (i.e., angle of inclination of orbit to equator is 0 degrees)
- Communication satellites and weather satellites are often placed in Geostationary orbits, so that satellite antenna which communicate with them don't have to rotate to track them but can be pointed permanently at the position in the sky where they stay.
- **Advantages**
 - Geo systems have significantly greater available bandwidth than the Low Earth Orbit
 - LEO and Medium Earth Orbit
 - Covers 1/3rd of Earth's surface.
 - Less expenses on tracking activities
 - Higher life span of satellites
- **Limitations**
 - Would require line of sight communication paths between terrestrial antenna and the satellites.
 - Long path length, and hence losses when compared to LEO, or MEO.
 - Long path length introduces delays.
 - Satellite costlier to install in GEO in view of the greater altitude
 - Geostationary Orbit (GEO) can only be above equator and therefore poles can't be covered.



Geostationary orbit can only be over the Equator

3) HIGHLY ELLIPTICAL SATELLITE ORBITS

- Elliptical Orbits are often called Highly Elliptical orbits or HEO.
- Key Features
 - Follows the curve of an ellipse.
 - Moves much faster when it is near earth and slower when it is away from earth.
 - There are two focal points and one of these is the geocentre of the earth.
 - **Apogee:** Point where the satellite is furthest from Earth - gravitation pull is lowest - satellite moves the slowest
 - **Perigee:** Point where the satellite is nearest from earth - gravitation pull is highest - satellite moves the fastest
 - **How permanent coverage can be achieved?**
- Applications
 - Provide coverage at any point on the globe
 - It may provide high latitude and polar coverage.
 - Countries such as Russia which needs coverage over polar and near polar areas make significant use of highly elliptical orbits.

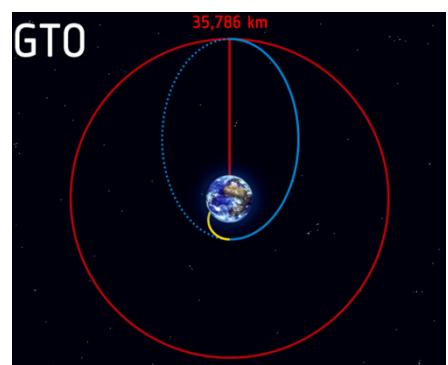


4) TRANSFER ORBITS

- These are special kind of orbits used to transfer satellites/spaceships from one orbit to another. These orbits are elliptical, with its perigee closer to earth. Satellites are taken to Perigee with the help of a rocket. After reaching this orbit, satellites by using relatively little energy from built in motors, can move to another larger orbit.
- This allows a satellite to reach a very high orbit, without needing the rocket to go to that height. **Geostationary Transfer Orbit (GTO)** is the most common type of transfer orbit.

A) GEOSTATIONARY TRANSFER ORBIT

- It is a Hohmann transfer orbit used to reach, geosynchronous or geostationary orbit. It is highly elliptical earth orbit with an apogee of 42,164 km, or 35786 km above sea level. Perigee can be anywhere above atmosphere, but it is generally restricted to few hundred Kms above the earth's surface.
- **Hohmann transfer orbit:** It is an elliptical orbit used to transfer between two circular orbits of different radii in the same plane.

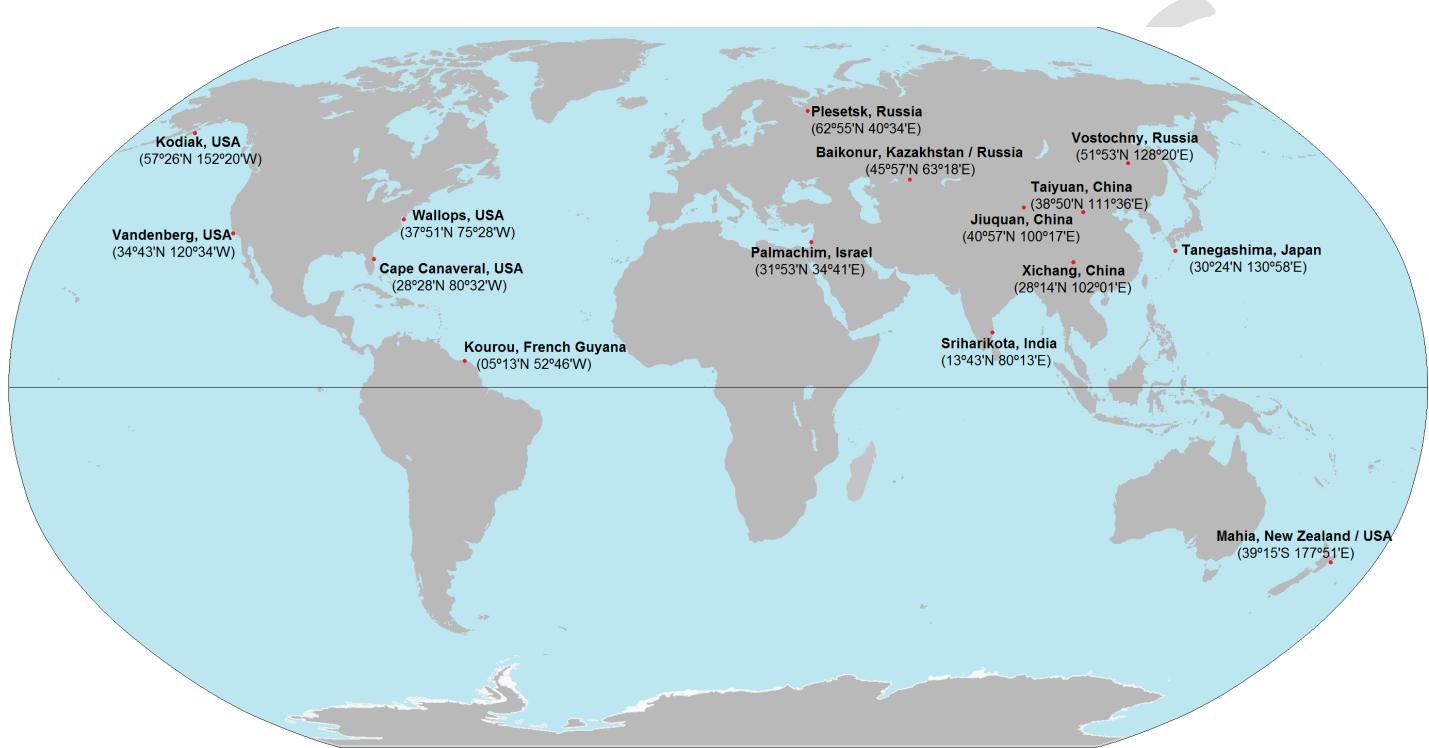


5) SOME OTHER BASICS (CLASS DISCUSSION)

Why are satellites generally launched in west to east direction?

Why are satellites generally launched from the east coast?

Why are satellites launched from near the equator?



2. TIMELINE: INDIA IN SPACE, THROUGH THE YEARS

- 1) **1962:** The Indian National Committee for Space Research is formed under the leadership of Vikram Sarabhai and physicist Kalpathi Ramakrishna Ramanathan
- 2) **21 Nov 1963:** India's space program takes off with launch of a sounding rocket from Thumba Equatorial Rocket Launching Station in Kerala. It was for probing upper atmosphere.
- 3) **Aug 15, 1969:** ISRO is formed.
- 4) **Aug 19, 1975:** Aryabhata – India's first satellite is launched from a Soviet Kosmos-3M rocket from Kapustin Yar in the Soviet Union. It was designed and built in India.
- 5) **1979:** Bhaskara-1, the first experimental remote sensing satellite built in India, is launched. Images taken by its camera were used in hydrology, forestry and oceanography.
- 6) **1980:** Satellite Launch Vehicle (SLV)-3, India's first experimental satellite launch vehicle, takes off with Rohini Satellite RS-D2. Camera had the ability to use data for classifying ground features like water, vegetation, bare land, clouds and snow.
- 7) **1982:** INSAT 1-A is launched. Abandoned in 1983 where its altitude control propellant was exhausted.

- 8) **1984:** Rakesh Sharma, former IAF pilot, becomes the first Indian in space. In a joint India-Soviet Union Mission, Sharma boards the Soyuz T-11 spacecraft to the Salyut 7 orbital station.
- 9) **2008:** Launch of Chandrayaan-1. It orbits the Moon but doesn't land. It performs high resolution remote sensing aiming, among various missions, to prepare a 3D atlas of both the near and far sides of the moon.
- 10) **2013:** Launch of Mangalyaan, the Mars Orbiter Mission. Orbiting and studying Mars since Sep 24, 2014.
- 11) **2016:** All 7 satellites of IRNSS system placed in Orbit
- 12) **2019:** Chandrayaan-2 launched using GSLV MK-III
- 13) **2023:** Chandrayaan-3 succeeded in landing on the surface of the moon.

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3. ISRO LAUNCHERS (OPERATIONAL)

PSLV, GSLV, Sounding Rockets are three broad categories of rockets (launchers) that ISRO has developed over the years.

Both PSLV (Polar Satellite Launch Vehicle) and GSLV (Geosynchronous Satellite Launch Vehicle) are the satellite launch vehicles (rockets) developed by ISRO.

1) PSLV (POLAR SATELLITE LAUNCH VEHICLE)

- The PSLV is the third-generation satellite launch vehicle of India. It is an expandable system and was the first Indian Launch Vehicle to be equipped with Liquid Stage.
 - **Note:** ISRO has over the years realized **5 generations of rockets** – SLV, ASLV, PSLV, GSLV, and GSLV-MK-III.
- **Where is PSLV used?**
 - It was developed to allow India to launch its Indian Remote Sensing (IRS) satellite into **Sun synchronous orbit**, a service that was, until the advent of the PSLV, commercially available only from Russia.
 - PSLV can also launch small size satellites into **Geostationary Transfer Orbit**.
- It is one of the world's most reliable launch vehicles.

PSLV was developed for Low Earth Orbit satellites into Polar and Sun Synchronous Orbits, and GSLV for heavier INSAT class of Geosynchronous satellites into orbit.

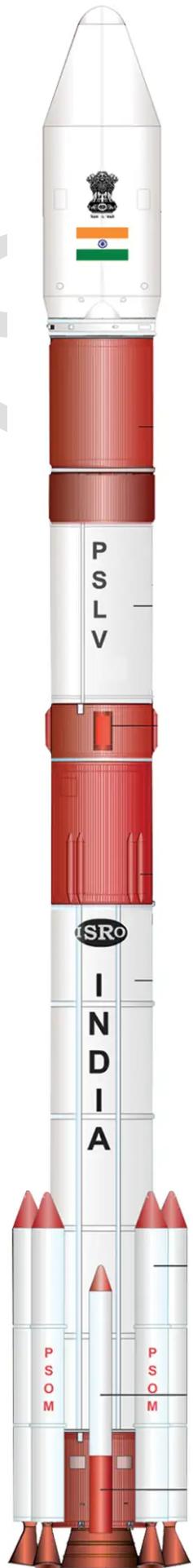


	SLV-3	ASLV	PSLV-XL	GSLV MK-II	GSLV MK-III
Height	22.7 m	23.5 m	44 m	49 m	43.43 m
Liftoff weight	17 t	39 t	320 t	414 t	640 t
Propulsion	All solid	All solid	Solid and liquid	Solid, liquid, and cryogenic	Solid, liquid, and cryogenic
Payload mass	40 kg	150 kg	1860 kg	2200 kg	4000 kg
Orbit	Low Earth Orbit	Low Earth Orbit	475 km Sun Synchronous Polar Orbit*	Geosynchronous Transfer Orbit	Geosynchronous Transfer Orbit

- **Launches So Far**
 - Developed in early 1990s, its first launch in 1993 was a failure.
 - First successful launch of PSLV took place in 1994 and till Jan 2023 (i.e., PSLV C-58), PSLV has had 60 launches with only two failures.

- Technical Specifications of PSLV

- **Payload Capacity:** SSPO (1,860 Kg); GTO (1,425 Kg)



- **Key features of PSLV Engines:** PSLV has four stages using solid and liquid propulsion alternatively.
- **Expansion of capabilities: Strap on Motors**
 - PSLV uses 6 solid rocket strap-on motors to augment the thrust provided by the first stage in its PSLV-G (1678 kg in SSPO) and PSLV-XL (1750 kg to SSPO) variants. PSLV-DL, PSLV-QL versions use 2 and 4 straps on motors respectively. PSLV-CA (1100 kg in LEO) uses no strap on motors.

» **Key Significance and Achievements of PSLV**

- **Reliability:** Only 2 failures in almost 3 decades of service and 60 launches.
- **Commercial use:** PSLV has launched **more than 350 foreign satellites** from 34 different countries so far.
- It has played significant role in various major ISRO missions (including Chandrayaan-1, MOM, IRNSS system etc.)
- **Strengthen India's Soft Power**
- Many **learnings** from the development of PSLV has helped scientists develop several non-space applications like fire resistant tiles, better engines for missiles etc.

A) SOLID FUEL ENGINE VS LIQUID FUEL ENGINE (EXTRA GYAN)

- » **A solid rocket fuel** has its fuel and oxidant mixed together as fine powders and then pressed into solid cake.
 - **Key characteristics**
 - **Higher Thrust** -> Higher force to launch the vehicle.
 - **Less volume**
 - **One time burn** -> all fuel burns at the same time, i.e., once it has been lit it will carry on burning until it is used up.
 - **Produces a lot of smoke** -> **large particles** when fired
- » **A liquid fuel engine** uses liquid fuel which can have following advantages
 - **Controlling Thrust**
 - **Engine can be shut down and restarted**
 - **Higher energy density** (joules per kg of propellant) is higher.
 - **Higher Specific Impulse** (impulse (in Newton second) per kg of propellant)
 - E.g., a modern solid fuel rocket has specific impulse of around 2500 N s Kg⁻¹, while a good liquid fuel rocket produces an impulse of about 4500 N s Kg⁻¹.
 - **Disadvantage: More complicated Engine requirements and thus more expensive and heavier engine** -> pumps, piping, separate storage for the fuel and oxidant means that extra mass has to be carried by the launch vehicle.

» **Why Hybrid Engines**

- Vastly reduce overall system weight and cost. It increases reliability (a smaller number of components which can fail)

B) PSLV C-58

- ISRO's PSLV C-58 has launched **XPOSAT Satellite** into an eastward low inclination orbit on 1st Jan 2024.
- After injection of XPOSAT, the PS4 stage was restarted twice to reduce the orbit into 350 km circular orbit for orbital platform (OP) experiments. The PSLV Orbital Experiment Module-3 (POEM-3) experiment was executed to meet the objective of 10 identified payloads, supplied by ISRO and IN-SPACe.
 - » These 10 payloads are developed by start-ups, education institutions and ISRO Centres.
 - » They are:
 - The Radiation Shielding Experimental Module (RSEM) by TakeMe2Space;
 - Women Engineered Satellite (WESAT) by LBS Institute of Technology for Women;
 - BeliefSa-t0 Amateur radio satellite by K.J. Somaiya Institute of Technology;
 - Green Impulse TrAnsmitter (GITA) by Inspecty Space Labs Private Limited;
 - Launching Expeditions for Aspiring Technologies -Technology Demonstrator (LEAP-TD) by Dhruva Space Private Limited
 - RUDRA 0.3 HPGP by Bellatrix Aerospace Private Limited;
 - ARKA-200 by Bellatrix Aerospace Private Limited;
 - Dust Experiment (DEX) by PRL;
 - ISRO Fuel cell Power System (FCPS) by VSSC, ISRO and;
 - FCPS payload is significant as it has potential applications in India's space station which is proposed to come up by 2035.
 - Si-based High Energy cell by VSSC, ISRO
- **Note:** This is the third time ISRO has operated the PSLV fourth stage in this way.
- **Thus**, it can be said that the PSLV-C58 mission represents a union of the aspirations of professional scientists, aspiring students of science, and India's private spaceflight sector.

ISRO SUCCESSFULLY TESTS POLYMER ELECTROLYTE MEMBRANE FUEL CELL ON PSLV'S-C58'S ORBITAL PLATFORM POEM3 (JAN 2024)

- ISRO successfully tested a 100 W class Polymer Electrolyte Membrane Fuel Cell based power system in its orbital platform, **POEM-3** which was launched onboard PSLV-C58 on 1st Jan 2024.
- The objective of the experiment was to assess Polymer Electrolyte Membrane Fuel Cell operation in space and to collect data to facilitate the design systems for future mission.
- **Outcome of the test:**
 - » During the short duration test onboard POEM, 180 W power was generated from Hydrogen and Oxygen gases stored onboard in high pressure vessels. It provided a wealth of data on performance of various static and dynamic systems.

C) PSLV C-57/ ADITYA-L1 MISSION (SEP 2023)

D) PSLV-C56 / DS-SAR MISSION (JULY 2023)

- The launch of PSLV C-56 carrying DS-SAR satellite, along with 6 co-passengers [all 7 Singaporean satellites] was accomplished successfully on July 30, 2023.
- PSLV C-56 was configured in **core alone model**, similar to C-55.
- **DS-SAR** is a 360 kg satellite into a Near-equatorial Orbit (NEO) at 5 degrees inclination and 535 km altitude.
 - DS-SAR satellite is used for satellite imagery requirements of various agencies within the government of Singapore.
 - It carries a Synthetic Aperture Radar (SAR) payload developed by Israel Aerospace Industries (IAI). This allows DS-SAR to provide all weather day and night coverage, and capable of imaging at 1m-resolution at full polarimetry.
- After the launcher placed all the seven satellites into a 535 km circular orbit, **PS4 stage was brought back to a lower orbit of 295 km X 300 orbit**. This has been done so that the stage spends less time in space, reducing its duration from over two decades to less than two months, before re-entering into the earth's orbit.

E) PSLV C-55/TELEOS-2 MISSION (APRIL 2023)

- **PSLV C-55/ TeLEOS-2** was launched successfully on April 22, 2023, from SDSC-SHAR, Sriharikota.
- This is a dedicated commercial mission through NSIL with **TeLEOS-2** as primary satellite and **Lumelite-4** as a co-passenger satellite.
- The satellite weigh about 741 kg and 16 kg respectively. Both belong to Singapore.

POEM-2: The mission has the PSLV Orbital Experiment Module (**POEM**), where the spent PS4 stage of the launch vehicle would be utilized as an orbital platform to carryout scientific experiment through non-separating payloads. The payloads belong to ISRO, Bellatrix, Dhruva Space, and Indian Institute of Astrophysics.

2) GSLV (GEOSYNCHRONOUS SATELLITE LAUNCH VEHICLE)

- **Background of GSLV**
 - » GSLV is an expandable launch system operated by ISRO.
 - » First launch in 2001. First successful flight in 2003: successfully placed GSAT-2 in 2003.
 - » **Main Purpose:** GSLV was primarily developed to launch INSAT class of satellites into Geosynchronous Transfer Orbits. GSLV is being used for launching GSAT series of satellites.
 - » **Payload to GTO:** Presently GSLV-mk-II can inject 2.5 ton (GSLV Mk-2) of communication satellite into Geosynchronous Transfer Orbit.
 - » **Payload to LEO:** GSLV's capability of placing up to **5 tonnes** in LEO broadens the scope of payloads from heavy satellite to multiple smaller satellites.
- **Three Stage Launcher (GSLV-Mk-2) (one solid motor stage (expandable with four liquid engine strap ons), one earth Storable Liquid stage, and one cryogenic stage)**
- **Third Stage: CUS**
 - Developed under Cryogenic Upper Stage Project (CUSP), the CE7.5 is India's first cryogenic engine, developed by Liquid Propulsion Systems Centre in Mahendragarh, Tamil Nadu. CE-7.5 has a staged combustion operating cycle.
 - Fuel: LOX + LH₂ (Liquid Oxygen + Liquid Hydrogen)
 - Max Thrust: 75 KN
- **Variants**
 - **GSLV Mk 1(a,b,c)** - Not important
 - **GSLV Mk 2 (Operational)**
 - This variant uses an Indian cryogenic engine, the CE-7.5, and is capable of launching 2500 Kg into Geostationary transfer orbit. Previous GSLV vehicles (GSLV Mk1) have used Russian cryogenic engines.

A) LAUNCH VEHICLE MARK 3 (LMV3 OR GSLV MARK 3)

- LVM3 is a **3-stage** heavy lift launch vehicle developed by ISRO.
- 1) **Solid Rocket Boosters: S200** – GSLV MK III uses two S200 solid rockets boosters to provide the huge amount of thrust required for lift off. Fuel: **HTPB**.
- 2) **A liquid Propellant core stage (L110):** The L110 liquid stage is powered by 2 Vikas engines.
- 3) **A Cryogenic Stage (C25):** The C25 is an improvement on CE-20 Cryogenic engine, India's largest cryogenic engine, designed and developed by the Liquid Propulsion System Center
 - a. Fuel: LOx + LH₂
- **Capability:** GSLV-Mk III can launch 4 tons class of satellites to Geosynchronous Transfer orbit (GTO) or about 8-10 tons to LEO, which is twice the capability of GSLV Mk II.
- **GSLV MK-III Flights so far:**
 - » GSLV-Mk III – D1 (2017): GSAT-19 to GTO

- » GSLV-MK III – D2 (2018): GSAT-29 to GTO
- » GSLV-MK III – M1 (2019): Chandrayaan-2
- » GSLV-MK III – M2 (2022): OneWeb India-1 Mission
- » GSLV MK III – M3 (2023): OneWeb India-2 Mission
- » GSLV MK III – M4 (2023): Chandrayaan-3

▫ **GSLV MK-III – M2/ OneWeb India-1 Mission (Oct 2022)**

- It was only the second operational flight of LVM3 (after Chandrayaan-2 mission). It was a dedicated commercial satellite mission of NewSpace India Limited (NSIL). This mission was undertaken as part of the commercial arrangement between NSIL and m/s Network Access Associates Limited (m/s OneWeb Ltd), a UK based company. A total of **36 OneWeb Gen-1** satellites of about 150 Kg each totaling about **5,796 Kg** were launched to a circular LEO of about 601 km with a 87.4 degree inclination.
- This was one of the biggest commercial orders executed by ISRO.
- **Note: Some Unique features of the Mission**
 - First Commercial Mission of LVM3
 - First multi-satellite mission with 36 OneWeb Satellites onboard
 - First launch of LVM3 to LEO
 - First Indian rocket with six-ton payload
 - First NSIL Mission with LVM3
 - First OneWeb Mission with NSIL/DoS

LVM3 M3/ OneWeb India-2 Mission Accomplished Successfully (March 2023)

- In its sixth consecutive successfully flight of LVM3, the vehicle placed 36 satellites belonging to the OneWeb Group company in their intended 450 km circular orbit with an inclination of 87.4 degrees.
- The total weight of the payload was 5,805 kg.

LVM3 M4/ Chandrayaan 3.0 Mission was accomplished in July 2023

B) INDIA'S JOURNEY TOWARDS DEVELOPING ITS OWN CRYOGENIC ENGINE

- **Basics about Cryogenic Engine**
 - **Cryogenic engine** is a rocket engine that uses cryogenic fuel or oxidizer, i.e. its fuel or oxidizer (or both) are gases liquified and stored at very low temperatures.
 - **Note:** All Cryogenic engines are also, liquid propellant rocket engines or hybrid rocket engines.
 - **Fuel:** Combination of Liquid hydrogen and Liquid Oxygen is the most commonly used propellant in cryogenic engine. The fuel provides very high specific impulse.
- **Difficulties in developing Cryogenic engine:** Burning super cooled fuel at extremely high temperature; Developing material that can withstand high temperature and pressure during combustion.
 - **Advantages**
 - More efficient and provides more thrust for every kg of propellant it burns.

- **Current status**
 - CE-7.5 being used in GSLV MK-II.
 - CE-20 is being used in GSLV MK-III. It is indigenously developed for LVM-3.
- **Further upgradation:**
 - In Nov 2022, ISRO has successfully conducted a hot test of CE20 cryogenic engine. This successful hot test was at an uprated thrust level of 21.8 tonne for the first time.
 - This will enhance the LVM3 payload capability upto 450 Kg with additional propellant loading. The major modification carried out on this test article compared to previous engines was introduction of Thrust Control valve (TCV) for thrust control.
 - In addition to the hot test, a 3D printed LOX and LH2 turbine exhaust casings were also inducted in the engine for the first time.

4) SOUNDING ROCKETS

- Sounding rockets are one or two stage solid propellant rockets used for probing the upper atmospheric regions and for space research.
- They also serve as easily affordable platforms to test or prove prototypes of new components or subsystems intended for use in launch vehicles and satellites.
 - With the establishment of the Thumba Equatorial Rocket Launching Station (TERLS) in 1963 at Thumba, a location close to the magnetic equator, there was a quantum jump in the scope for aeronomy and atmospheric sciences in India.
 - The launch of the first sounding rocket from Thumba near Thiruvananthapuram, Kerala on 21 November 1963, marked the beginning of the Indian Space Programme. The rocket was US Nike Apache.
- **Operational Sounding Rockets**
 - Currently **3 versions** are offered as operational sounding rockets, which cover a payload range of 8-100 Kg and an apogee range of 80-475 Km.

Vehicle	RH-200	RH-300-Mk-II	RH-560-MK-II
Payload (in kg)	10	60	100
Altitude (in km)	80	160	470
Purpose	Meteorology	Aeronomy	Aeronomy
Launch Pad	Thumba, Kerala	SDSC-SHAR	SDSC-SHAR

- **Rohini (Rocket Family)** is a series of sounding rockets developed by ISRO for meteorological and atmospheric study.
- ISRO's RH-200 sounding rocket records **200th consecutive successful flight** (Nov 2022)

- The small rocket lifted off from the launchpad at the **Thumba Equatorial Rocket Launching Station (TERLS)** at the Vikram Sarabhai Space Centre (VSSC).
- **Example of Experiment: Air Breathing Propulsion Experiment** using RH-560 rocket fitted with a supersonic combustion (Scramjet) engine on Aug 28 from Sriharikota. (Aug 2016)

4. OTHER ENGINES AND RELATED PROJECTS IN NEWS

1) ISRO'S NEXT-GEN LAUNCH VEHICLE (NGLV) MAY ASSUME PSLV'S ROLE

- ISRO is developing a Next-Gen Launch Vehicle (NGLV), which will one day replace operational systems like PSLV. Here ISRO is planning a three stage to orbit, reusable heavy lift vehicle with payload capacity of 10 tons to GTO.
- It will feature semi-cryogenic propulsion; simple and robust design (allowing bulk manufacturing, modularity and minimal turnaround time)

2) SEMI-CRYOGENIC ENGINE (UNDER DEVELOPMENT)

- Semi-Cryogenic Engine is an Indian Liquid fuel rocket engine using a combination of liquid oxygen (LOX) and refined kerosene (Isrosene) as propellants. It is being developed for future heavy lift launch vehicles and reusable launch vehicles.
- It is being developed by Liquid Propulsion System Centre, a subsidiary of ISRO.
 - Project Codename: SCE-200
- **Where will it be used?**
 - Immediate Application: One of the immediate applications will be to replace the liquid core (L110) engine of GSLV Mark-3 with the SCE-200 to boost the payload capacity of the rocket from 4 to six tonnes.
- **SCE-200: Other Details**
 - Cost of project: 1800 crore (Cabinet cleared the project in 2008).
 - Currently, only US and Russia have this technology.
 - In 2015, ISRO signed an MoU with Russian Space Agency to boost its plan for Semi-Cryogenic Launch Vehicle

3) DIFFERENCES BETWEEN CRYOGENIC ENGINE AND SEMI-CRYOGENIC ENGINE

	Cryogenic	Semi-Cryogenic
Fuel	Liquid Hydrogen + Liquid Oxygen	Isrosene + Liquid Oxygen
Temperature	Liquid hydrogen required to be stored at -253-degree celsius	Kerosene can be stored at normal temperatures
Weight	LH ₂ + LO ₂ is <u>heavier</u> than Kerosene and has to be stored	Lighter than liquid fuel and can be stored at normal temperature.

	at freezing temperature of - 253 degree celsius.	Therefore, kerosene occupies less space, and more propellant can be packed in the semi-cryogenic engine's fuel compartment.
Specific Impulse	Cryogenic engine offers <u>higher specific impulse</u> than SCE	
Thrust to weight Ratio		It offers <u>better thrust to weight ratio</u> upto 180. Higher density of the exhaust gas in case of the SCE contribute to high mass flow rates making it <u>easier to develop high thrust engines</u> .
Stage	Higher specific impulse is valuable for upper stage, where mass comes at a premium price. So Cryogenic is used at upper stage.	<ul style="list-style-type: none"> SCE have been preferred in lower stages when <u>high thrust is must-have over specific impulse</u>.

4) REUSABLE ROCKETS: REVOLUTIONIZING ACCESS TO OUTER SPACE

- **Details**
 - Reusable launch system is a launch system that includes the recovery of some or all of the component stages and reuse of these components in another launch.
 - Till now, several **fully reusable sub-orbital system** and **partially reusable orbital systems** have been flown. During 21st century, the interest in reusable launch system has grown considerably, with several active launchers.
 - SpaceX's Falcon 9 rocket has a reusable first stage and expendable second stage. Plans for the second stage of the Falcon 9 to be made reusable, creating a fully reusable system, have been cancelled, with the SpaceX starship being planned as a fully reusable launch vehicle.
 - If ISRO is able to develop this technology, it will reduce the cost of launch by 70-80% and increase the competitiveness of ISRO in satellite launch market.
- **Steps taken by ISRO to develop RLV.**
 - In May 2016, ISRO successfully test fired its first indigenous winged reusable satellite launch vehicle.
 - In this experimental mission, the HS9 solid rocket booster carrying RLV-TD lifted off from the First Launch Pad at Satish Dhawan Centre, Sriharikota.
 - The RLV-TD re-entered the earth after reaching a height of 70 km.
 - It was a baby step towards developing reusable launch vehicle.
 - Ultimate Aim:** Ultimate aim of the project is to put satellite into orbit around earth and then reenter the atmosphere.
 - The final version would take another 10-15 years to get ready.

5) LOW-COST SMALL SATELLITE LAUNCHER (SSLV)

- Introduction

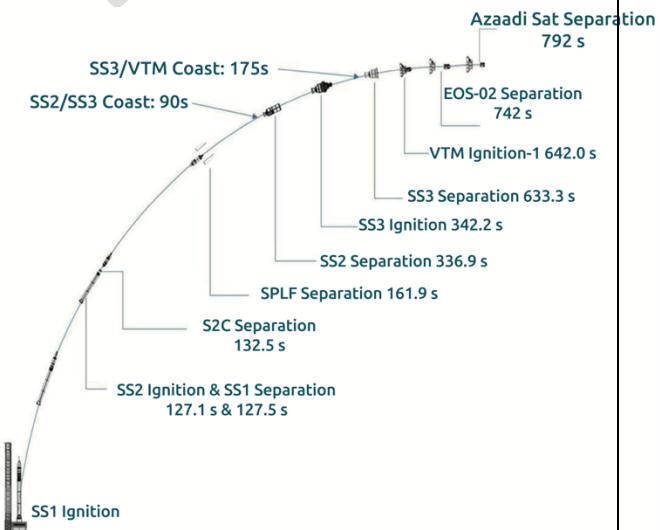
- The Indian SSLV (Small Satellite Launch Vehicle) is a small launch vehicle which serves small satellite launches.
- It is the smallest vehicle at 110-ton mass at ISRO.
- **Low turnaround time:** It takes only 72 hours to assemble (unlike around 70 days needed for PSLV).
- **Low Human Resource requirement:** Only 6 people are required to do assembly (unlike 60 people for the PSLV).
- **Cost Effective:** The overall cost of building the SSLV will only be Rs 30 crores.
- **Capability:** Payload capacity of 500 Kg to 500 km planar orbit or 300 kg to SSPO. Using PSLV for these small satellites was an overkill.
- It uses three solid fuel-based stages and a liquid fuel-based velocity trimming module (VTM) to place the satellite in orbit.
- It is ideal for on-demand, quick turn-around launch of small satellites.
- **Major technologies** developed as part of SSLV are flexible nozzle control with electro-mechanical actuators for all stages, miniaturized avionics, and a velocity trimming module in the upper stage for precise satellite injections.

- Need

- The **global demand** for launch of small satellite is increasing. It is being demanded by businesses, government agencies, universities, and various research labs.

- First Developmental Flight

- » The maiden flight of SSLV in Aug 2022 can be considered a partial success.
 - When it came to the stage when the satellite had to be set in orbit, there was a glitch which resulted in the satellite being lost forever. ISRO announced that there was a malfunction of a sensor which resulted in placing the satellites in an elliptical orbit, rather than a circular orbit.
 - It placed the satellites into 356 km X 76 km elliptical orbit instead of 356 km circular orbit.



- 2nd Developmental Flight: SSLV-D2 / EOS-07 Mission (Feb 2023)

- » The 2nd developmental flight of SSLV-D2 was successfully launched on Feb 10, 2023.
- » It intended to inject EOS-07, Janus-1 and AzaadiSAT-2 satellite into 450 km circular orbit, in its 15 minutes flight.
 - **EOS-07** is 156.3 kg satellite designed, developed and realized by ISRO. New experiments include mm-wave Humidity Sounder and Spectrum Monitoring payload.

- Janus-1, a 10.2 kg satellite belongs to Antaris, USA.
- **AzaadiSAT-2** is a combined effort of about 750 girl students across India guided by SpaceKids India, Chennai.

5. ISRO SATELLITES

1) BASICS

What is a satellite?

- Satellite means a smaller, space-based object moving in a loop (an orbit) around a larger object.
 - The Moon is a natural satellite of earth because gravity locks it in orbit around our planet.

2) COMMUNICATION SATELLITES

- **Introduction**
 - A communication satellite is an artificial satellite that is placed in earth's orbit for the purpose of sending and receiving communication data between a source and destination. They are basically "space mirrors" that can help us bounce radio, TV, Internet data, and other kinds of information from one side of earth to another.
 - It is used to provide data communication and relaying services for televisions, radio, telecommunication, weather and internet.
 - Communication satellites essentially overcome the problem of sending radio waves, which travel in straight lines, around our curved planet.
 - They commonly move in geo-stationary orbit.
 - Why?
 - Communication satellites can also move in highly elliptical orbit.
- **Two types of Communication Satellites – Passive and Active**

A) COMMUNICATION SATELLITES OF INDIA / ISRO

- **The Indian National Satellite System (INSAT) System** is one of the largest domestic communication satellite systems in Asia-Pacific region.
 - It was established in 1983 with the launch of INSAT 1B, it initiated a major revolution in India's communications sector and sustained the same later.
 - The system presently consists of the constellation of INSAT system consisting of around 20 operational satellites, namely INSAT-3A, 3C, 4A, 4B, 4CR, GSAT 6,7,8,9,10, 12, 14, 15, 16, 18, 19, 17, 6A, 29, 11 (largest 5850 Kg, Dec 2018), 7A (Mostly for serving air force, Dec 2018) and 31 (Feb 2019).
- INSAT system with more than 200 transponders in the C, extended C and Ku-bands provides services to telecommunication, television broadcasting, satellite newsgathering, societal application, weather forecasting, disaster warning and search and rescue operations.

B) RECENT EXAMPLES OF COMMUNICATION SATELLITES

GSAT-20

- **Why in news?**
 - ISRO's commercial arm to launch GSAT-20 Satellite on SpaceX's Falcon-9 in 2024 (Jan 2024)
- **Details about GSAT**
 - The GSAT-20 is a high throughput Ka-band satellite which will be fully owned, operated and funded by NSIL.
 - a. It will offer Ka-Ka band HTS capacity with 32 beams having Pan-India coverage including A&N and Lakshadweep.
 - b. The satellite weighs 4,700 kg and offers HTS capacity of nearly 48 Gbps and has been specifically designed to meet the demanding service needs of remote and unconnected areas.

3) EARTH OBSERVATION SATELLITES (PHOTOGRAPHY, IMAGING AND SCIENTIFIC SURVEYING)

- Earth Observation Satellites are specifically designed for Earth Observation from Orbit and are used for environmental monitoring, meteorology, map making etc. Most earth observation satellites carry instruments that should be operated at a relatively low altitude.
- **Earth Observation Satellites of India**
 - » Starting with IRS-1A in 1988, ISRO has launched many operational remote sensing satellites.
 - » Today, India has one of the largest constellations of remote sensing satellites in operation. Currently, earth observation satellites which are in **Sun-synchronous orbit** include
 - EOS-01, EOS-02, EOS-06 (Oceansat-3)
 - RESOURCESAT-1, 2, 2A
 - CARTOSAT-1, 2, 2A, 2B etc
 - CARTOSAT-3 (Launched in Nov 2019)
 - RISAT-1, RISAT-2, RISAT-2B (launched in May 2019 – PSLV C46), RISAT-2BR1 (launched in Dec 2019 – PSLV C-48)
 - OCEANSAT-2
 - Megha-Tropiques, SARAL and SCATSAT-1
 - **HySIS**
 - Earth Observation satellites in **Geostationary Orbit** include:
 - EOS-03 (couldn't be put in orbit due to failure of GSLV-F10)
 - INSAT-3D, INSAT 3DR
 - Kalpana & INSAT 3A
- » Varieties of instruments have been flown onboard these satellites to provide necessary data in a diversified spatial, spectral and temporal resolutions to cater to different user requirements in the country and for global usage. The data from these satellites are used for several applications covering

agriculture, water resources, urban planning, rural development, mineral prospecting, environment, forestry, ocean resources and disaster management

4) SATELLITE NAVIGATION (SAT – NAV)

- Why in news recently?
 - ISRO's GSLV-F12 successfully places navigation satellite NVS-01 into intended orbit (May 2023)

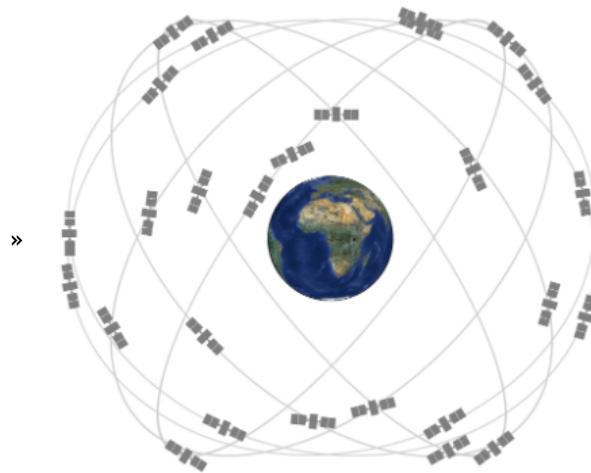
A) BASICS ABOUT SATNAV

- A satellite navigation (SATNAV) system is a technology that allows users to determine their precise location, velocity, and time information anywhere on or near Earth's surface.
- It uses a network of satellite in space and provide accurate positioning data.
- Currently, there are four global satellite-based navigation system – the American GPS, the Russian GLONASS (GLObalnaya NAvgatsionnaya Sputnikovaya Sistema), the European Galileo and the Chinese BeiDou.
- India has a regional system called NavIC and Japan has Quasi Zenith.
- **Methods used in SATNAV: Triangulation and Trilateration:**
- **Accuracy:** They generally provide high levels of positioning accuracy (within a few meters), depending on the quality of receiver and the number of satellites in view. However, various factors such as signal obstruction, atmospheric conditions, and receiver limitations can affect the accuracy.
- **Applications: Navigation purposes** -> helping users find their way while driving, hiking, or boating. It is also used in aviation, surveying, geolocation-based services, precision agriculture, and even in some outdoor recreational activities. It can be used for vehicle tracking, fleet management, precise timing etc.

B) GLOBAL POSITIONING SYSTEM (GPS)

- The best-known satnav system, GPS, uses 24 active satellites (including backups). Day and night, 365 days a year, they whiz around earth once every 12 hours on orbital plane inclined 55 degrees to the equator.
- Wherever you are on earth, you are in sight of at least half a dozen of them, but **you need signals from 3 or 4 satellites** to determine your position with an accuracy of just a few meters.
- **How GPS Finds your location?**
 - It uses **Trilateration**
- **GPS Constellation arrangement**
 - » GPS constellation fly in medium earth orbit (MEO) at an altitude of approx. 20,200 kms. Each circle orbits the earth twice a day.

- » The satellites are arranged in six equally placed orbital planes surrounding the earth. Each plain contains four slots occupied by baseline satellites. This 24-slot arrangement ensures users can view at least four satellites from virtually any point on the planet.



C) BEIDOU

- **Details**
 - China initiated BeiDou in 1994 with first BeiDou satellite launched in 2000.
 - **Second generation BeiDou (BDS-2)** provided coverage to Asia Pacific region starting in 2012.
 - **Third generation BeiDou (BDS-3)** satellite deployment started in 2015. In 2020, the system has been completed and it can now provide global services. With this they have joined United States' GPS and Russia's GLONASS in providing global PNT services, with Europe's Galileo to follow. These are all compatible and interoperable, meaning users can draw services from all of those to improve accuracy.
- **Satellite Constellation**
 - **24 satellites in Medium Earth Orbit** (around 21,500 kms above the earth) provide the positioning, navigation, and timing (PNT) services. These satellites use rubidium and hydrogen atomic clocks for highly-accurate timing that allows precise measurement of speed and location.
 - **Satellites in geosynchronous Orbit** (including Geo-stationary orbit) help BeiDou provide short messaging service through which 120-character messages can be sent to other BeiDou receivers.
- **Plans of Expansion:**
 - In Nov 2022, China outlined plans to further expand the global reach of its home grown BeiDou satellite navigation system.
 - a. **Pakistan** in 2014 became the first foreign country to set up a BeiDou network.
 - b. **BeiDou** has set up a first of three Continuously Operating Reference Stations (CORS) for its network in Thailand in 2013, to serve as a hub for ASEAN.

D) GAGAN AND GEMINI (CLASS DISCUSSION)

E) NAVIC (NAVIGATION USING INDIAN CONSTELLATION)

- Indian Regional Navigation Satellite System (IRNSS) (also called Navigation Using Indian Constellation (NAVIC)), is a regional satnav system developed by ISRO. It aims to provide reliable position, navigation and timing (PNT) services over India and its neighbourhood, upto 1500 km from its boundary. In addition it is also capable of broadcasting messages. This can be used for broadcasting safety-of-life alerts in areas with poor or no communication, particularly in Ocean.

- **Need of IRNSS** when services like GPS are easily available.

- The access to foreign controlled global navigation satellite systems is not guaranteed in hostile situations, as happened to Indian military depending on American GPS during **Kargil War**.

- **NAVIC provides two types of services:**

- » **Standard Positioning Service** (Open for Civilian Use)
 - » **Restricted Services** (Encrypted one, for authorized users (military))

- **Components of IRNSS System:**

- » Space segments consists of **7 satellites, 3 satellites in GEO stationary orbit (GEO) and 4 satellites in GEO synchronous orbit(GSO)** with inclination of **29 degree** to the equatorial plane.
 - » All the satellites will always be visible in the Indian region.
 - » **First of the 2nd generation satellite – NVS-01** was successfully launched in May 2023
 - ISRO's **GSLV F12** (GSLV-MK-II mission)successfully places navigation satellite NVS-01 into intended orbit.
 - **About GSLV F12:**
 - » It is the **15th** flight of India's GSLV and the **9th** flight with indigenous cryo stage.
 - **About NVS-01:**
 - » **Heavier:** It weighs **2232 kg** and has been placed in **geosynchronous orbit** (older IRNSS satellites weighed 1,425 kg)



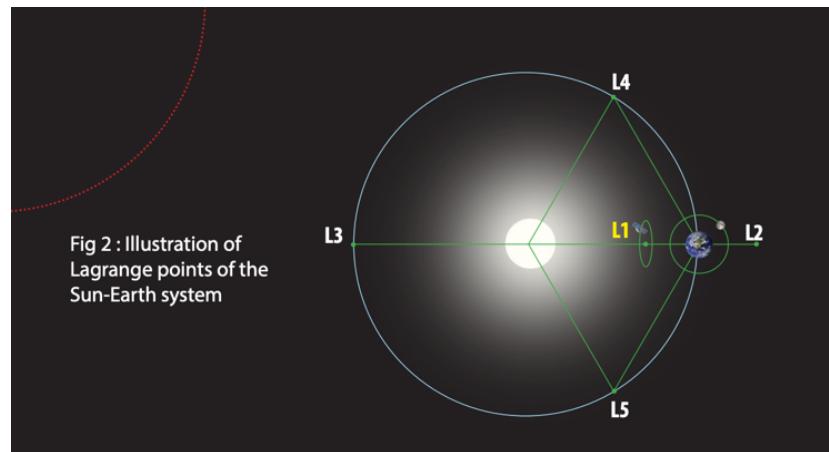
- » **Indigenous Atomic Clock:** For the first time, the satellite carries an indigenous atomic clock. The space qualified Rubidium atomic clock has been indigenously developed by Space Application Centre – Ahmedabad.
- » **L1 signals for better use in wearable devices:** The second generation satellites have send signals in a third frequency, L1, besides the L5 and S frequency signals that the existing satellites provide. This will increase operability with other satellite based navigation systems. L1 frequency is the most commonly used in the GPS and will increase the use of NavIC in wearable devices which use low power signal frequency chip.
- » **Longer Mission Life** of 12 years (earlier NavIC satellites have a mission life of 10 years).

- **Current Situation** (June 2023)
 - The receivers have now been deployed, and NavIC is in use for projects like public safety, power grid synchronization, real-time train information system, and fishermen's safety.
 - Other upcoming initiatives (such as) common alert protocol based emergency warning, time dissemination, geodetic network, unmanned aerial vehicles are in the process of adopting NavIC system.

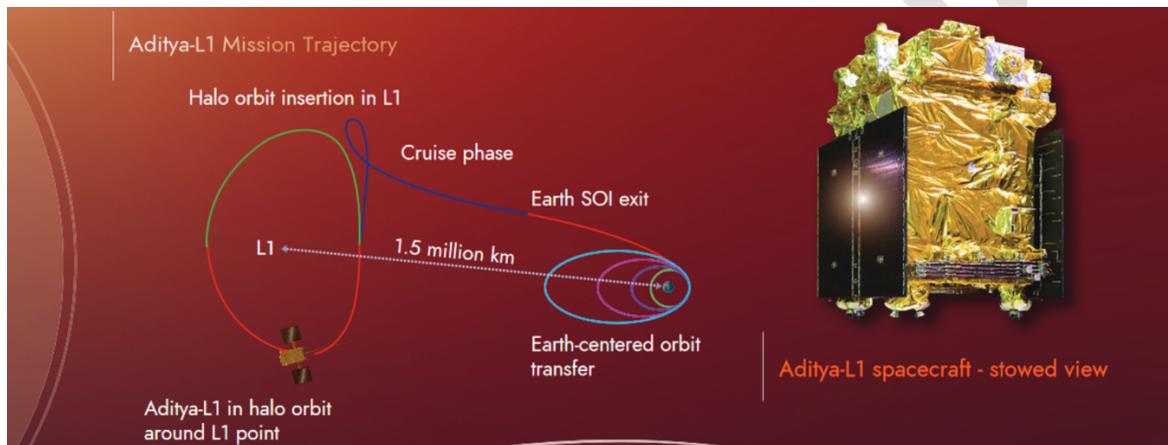
Some cell phone chipsets build by Qualcomm, MediaTek integrated NavIC receivers in 2019. Some example phones which are NavIC enabled include Redmi Note 9, realme 6, the OnePlus Nord etc.

5) SATELLITES TO STUDY THE SUN: ADITYA L1

- It is India's first observatory class space based solar mission.
- It was launched into space on 2nd Sep 2023 onboard PSLV-C57 and reached the L1 point on 6th Jan 2024, 127 days after its launch.
- It has a mission life of 5 years during which its payloads will study various aspects of sun. It serves as a space weather station and the data from the spacecraft will aid in making models and predicting storms in advance.
- The orbit of Aditya-L1 spacecraft is a periodic Halo Orbit with an orbital period of about 178 earth days. This halo orbit is a periodic, three dimensional orbit at L1 involving sun, earth and spacecraft.
- **Why study sun from space and specifically from Lagrangian point 1?**
 - **Why study sun from Space?**
 - Various types of radiations from sun are not able to reach earth due to atmosphere of the earth and earth's magnetic field making their study difficult from earth.
 - **Why from Lagrangian Point-1 (L1)?**
 - A Satellite placed in the halo orbit around the Lagrangian point 1 (L1) of the Sun-Earth system has the major advantage of continuously viewing the Sun without any occultation/ eclipses.



What Trajectory ADITYA-L1 followed to reach Lagrangian Point-1: Through various orbit raising manoeuvres and cruise phase, it was placed in a halo orbit around the Lagrangian Point-1 (L1) of the Sun Earth System, which is about 1.5 million km from the Earth.



The path Aditya-L1 will take to get to L1. | Photo Credit: ISRO

- **Major Science Objectives:**
 - Understand the coronal heating and solar wind acceleration; understand the initiation of Coronal mass ejection (CME), flares, and near earth space weather; understand the coupling and dynamics of the solar atmosphere; understand solar wind distribution and temperature anisotropy.
- **Aditya-L1 went with 7 Payloads:**

Remote Sensing Payload:

 - a. **Visible Emission Line Coronagraph (VELC):** It can peek as close as **1.05 solar radii**, a region never imaged by any solar telescope. It can thus give us more information about **coronal mass ejection**.
 - b. **Solar Ultraviolet Imaging Telescope (SUIT):** It will observe UV radiations from different zones of the solar atmosphere. It will help us to better understand the climate variation on earth.
 - c. **Solar Low Energy X-Ray Spectrometer (SoLEXS)**
 - d. **High Energy L1 Orbiting X-Ray Spectrometer (HEL1OS)**

In-Situ Payloads:

- a. Aditya Solar Particle Experiment (ASPEX): In-situ measurements of solar particles and ions.
- b. Plasma Analyzer Package for Aditya (PAPA)
- c. Advanced Tri-axial High Resolution Digital Magnetometers

With the help of e,f, and g scientists can predict probable geomagnetic storms and better understand space weather dynamics.

Understanding Lagrangian Points

- These are position in an orbital configuration of two large bodies where a small object affected only by gravity can maintain a stable position relative to two large bodies. The Lagrange points mark positions where the combined gravitational pull of two large masses provides precisely the centripetal force required to orbit with them.
- The interaction of the forces creates a point of equilibrium where a spacecraft may be "parked" to make observation.
- These points are named after Joseph-Louis Lagrange, an 18th-century mathematician.
- There are five such points, labeled L1 to L5 all in the orbital plane of two large bodies.
 - Three of these Lagrangian points – L1, L2, and L3 – are unstable positions that lie along an imaginary straight line connecting the two larger bodies.
 - Because of this instability, an object positioned at one of the three unstable Lagrange points L1, L2, and L3 – can be easily de-orbited by even weak force and they will then drift into space. Therefore, spacecraft here will need to frequently burn fuel via its thrusters, at the various moments of displacement to adjust to orbital movement frequently.
 - The other two – L4 and L5 – are stable locations that from the apexes of two imaginary equilateral triangles with the two large celestial bodies at the vertices of each triangle. Objects stay undisturbed at L4 and L5 because of a restoring force – a force acting against any displacement – that prevents them from being nudged away from the stable point. Because of this stability, this point tends to accumulate a lot of interstellar dust and asteroids called Trojans that zip around the points. Scientists have detected various Trojans at L4 and L5 of Sun-Jupiter System, Sun-Mars System, Sun-Neptune system etc.
 - They are also potential Site for Space Colonies
- Are there other space explorers at L1?
 - Yes, it is already home to four robotic explorers – NASA's Solar and Heliospheric Observatory Satellite, Deep Space Climate Observatory, Advanced Composition Explorer, and the Global Geospace Science Wind Satellite.
 - In next few years, some more observatories by USA and EU will be reaching here.

About HALO Orbits: A halo orbit is a, three dimensional orbit near the L1, L2, or L3 Lagrangian point in the three body problem of orbital mechanics. Although the Lagrange point is just a point in empty space, its peculiar characteristics is that it can be orbited.

6. OTHER IMPORTANT PROJECTS OF ISRO

1) PROJECT NETRA

- It is an EWS in space to detect debris and other hazards to satellite. It will also provide warning against missile and space attack against India's assets.
- It will consist of many observational facilities, connected radars, telescopes, data processing units, control centers etc.
- Initially, it will be launched for **LEO satellites** which inhabits remote sensing satellites. Eventually, NETRA will also have the capability to capture **GEO**, where communication satellites mostly reside.
 - **Does India not have any collision avoidance detection mechanism now?**
- Even now, India does collision avoidance maneuvers on our satellites. But for this it depends on data from **NORAD** (North American Aerospace Defense Command) and others available in the public domain.
- **NOTE:** NORAD is an initiative of USA and Canada and shares selective debris data with many countries

2) MISSION SHAKTI

- An ASAT tested by India.

3) GAGANYAAN

4) XPOSAT (X-RAY POLARIMETER SATELLITE)

- **Why in news?**
 - ISRO launched the XPoSat, in a two-part mission, onboard a PSLV C58 flight on 1st Jan 2024.
- **More Details**
 - XPoSat is a specialized science mission that will study the **polarization of X-Rays** in space.
 - The mechanization of polarization of radiation gives away the nature of its source, including the strength and distribution of the magnetic field and the nature of radiation around it.
 - XPoSAT carries two scientific payloads in a **low earth orbit**:
 - The Primary Payload (POLIX) (Polarimeter Instrument of X-Rays) will measure the polarimetry parameters (degree and angle of polarization) in medium X-ray range of 8-30 Kilo electron volt (KeV) photons of astronomical origin.

- The **POLIX** payload is developed by the Raman Research Institute (RRI), Bangalore, with support from ISRO centres.
- The **XSPEC** (X-Ray Spectroscopy and Timing): It will study X-rays of energy 0.8-15 KeV and changes in continuous X-Ray emissions.
 - The **XSPEC** payload is developed by the UR Rao Satellite Centre (URSC), ISRO.
- Together (POLIX and XSPEC), they are expected to shed light on intense X-ray sources such as pulsars and blackholes.

- **Need:**
 - **Better understanding of the universe:**
 - So far, astronomers have largely used and depended on spectroscopic, imaging and timing-based data obtained from either ground-based telescopes or satellite based missions. **Polarization** based study was done either in the optical or radio bands.
 - **XPOSAT** will be game changer and will facilitate X-Ray polarization measurement possible from bright source, that too in the medium energy band (8-30 KeV) – which has never been attempted before.
 - It is thus an excellent diagnostic tool to understand the emission processes from astronomical sources.
 - In space, X-Rays get polarized by multiple factors - for e.g. when X-rays are subjected to strong magnetic field or due to interactions with material present around black holes. So, by studying this polarization, scientists can understand the key characteristics of the source.

- **International Trend in Space-Based X-Ray Polarimetry**
 - Internationally, space-based x-ray polarimetry is gaining importance.
 - The **Imaging X-Ray Polarimetry Explorer** (IXPE) mission, launched in 2021, represents NASA's inaugural space-based endeavor, focused on scrutinizing X-Ray Polarization across various celestial bodies.
 - **Note:** XPoSAT energy range of 8-30 keV for polarization measurement is complimentary to IXPE energy range of 2-8 KeV (soft X-Ray band). Therefore, XPoSAT and IXPE spacecrafts will collectively probe different emission mechanisms and physics for bright X-Ray sources. Their coordinated observation will provide a wide window in the energy range of 2-30 KeV for polarimetric observations for bright X-Ray sources.
 - **Note:** India's ASTROSAT – India's first astronomy-based space mission launched in Sep 2015 – performed timing and broadband spectroscopy of X-Ray sources but no polarization studies were performed.

- **Which sources will be observed?**

- The XPoSat team has identified several tens of sources radiating X-Rays. XPoSat will observe two kinds of sources – Persistent Sources (targeted known source) and transient sources (pulsars, active galactic nuclei, magnetars)
- **Other Facts about XPOSAT:**
 - Launched on Jan 1, 2024
 - Precise Circular Orbit of 650 km, inclination of 6 degrees.
 - It is only the second space-based experiment, to study X-ray polarization, and at higher x-ray energies than the other, NASA's Imaging X-Ray Polarimetry explorer.
 - The instrument is totally indigenous in design and fabrication.

A) UNDERSTANDING POLARIZATION – CLASS DISCUSSION

B) UNDERSTANDING POLARIZED GLASSES

Polarized glasses cut the hazardous glare off the flat surfaces such as water, glass, and asphalt. When the polarized axis is vertical, all light that has been polarized through reflection and is now traveling horizontally (such as glare off of water or a windshield), will be blocked by the filter.

Polarized glasses are special materials which allow only vertically altering electric fields, and helps to decrease the glare from ground reflection, which consist of mostly horizontal polarization. Reflection polarizes the randomly varying sunlight into a single direction. Scattering of sunlight by air molecules also has a similar effect.

5) NASA-ISRO SYNTHETIC APERTURE RADAR (NISAR) IMAGING SATELLITE

- **Introduction:**
 - NASA-ISRO SAR (NISAR) is a LEO observatory being jointly developed by NASA and ISRO. It will map the entire globe in 12 days and provide spatially and temporally consistent data.
 - It carries L and S dual band SAR, which works with sweep SAR technique to achieve large swath with high resolution data.
 - Once launched, it will be world's most expensive earth-imaging satellite till date costing around \$1.5 billion.
- **Collaboration**
 - NISAR is considered the first big collaboration between ISRO and NASA, certainly on RADAR but just in general as well.
 - S-Band SAR is being built by ISRO and L-band by NASA
 - » The satellite will be launched from India using **GSLV-MK-2**.
 - » **Uses:** NISAR will provide an unprecedented, detailed view of the earth by using Advanced RADAR imaging. It is designed to observe and take measurements of some of the planet's most complex process, including ecosystem disturbances, ice-sheet collapse, and natural hazards such as earthquakes, tsunamis, volcanoes, and landslides. The satellite thus will be used for:

- Mapping and monitoring of natural resources
- Estimating agricultural biomass over full duration of crop cycle.
- Assessing soil moisture
- Monitoring of floods and oil slicks
- Monitoring coastal erosion, coastline changes, and variation in the wind.
- **Target:** The target launch readiness date is January 2024.

7. NASA'S INTERPLANETARY MISSION

1) MARS ORBITER MISSION

- **Details**
 - Mars Mission (MOM), also called Mangalyaan is spacecraft orbiting MARS since 24 September 2014.
 - It was launched on 5 November 2013 by the Indian Space Research Organization (ISRO).
 - It is India's first interplanetary mission and ISRO has become the fourth space agency to reach Mars, after the Soviet space program, NASA, and the European Space Agency.
 - It is the first Asian nation to reach Mars orbit, and the first nation in the world to do so in its first attempt.
- **What is MOM doing?**
 - It has been looking for signs of atmospheric methane while studying surface features - just like NASA's MAVEN Mission. Methane is considered a biomarker: a substance whose presence indicates the current or historical presence of life.
 - MOM is also exploring and observing Mars surface features, morphology, mineralogy, and the Martian atmosphere.
- **Mars Orbiter Mission – 2** (Mangalyaan – 2) is expected to be launched in the year 2024. It will consist of an orbiter and may also include a lander and rover.

2) VENUS: SHUKRAYAAN-1

Why in news?

- India to launch Shukrayaan Venus Mission in 2024 after pandemic delays

Details

- Shukrayaan-1 is a **proposed orbiter to Venus by ISRO** to study the surface and atmosphere of Venus. It will be first mission to Venus by ISRO.
- ISRO has been soliciting ideas for instruments for a Venus-mission since at least 2018.
- **Earlier**, ISRO was aiming for a mid-2023, but pandemic related delays have pushed the target to Dec 2024.

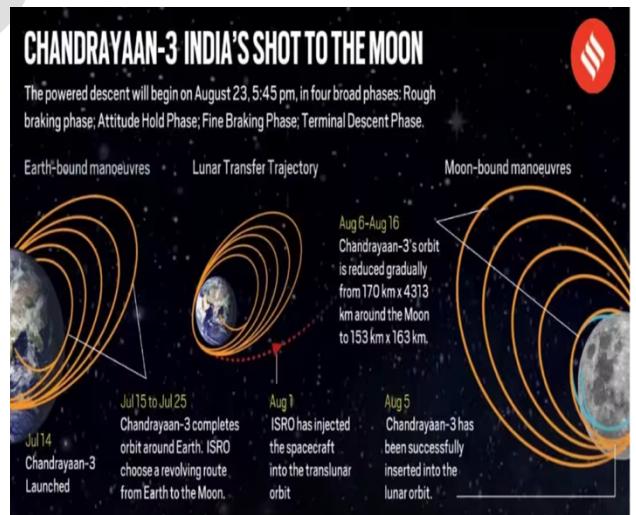
- » **Note:** This launch opportunity comes only in 19 months due to orbital configuration and period of Earth and Venus. So, after Dec 2024, the next opportunity will be available in mid-2026.
- It will be launched with the help of GSLV MK-II or GSLV MK-III.
- **Venus Missions in the Past**
 - » **Dozens of missions** have flown to Venus since the 1960s, but only a few in recent years.
 - **ESA's Venus Express** orbited the Venus between 2006 – 2014.
 - **Japan's Akatsuki** spacecraft entered orbit in 2015 after a previous unsuccessful attempt.
 - Several aircrafts are also performing **flybys** of Venus in the near future, including **NASA's Parker Solar Probe** for Solar Observation, and **Europe's BEPIColombo** en route to Mercury.

3) CHANDRAYAAN 3.0 (LVM3-M4) MISSION

- **Why in news?**
 - Chandrayaan-3 becomes the first to land near Moon's south pole (Aug 2023)
- **Details**
 - Chandrayaan -3 is the third Moon Mission of ISRO that was launched in July 2023 perched on GSLV-MK-3 heavy lift vehicle. It is a follow-on mission to Chandrayaan-2 and demonstrated end-to-end capability in safe landing and roving in lunar surface when it landed on the south pole of Moon on 23rd Aug 2023.
 - With this, India has become the fourth country in the world after USA, Russia and China to successfully land on Moon.

A) UNDERSTANDING THE DIFFERENT PHASES AND PATH TAKEN BY CHANDRAYAAN

- LVM-3 launched the Chandrayaan-3 in an elliptical parking orbit of 170 X 36500 km.
- Chandrayaan was launched on 14th July 2023. The whole process took 42 days, with the landing taking place on Aug 23.



B) COMPONENTS OF CHANDRAYAAN 3.0:

- It consists of a Propulsion Module (PM), Lander Module (LM), and a Rover with an objective of developing and demonstrating new technologies required for inter-planetary mission. **Note:** It doesn't have an orbiter module.

Propulsion Module (PM)

PM carried the LM from launch vehicle injection till final lunar 100 km circular orbit and separated LM from PM.

This propulsion module has Spectro-Polarimetry of Habitable Planet Earth (SHAPE) payload to study the spectral and Polarimetric measurements of Earth from the lunar orbit.

The Lander (**Vikram**) had the capability to soft land at a specified lunar site and deploy rover. It happened on 23rd Aug 2023. It remained stationary on the surface and carries four payloads which would record the chemical, thermal, and seismic instruments of the moon's surface.

Lander Payloads: Lander module has four payloads (Chaste, RAMBHA, ILSA and LRA)

Chandra Surface Thermophysical Experiment (ChaSTE): To carry out the measurements of thermal properties of lunar surface near polar region.

Instrument for Lunar Seismic Activity (ILSA) for measuring the seismicity around the landing site and delineating the structure of the lunar crust and mantle.

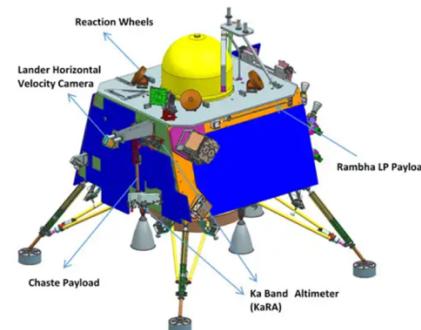
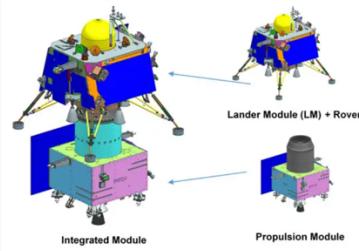
Rover (Pragyaan) is a 6 wheeled robotic vehicle.

Life: One lunar day (14 earth day)

Payload:

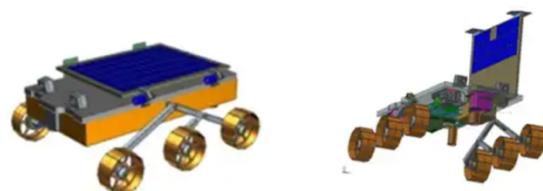
Laser Induced Breakdown Spectrometer (LIBS): It will determine the chemical and mineral composition of the lunar surface.

Alpha Particle X-Ray Spectrometer (APXS): It will determine the composition of elements such as magnesium, aluminium, silicon, potassium, calcium, titanium and iron in the lunar soil and rocks.



RAMBHA- LP (Radio Anatomy of Moon Bound Hypersensitive ionosphere and atmosphere) - RAMBHA: To measure the near surface plasma (ions and electrons) density and its changes with time.

A passive **Laser Retroreflector Array (LRA)** from NASA is accommodated for lunar laser ranging studies. It acts as a target for lasers for very accurate measurements for future missions.



C) LANDING WAS THE MOST COMPLICATED PART HERE:

- Landing is the most complicated part of the mission. The Lander and Rover get ejected at a speed of around 6,000 km/hr and have to be slowed down to roughly 3 km/hr before it lands. Since

moon doesn't have atmosphere, parachute kind of mechanism can't be used. Here, thrusters had to be fired in opposite direction to slow down the lander.

D) WHERE DID LANDER LAND?

- It landed at around 70-degree S near the southern pole of the moon.
- **Why?**
 - a. The site was selected as there are several craters here that are permanent in shade and can be reservoir of frozen water which is key to the future space mission.

E) ROVER:

Within a few hours of landing, ISRO also released a 26-kg rover from the lander module, which滑了 on the ramp to reach the moon's surface. The six wheeled rover, which is carrying two instruments and moves very slowly, is expected to crawl on the surface for 14 days, conducting chemical and elemental analysis of lunar soil and rocks.

E) COMPARING CHANDRAYAAN-1, CHANDRAYAAN-2 AND CHANDRAYAAN-3

	Chandrayaan-1	Chandrayaan-2	Chandrayaan-3
Year	2008	2019	2023
Rocket Used	PSLV	LVM-3	LVM-3
Payloads	Orbiter + Impactor Module (for crash landing)	Orbiter + Lander (Vikram) + Rover (Pragyan)	Lander + Rover
Successful	Yes	Partially Yes (Lander failed)	Yes
	<p>Perhaps the <u>most important</u> discovery of Chandrayaan-1 was the <u>discovery of water and hydroxyl (OH) molecules</u> in the Moon's thin atmosphere (exosphere) as well on the lunar surface.</p> <p>Buried Lava Tubes: The terrain mapping camera and hyperspectral imager on board Chandrayaan-1 detected an <u>underground lava tube</u>, which, scientists believe, can provide a <u>safe environment for human habitation in the future</u>. It can protect against hazardous radiation, small meteoric impacts, extreme temperature and dust storms on the surface.</p>	<p>It helped in <u>separately</u> identifying the water and hydroxyl molecules, and mapping water features across the moon for the first time.</p>	

D) CHANDRAYAAN 3 PROPULSION MODULE RETRACES STEPS TO EARTH ORBIT: WHY IT MATTERS? (DEC 2023)

- **What happened?**
 - Scientists have brought the propulsion module (PM) of Chandrayaan 3 mission back into earth orbit.
 - This was not part of original mission plan. It utilized the logistics advantage of near perfect mission, especially the availability of more than 100 Kg of fuel.
- **How was this achieved?**
 - ISRO performed maneuver to raise the orbit of the PM around the moon (from 150 km to 5,112 kms)
 - Second maneuver targeted an earth orbit of 1.8 lakh X 3.8 lakh km.
- **Significance:**
 - This experiment prepares ISRO for future missions, especially the ambitious Lunar Sample Return Mission.
 - Through this ISRO has been able to understand what is involved in the “planning and execution of trajectory and maneuvers to return from Moon to Earth”

E) SIGNIFICANCE OF GOING TO MOON:

- It underlined India's rise as a space and technology powerhouse. It will also strengthen India's soft power in the global community.
- Since moon is the closest cosmic body to Earth, the plans to explore rest of the universe starts with exploration of the moon. Moon can also act as a promising test bed to demonstrate technologies required for future deep-space missions.
- It would further help “stimulate the advancement of technology, promote global alliances and inspire a future generation of explorers and scientists.”
- **Resources:** Recent increase in interest in Moon is primarily due to possibility of important minerals being found on Moon.

8. OTHER IMPORTANT PROJECTS OF ISRO

1) INDIA'S OWN SPACE STATION: PLANS

- **What advancements will India need to achieve to have its space Stations?**
 - All the **Gaganyaan requirements** (Space suits, Training facilities for astronauts, Crew Escape Module, making GSLV Human rated, developing a habitable module etc)
 - **Larger bigger rocket** by upgrading the capabilities of GSLV-MK-III (it is right now capable of carrying on 10 tonnes to LEO)
 - Developing ability to perform **space docking**. ISRO has revealed its plan to carry out a space docking experiment, Spadex.



8. INTERNATIONAL COLLABORATION IN NEWS

1) ISRO – NORWAY

- **Why in news?**
 - Norwegian Ambassador Han Jacob Frydenlund's visit to ISRO's headquarters (June 2023)
- In June 2023, Norwegian Ambassador Frydenlund, accompanied by officials of Kongsberg Satellite service (KSAT), called on ISRO Chairman S. Somanath in Bengaluru, ISRO. The meeting concluded with a mutual agreement on the importance of maintaining a continued partnership and fostering increased engagements between India and Norway.
- It also offered an occasion to recall the 'Svalbard mission' of 1997.

A) SVALBARD MISSION OF 1997

- On Nov 20, 1997, a Rohini RH-300 Mk-II sounding rocket rose to the skies from Svalbard, Norway, operationalizing a new rocket launching range.
- ISRO bagged the Norway mission after its commercial arm Antrix Corporation won a global tender floated by the Norwegian space agency.
- The RH-300 MK-II was given a new name by the NSC (Norwegian Space Centre): **Ibjorn-1**, which translates literally as 'Polar Bear-1'.

9. IMPORTANT TELESCOPES IN NEWS RECENTLY

1) VARIOUS TELESCOPES AT DEVASTHAL

- Devasthal observatory is located at Aryabhatta Research Institute of Observational Science (ARIES) in Nainital. It is located at the height of 2,450 metres in Himalayas. It is considered as one of the best sites for astronomical observations. This facility is the result of collaborative work between astronomers from ARIES, Institute of Astrophysics and Geophysics, Liege University, Belgium; the Canadian Astronomical Institutes from Vancouver, University of British Columbia; etc.

- **Telescopes at Devasthal:**
 - **Devasthal Optical Telescope (DOT)** is a custom-built instrument of great complexity. It has the distinction of being the largest telescope in India for study of celestial objects at optical wavelength. It is a national facility installed at Devasthal in the district of Nainital, India. It was commissioned in 2016 and is being maintained and operated by ARIES (Aryabhata Research Institute of Observational Sciences)
 - **Devasthal Fast Optical Telescope (DFOT)**: It was commissioned in 2010.
 - **The International Liquid Mirror Telescope (ILMT)** is the only liquid mirror telescope operational anywhere in the world. It will also hold the unique tag of being the maiden liquid-telescope globally to be designed exclusively for astronomical purposes. It is the third telescope operating from Devasthal after DOT and DFOT.
 - The telescope was designed and built at the Advanced Mechanical and Optical Systems Corporation and the Centre Spatial de Liege, Belgium. The major instrumentation funding was jointly provided by Canada and Belgium while India will be responsible for the operations and upkeep of the telescope.
 - Unlike the conventional telescopes that can be steered to track specific stellar source objects, the ILMT will be stationary. It will basically carryout observations and imaging at the Zenith, that is, of the overhead sky. This is a survey telescope having high potential for discovering newer objects.
 - ILMT will operate every night for five years and carry out daily imaging except during June – Aug monsoon months, a precaution to protect the instruments from humid conditions.
- **What is liquid mirror telescope?**
 - LMTs are telescopes with mirrors made with a reflective liquid. The most common liquid is mercury, but other liquid will also work including (low melting alloys of gallium).
 - The liquid is rotated at a constant speed around a vertical axis, which causes the surface of liquid to assume a paraboloidal shape. This parabolic reflector can serve as the primary mirror of a reflecting telescope.
 - **Advantages:**
 - Low-cost alternative to conventional large telescopes.
 - **Limitations:** It can only be used as zenith telescopes (i.e. for looking straight up), so it is not suitable for investigation where the telescope needs to be continuously moved.

2) INDIA'S FIRST DARK SKY RESERVE

- **What is a Dark Sky Reserve?**
 - A Dark Sky Reserve is a designation given to a place that has policies in place to ensure that a tract of land or region has minimal artificial interference.

- The International Dark Sky Association (IDSA) is a US based non-profit that designates places as International Dark Sky Places, Parks, Sanctuaries, and Reserves, depending on the criteria they meet. Several such reserves exist in the world. **Between 2001 and Jan 2022**, there have been 195 sites recognized as International Dark Sky Places globally. But, so far, no such reserve is in India.
 - These reserves “consist of a core area meeting minimum criteria for sky quality and natural darkness, and a peripheral area that supports dark sky preservation in the core”.
- **How does a site become a ‘Dark Sky Reserve’?**
- Individuals or groups can nominate a site for certification to the IDSA. There are five designated categories, namely International Dark Sky parks, communities, reserves, sanctuaries, and Urban Night Sky Places.
 - The certification process is similar to that of a site being awarded the UNESCO World Heritage Site tag or getting recognized as a Biosphere Reserve.
 - **Note:** India is still in the process of filing its nomination to IDSA.
- **Who is developing India’s first Dark Sky Reserve?**
- The Ladakh UT administration is leading the efforts to establish the country’s first Dark Sky Reserve. The Department of Science and Technology (DST) and experts from Indian Institute of Astrophysics (IIA), Bengaluru, are providing scientific and technological support in developing this first of its kind facility. The formal decision to set up this Dark Sky Reserve was made through a MoU signed between officials from the IIA, Bengaluru, the Ladakh UT and the Ladakh Autonomous Hill Development Council in June 2022.
 - It will be situated at a height of 4,500 metres above sea level, the Hanle Dark Sky Reserve (HDSR) will come up within the Changthang WLS.
 - The IIA already manages the Indian Astronomical Observatory (IAO) complex at Hanle, Ladakh. Here scientists have been carrying out astronomical observations using the existing gamma ray, an infrared and an optical telescope to study exoplanets, galaxies, and stars through the pristine skies of Hanle.
 - For Dark Sky Reserve, in the pilot phase, IIA has procured ten small and easy to handle telescopes and light reflecting shields. IIA’s scientific and outreach experts will identify locals and train them to use these telescopes. This will include basic sky gazing, identification of constellations, and locating the pole star, among others. These telescopes will be installed at the homestays, which is a popular option for tourist accommodation in Ladakh.
- **Why was Ladakh chosen for the project?**
- It is a unique cold desert located about 3,000 metres above sea level with high mountainous terrains. Very cold temperature and long and harsh winter makes the UT very inhabitable. This aridity, limited vegetation, high elevation, and large area with sparse populations – all make it the perfect setting for long-term astronomical observatories and dark sky places.

- **Promotion of Astronomy Tourism** in an environment friendly and sustainable manner is one of the primary objectives of the proposed reserve. Scientific methods would be used here to keep light pollution under control.

A) THE INDIAN ASTRONOMICAL OBSERVATORY (IAO)

- The Indian Astronomical Observatory, the high-altitude station of IIA, is situated to the north of Western Himalayas, at an altitude of 4,500 meters above mean sea level.
- It is located atop Mt. Saraswati in the Nilamkhul Plain in the Hanle Valley in Changthang, it is a dry, cold desert with sparse human population and has the Hanle monastery as its nearest neighbours.
- The cloudless sky and low atmospheric water vapor make it one of the best sites in the world for optical, infrared, sub-millimeter, and millimeter wavelengths.
- **Prominent Telescopes located at the Hanle Observatory:**
 - The Himalayan Chandra Telescope
 - High Energy Gamma Ray Telescope (HAGAR)
 - The Major Atmospheric Cherenkov Experiment Telescope (MACE)
 - Growth-India

10. SPACE INFRASTRUCTURE IN INDIA

- **Background:**
 - Space activities in India began with the establishment of the Indian National Committee for Space Research (INCOSPAR) in 1962. In the same year, work on establishment of Thumba Equatorial Rocket Launching Station (TERLS) near Thiruvananthapuram was also started.
 - ISRO was formed on 15th Aug 1969, and superseded INCOSPAR with an expanded role. In 1972, Space Commission and Department of Space (DOS) were constituted by the GoI, and ISRO was brought under DOS.
 - ISRO is the space agency of India. It is involved in science, engineering, and technology to harvest the benefits of our space for India and mankind. It has established major space systems for communication, television broadcasting, and remote sensing. It has also developed satellite launch vehicles like PSLV, GSLV, LVM-3 etc. It also contributes to science and science education in the country. It has launched Indian's NAVIC, Chandrayaan, MOM-1, Aditya-L1 and several other incredible missions.
 - Space Commission formulates the policies and oversees the implementation of the Indian Space Program to promote development and application of space science and technology for the socio-economic benefit of the country.
 - DOS implements these programs through ISRO and other associated organizations:



- The Major establishments of DOS and their area of activities are:

A) VIKRAM SARABHAI SPACE CENTRE (VSSC):

- Located in Thiruvananthapuram, it is responsible for design and development of launch vehicle (rocket) technology. Its major programs include, PSLV, GSLV, LVM-3, RLV, Rohini Sounding Rockets etc.

B) UR RAO SATELLITE CENTRE (URSC)

- Located in Bengaluru, it is the lead centre for design and development of satellites including communication, navigation and remote sensing satellites. These satellites provide applications in the areas of telecommunication, television broadcasting, VSAT services, tele-medicines, tele-education, navigation, weather forecasting, disaster warning etc.

C) SATISH DHAWAN SPACE CENTRE (SDSC)-SHAR

- It is the 'Spaceport of India'. It is the backbone of the ISRO in providing launch base infrastructure for the Indian Space Program.
- It is located at Sriharikota, Andhra Pradesh.

D) LIQUID PROPULSION SYSTEMS CENTRE (LPSC)

- It is the lead centre of ISRO for the design, development, and realization of advanced propulsion systems for launch vehicles.
- It is primarily responsible for developing and deploying earth storable, cryogenic, semi-cryogenic, and electric propulsion systems for ISRO's launch vehicles and satellites.
- Its activities are spread across its two campuses, namely, LPSC, Valiamala, Thiruvananthapuram, and LPSC, Bengaluru.

E) SPACE APPLICATION CENTRE (SAC)

- Located in Ahemedabad, it's a major R&D centre of ISRO.
- It develops space borne and air-borne instruments and payloads and their applications for national development and societal benefits.
- For e.g., the communication transponders developed at this centre for the INSAT and GSAT series of satellites are used by the government and private sector for VSAT, DTH, Internet, broadcasting etc.
- It also designs and develops optical and microwave sensors for satellites, signal and image processing software, GIS software, and many applications for Earth Observation Program of ISRO.

F) HUMAN SPACE FLIGHT CENTRE (HSFC)

- Set up in 2019, it is the lead centre for ISRO's Human Spaceflight program.

- It undertakes multidisciplinary R&D activities in new domains of human science and technology while conforming to high standards of reliability and human safety.
- It is currently focused on Gaganyaan mission and is working on end-to-end mission planning, development of orbital module, life support systems, selection and training of astronauts etc.
- It is currently operating from ISRO-HQ campus, Bengaluru.

G) NATIONAL REMOTE SENSING CENTRE

- It is responsible for establishment of ground centres for receiving satellite data, generation of data products, aerial remote sensing data acquisition, dissemination to the users, development of techniques for remote sensing applications including disaster management support, geospatial services etc.

H) ISRO PROPULSION COMPLEX (IPRC)

- Located in Mahendragiri, it is responsible for assembly, integration and testing of liquid propulsion systems for operational and developmental launch vehicles.
- It is also responsible for qualification, testing and acceptance of liquid engines, cryogenic engines, spacecraft engines etc.

I) ISRO TELEMETRY, TRACKING AND COMMAND NETWORK (ISTRAC)

- It is responsible for providing telemetry, tracking and command (TTC), and mission control services to major launch vehicle, laboratory for electro-Optics Systems (LEOS) and Interplanetary Spacecraft missions of ISRO.
- It is also responsible for operating the complex ground segment of NaVIC.

J) MASTER CONTROL FACILITY (MCF)

- It is responsible for on-orbit Operations (OOP) and Launch & Early Orbit Phase (LEOP) operations of geostationary/geosynchronous & IRNSS class of spacecrafts of ISRO.
- It is located at Hassan in Karnataka.

K) ISRO INERTIAL SYSTEMS UNIT (IISU)

- Located in Thiruvananthapuram, it is responsible for design and development of inertial systems for launch vehicles and satellites. These include mechanical and optical gyros, Altitude reference systems, accelerometer packages etc.

L) LABORATORY FOR ELECTRO OPTICS SYSTEMS (LEOS)

- Located in Bengaluru it is responsible for design, development and production of altitude sensors, high resolution imaging optics, and special purpose science instruments for several spacecrafts.

M) INDIAN INSTITUTE OF REMOTE SENSING (IIRS)

- IIRS, Dehradun, is a premier institute with primary aim to build capacity in Remote Sensing and Geoinformatics and their applications through education and training programs at the postgraduate levels.

N) DEVELOPMENT AND EDUCATIONAL COMMUNICATION UNIT (DECU)

- Located in Ahmedabad, it is responsible for implementation of satellite-based societal applications in the country.
- It is involved in the system definition, planning, implementation, and social research & evaluation of such applications.

O) NATIONAL ATMOSPHERIC RESEARCH LABORATORY

- Located in Gadanki near Tirupati, it is an autonomous organization engaged in cutting edge research in atmospheric and space sciences with the vision of developing capability to predict the behaviour of the earth's atmosphere through observations and modelling.

P) NORTHEASTERN-SPACE APPLICATIONS CENTRE (NE-SAC)

- It is an autonomous organization under DOS and Northeastern Council (NEC). It has the mandate of providing space-based governance and development by taking up projects in the fields of natural resource management, infrastructure planning, healthcare, education, emergency communication etc.
- It also conducts training and capacity building in the field of geospatial technology and UAV based remote sensing applications.

Q) INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

- Established in 2007 at Thiruvananthapuram, it is Asia's first Space University. It aims to provide high quality education in Space S&T to meet the demands of the Indian Space Program. It offers undergraduate, postgraduate, doctoral and post-doctoral programs.

R) ANTRIX CORPORATION LIMITED (ACL)

- It is a Gol company under the administrative control of DOS.
- It is engaged in providing space sector products and services worldwide ranging from supply of hardware and software, earth observation and scientific missions, transponder lease services, launch services etc.

11. IMPORTANT PERSONALITIES

A) DR VIKRAM SARABHAI (12TH AUG 1919 – 30TH DEC 1971)

- Vikram Sarabhai, **father of Indian Space Program**, was born on 12th of Aug, 1919 in Ahmedabad.

- **Key contributions**

- He was a great institution builder and established or helped to establish a large number of institutions in diverse fields. He established **Physical Research Laboratory (PRL)** in 1947. PRL was the cradle of space sciences in India. PRL had a modest beginning at his residence, the RETREAT, with research in cosmic rays. It was formally established at M.G. Science Institute, Ahmedabad, on 11th Nov 1947
- He played an important role in establishment of a number of institutions including IIM Ahmedabad.
- The establishment of ISRO was one of his greatest achievements. He successfully convinced the government of the importance of space program after the Russian Sputnik launch.
 - He was the first chair of Indian National Committee for Space Research (INCOSPAR) which was predecessor to ISRO (established in its current form in 1969).
 - He also contributed in the setting up of Thumba Equatorial Rocket Launching Station at Thiruvananthapuram, with its inaugural flight in 1963.
- He was also chairperson of Atomic Energy Commission.



- **Recognition**

- i) He received Shanti Swarup Bhatnagar Medal in 1962

- ii) Was awarded Padma Vibhushan (posthumously) in 1972. Earlier was awarded Padma Bhushan in 1966.

- **Other Key Positions held:**

- i) President of the Physics Section, Indian Science Congress (1962)

- ii) President of General Conference of the I.A.E.A, Vienna (1970)

B) S SOMNATH

- » Sreedhar Panicker Somanath is the current chairperson of the ISRO. Earlier he has served as the chairperson of Vikram Sarabhai Space Centre (VSSC), Thiruvananthapuram and Director of Liquid Propulsion Systems Centre (LPSC), Thiruvananthapuram.
- » He was associated with the PSLV project during its initial days. He was also the project director of the GSLV-MK-III launch vehicle in from 2010 to 2014.

12. COMMERCIALIZATION AND PRIVATIZATION IN SPACE SECTOR

A) PRARAMBH MISSION

- **Why in news?**

- Launch of Vikram-S (i.e., Vikram Suborbital) rocket by Skyroot Aerospace is being hailed as an important milestone in India's outer space journey (Nov 2022)

- **Details:**

- **Skyroot Aerospace**, an Indian private sector space enterprise, created history by launching India's first privately developed rocket **Vikram-S**.
- **Vikram-S** is a single stage rocket. It is India's first privately developed cryogenic hypergolic-liquid and solid fuel-based rocket engine. It was developed using advanced composite and 3-D printing technologies.
- It carried three customer payloads in a sub-orbital flight. It was launched from the sounding rocket complex of the ISRO's Satish Dhawan Space Centre in Sriharikota, Andhra Pradesh.
- The rocket reached a peak-altitude of 89.5 kms and has met all flight parameters.
- **More About Skyroot:**
 - It is a relatively new entity that was set up in 2018. In 2020, after government announced opening up of space sector for private entities, it became the first startup to sign an MoU with ISRO to launch a rocket.
 - It is producing a series of Vikram Satellite, named after Dr Vikram Sarabhai. The goal is to launch small satellites using this rocket.
- **Future Plans of SkyRoot:**
 - **Vikram-1** is being developed to carry 480 kg payload to Low inclination Orbit.
 - **Vikram-2** which will follow Vikram-1, will carry 595 kg to low inclination orbit.
 - **Vikram-3** will carry 815 kg to Low inclination orbit.
 - Skyrocket also says that the rockets will be able to undertake multi-orbit insertion and inter-planetary missions as well as offer "customized, dedicated and ride share options covering a wide spectrum of small satellite customers needs".

2) NEW INSTITUTIONS

B) NEW SPACE INDIA LIMITED (NSIL)

- NSIL is a wholly owned government of India undertaking/CPSE, under the administrative control of Department of Space (DOS). It was established in March 2019 to commercially utilize the R&D work of ISRO Centers and other constituent units of DOS.
- **Roles and Functions:**
 - i. Small Satellite technology transfer to Industry, wherein NSIL will obtain license from ISRO/DOS and sub-license it to industry.
 - ii. Manufacture of SSLVs in collaboration with Private sector.
 - iii. Productionization of PSLV through Indian Industry.
 - iv. Productionization and marketing of space-based products and services, including launch and applications
 - v. Transfer of technology developed by ISRO Centres and constituent units of DOS

- vi. Marketing spin-off technologies and product/services, both in India and abroad.
 - vii. Any other subject which GoI deems fit.

- **As part of the space sector reforms announced by GOI in June 2020, NSIL was mandated to build, launch, own and operate satellites in “Demand-driven mode” to meet the service needs of the user.**
- The **launch of Brazil’s Amazonia-1 satellite** in March 2021, was the first dedicated communication mission of NewSpace India Limited. Earlier launches facilitated by NSIL were piggybacked with ISRO’s primary satellites.
 - i. Launch of GSAT-24 in June 2022 was the first demand driven satellite mission undertaken by NSIL. The capacity onboard the satellite was fully secured by TataPlay.
 - ii. **Presently (Jan 2024) NSIL owns and operates 11 communication satellites in India.**
 - iii. On similar lines, in 2024, NSIL will be undertaking the GSAT-20 satellite mission to offer cost-effective Ka-Ka band HTS capacity primarily for meeting the Broadband. The bulk of the capacity onboard GSAT-20 have already been secured by Indian Service Providers.

- **Significance of NSIL:**
 - i. Meet the ever-increasing demands of Indian Space Program.
 - ii. Commercially exploit the emerging global space sector.
 - iii. Spur the growth of Indian Industries in the space sector and enable Indian industries to scale up manufacturing and production base.

B) IN-SPACE (INDIAN NATIONAL SPACE PROMOTION AND AUTHORIZATION CENTRE)

- It is an independent nodal agency under Department of Space (DoS). It was set up in 2020 to boost commercialization of Indian Space Activities and encourage private sector participation.
- It will permit and oversee the following activities of **non-Government Private Entities** (NGPEs):
 - Building of launch vehicles and satellites and providing space-based service as per the definition of space activities.
 - Sharing ISRO infrastructure/premise etc.
 - Establishment of temporary facilities within the premise of ISRO
 - Establishment of new space infrastructure and facilities, by NGPEs, in pursuance of space activities based on safety norms and other statutory guidelines and necessary clearance.
 - Building of Spacecrafts by NGPEs for registration as Indian satellites and all associated infrastructure
 - Using of spacecraft data and rolling out of space based services and all other associated infrastructure for the same.
- It will draw up integrated launch manifest – considering the needs of ISRO, NSIL, and NGPEs based on priorities and readiness.
- It will draw up suitable mechanism for promotion, handholding, infra-sharing etc. to encourage participation of NGPEs.
- The decision of IN-SPACe shall be final and binding on all stakeholders including ISRO, NSIL etc. NGPEs will not be required to seek separate permission from ISRO.

- **Structure of In-SPACe** – It has a Chairman, technical experts for space activities, safety experts, experts from academia and industries, legal and strategic experts from other departments, members from PMO and MEA of GoI.
- **Monitoring and Promotion Directorate of IN-SPACe** will have the oversight of the activities as per IN-SPACe decisions and shall report back to IN-SPACe for corrective actions and resolutions if any.



TARGET PRELIMS 2024

BOOKLET-2; S&T-2

SPACE AND ASTRONOMY-2

TABLE OF CONTENTS

1. <i>Table of Contents</i>	0
1. <i>International Efforts</i>	3
1) Space Governance: Global Norms	3
2) International Space Station (ISS)	3
1) Thirty Meter Telescope (TMT)	4
2) SKAO (Square Kilometer Array Observatory)	5
A) India Moves towards becoming full member of SKAO (Jan 2024)	6
3) Space Based Internet	6
2. <i>NASA Initiatives</i>	7
1) Great Observatory Program	7
B) The Hubble Space Telescope (HST)	7
C) The Compton Gamma Ray Observatory (CGRO) (not operating currently)	8
D) The Chandra X-ray observatory (CXO)	8
E) The Spitzer Space Telescope (SST)	8
2) James Webb Space Telescope	8
3) NASA's Artemis Accord	9
4) NASA's ARTEMIS Lunar Program	10
a) Artemis-1 mission	11
b) Artemis-2: 2024	11
c) Artemis-3: 2025	12
d) NASA's Gateway Lunar Orbit Outpost	12
5) NASA's Mars 2020 Mission - PERSEVERANCE Rover	12
6) Parker Solar Probe	13
7) Lucy Mission	14
8) Dart Mission	14
9) Voyager-2	15

3. Peregrine Mission-1: First US Spacecraft due to land on Moon since the Apollo Missions in the 1970s Lifts Off	16
4. China	17
1) China's Space Station: Tiangong	17
2) Chang'E-5	18
5. Space Tourism.....	19
6. RUSSIA:.....	20
1) LUNA-25.....	20
7. General SPACE ISSUES.....	21
1) Space Debris	21
8. BASICS OF ASTRONOMY.....	22
1) Galaxy	22
2) OUR SOLAR SYSTEM	22
3) PLANETS, DWARF PLANTS AND OTHER CELESTIAL BODIES.....	23
4) MOON.....	24
5) PLANETS WITH HIGHEST NUMBER OF MOON	24
6) ASTEROIDS	24
A) Near Earth Asteroid:	24
B) Psyche	25
7) JUPITER TROJANS (CLASS DISCUSSION)	25
8) EXOPLANETS (CLASS DISCUSSION).....	26
9) GRAVITATIONAL LENSING	26
9. Sun	26
A) Basics About Sun.....	26
B) Sun's Structure – 3 Atmospheric LAYERS	27
C) Understanding Solar Winds	28
1) Life Cycle of Stars: Stars – Dwarf Stars – Neutron Stars – Black Holes	29
A) Life Cycle of a Star	29
B) Medium Stars -> Red Giant -> White Dwarf -> Black Dwarf.....	29
C) Neutron Star	30
D) Black Hole	30
10. Electromagnetic Waves AND WIRELESS COMMUNICATION	32
1) Electromagnetic Spectrum	33
A) Radio waves:.....	34
B) Microwaves.....	34
C) Infrared Waves.....	35
D) Visible Rays	35
E) Ultraviolet Rays.....	35
F) X-Rays.....	36
G) Gamma Rays	36

C) 2) Penetration of various EM Waves in Earth's Atmosphere.....	36
2) WIRELESS CommunicatioN – Different Frequency Bands and THEIR Applications	37
A) Radio Waves (500 KHz – 1 G Hz)	37
A) MICROWAVES	38
D) Deep Space Optical Communication.....	40
11. PYQs	41

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1. INTERNATIONAL EFFORTS

1) SPACE GOVERNANCE: GLOBAL NORMS

- Current Space Regulations: Gaps and Loopholes
 - » United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) was established in 1958 with UN Office for outer space affairs as its secretariat. It oversees the implementation of five UN treaties related to outer space:
 - » Treaty on Principles Governing Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial bodies of 1967 (Outer Space Treaty)
 - It designates space as the “province of all mankind” and states that the exploration of the outer space would be for the benefit of all countries, irrespective of their degree of economic or scientific development. It also prohibits deployment of weapons of mass destruction in space, and establishment of military bases, installations, and fortifications.
 - Limitations: Doesn't clearly prohibit weapons other than weapon of mass destruction; Doesn't properly cover modern day technologies like lasers for communication.
 - Further, it doesn't provide a detailed mechanism to decide if activities are inconsistent with the treaty and it failed to address issues like growing weaponization of the space.
 - » Agreement on the Rescue of Astronauts, the Return of Astronauts and 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)
 - Limitation: The **Liability Convention** and **OST** have the potential to impede the private sector investment as it makes state liable for all the damages thus compelling states to impose license and insurance on such entities.
 - » Convention on Registration of Objects Launched into outer space of 1976 (Registration Convention). It has helped in development of an international registration system. Full knowledge of the presence of objects in space is crucial for peaceful and safe use.
 - » The Agreement Governing the Activities of States on the Moon and other Celestial Bodies of 1979 (Moon Treaty).
 - » It also oversees **other related treaties** including Treaties Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space, and under Water (NTB) of 1963 and the **Brussels Convention Relating to the Distribution of Programme – Carrying Signals transmitted by Satellite (BRS) of 1979** among others.

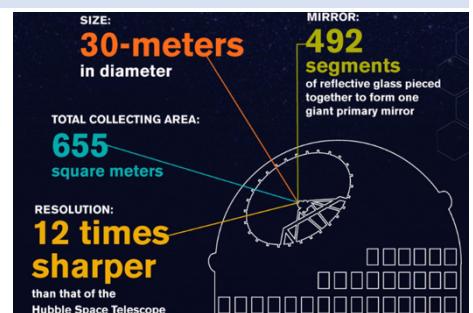
2) INTERNATIONAL SPACE STATION (ISS)

- The International Space Station (ISS) is a modular space station (habitable artificial satellite) in LEO.

- Its main construction was completed between 1988 and 2011, although the station continuously evolves to include new mission and experiments. It has been continuously occupied since Nov 2, 2000.
- It is a multinational collaboration with contribution from 15 nations.
 - A) NASA, ESA, ROSCOSMOS are the major partners of the space station and contribute most of the funding.
 - B) JAXA, and Canadian Space Agency are other partners.
 - C) Through a private company called Axiom Space, private astronauts are starting to work on the orbiting complex, from time to time.
 - D) The ownership and use of the space station is established by intergovernmental treaties and agreement.
- Details:
 - A) ISS is 109 meters from end to end with a weight of more than 4 lakh kg without visiting vehicles.
 - B) Orbits at an average height of 400 kms. It circles earth every 90 minutes at a speed of about 28,000 km/h.
- Space Vehicles to reach ISS:
 - A) Currently, astronauts travel to ISS via SpaceX's Crew Dragon capsule. Russian astronauts travel to the space station using Soyuz capsule.
 - B) Note: After retirement of NASA's Space Shuttle Program in 2011, Soyuz was the only spacecraft which could take humans to ISS. Later, in 2020, SpaceX's Crew Dragon also became available.
- Purpose:
 - A) It provides a platform for multi-gravity and space environment research laboratory.
- Future:
 - A) Current Plan calls for the space station to be operated through at least 2024 with the partners discussing a possible extension.
 - B) NASA has approved extension till 2030.
 - C) Russia has announced its withdrawal after 2024 to focus on building its own space station around 2028.
 - D) After 2030, plans for ISS are not clearly known. It could be deorbited or recycled for future commercial space stations in orbit.

1) THIRTY METER TELESCOPE (TMT)

- What is thirty-meter telescope?
 - Thirty-meter telescope is a new class of extremely large telescopes that will allow us 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. The images of TMT will be **12 times sharper than Hubble Space Telescope.**

- The TMT will **observe wavelengths** ranging from the ultraviolet to the mid-infrared.
- **Who is building TMT?**
 - » It is being built by **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 Institute of Natural Science of Japan, the National Astronomical Observatory of Chinese Academy of Sciences, the **DST India** and the National Research Council, Canada.

2) SKAO (SQUARE KILOMETER ARRAY OBSERVATORY)

- The Square Kilometer Array (SKA) is an inter-governmental radio telescope project under construction. Once completed it will be the world's largest and most powerful radio telescope.
- It will be built in two phases – with the core arrays located in:
 - **Australia:** Focusing on low frequency observation.
 - **South Africa:** Focusing on mid-frequency observation.
- **How will it function?**
 - The SKA will combine signals from thousands of smaller antennas spread across vast distances to function as a single giant telescope with exceptional sensitivity and angular resolution. This is achieved through a technique called aperture synthesis.
 - Some sub-arrays will also have very broad field view, allowing for surveying huge areas of the sky simultaneously.
- **The headquarters** and combining infrastructure, called the Square Kilometer Array Observatory (SKAO), are located at the Jodrell Bank Observatory in the UK.
- **The incredible sensitivity** of SKA will help understand the universe in a better way.
- **How will the SKA Observatory work?**

<p>The 197 dishes in South Africa are collectively referred to as SKA-Mid and will observe at radiofrequencies between <u>350 MHz</u> and <u>15.4 GHz</u>. They have combined effective collecting area of <u>33,000 sq m</u>.</p> <p>SKA-Mid's resolution will be <u>4-times that of JVLA</u> (the current best similar instrument in the world)</p>	 <p>Location: South Africa</p> <p>Frequency range: 350 MHz to 15.4 GHz with a goal of 24 GHz</p> <p>197 dishes (including 64 MeerKAT dishes)</p> <p>Total collecting area: 33,000m² or 126 tennis courts</p> <p>Maximum distance between dishes: 150km</p>
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In Australia, the 131,072 low frequency antennas are known as **SKA-Low** and have combined collecting area of **419,000 sqm**.

Compared to LOFAR(Low Frequency Array) in the Netherlands, this will be 8x more sensitive.



- The collecting area is a crucial component that makes the SKAO so powerful. It makes the telescope detect even the fainter objects.

- **Progress:**

- The construction of the project began in 2018, with the first light (the start of the scientific observations) expected in 2027

A) INDIA MOVES TOWARDS BECOMING FULL MEMBER OF SKAO (JAN 2024)

- In Jan 2024, GOI has approved India's participation in SKA, with a financial sanction of Rs 1,250 crores. This is the first step towards ratification of SKAO Convention. Countries have to sign and ratify this convention to formally become members.
 - **India**, through the Pune-based National Centre for Radio Astrophysics (NCRA) and some other institutions, has been involved in the development of SKA since its inception in the 1990s. India contributed heavily to the design and development of the SKA telescope over time, particularly in software domain, having been involved in SKA project since its earliest days.
 - **Full membership** was long anticipated. The Indian government was a party to the negotiation of the SKAO Convention and participated in the preparatory activities that led to the creation of the observatory in early 2021.
- The approval covers the funding support for the construction phase of the international SKA Observatory (SKAO) spread over the next 7 years.
- The project will be jointly funded by DAE and DST, with DAE being the lead agency.
- This participation is nationwide including project led consortium of more than 20 academic and research institutes (with NCRA-TIFR as the nodal institute)

3) SPACE BASED INTERNET

- **Space X Plan**
 - **The Starlink Network** of SpaceX eventually plans to install 42,000 satellites to ensure non-stop internet services throughout the earth at a cost-effective rate. These satellites will be connected with their neighboring satellites using lasers.

- China's "Guowang" (GW) constellation has also been announced which is meant to meet satellite-based internet services.
 - It will also be a LEO based system with satellites operating at different heights (500-1145 km), inclinations (30-85 degrees) and frequency bands.
- **Other such projects:** Several other companies including Amazon, OneWeb and O3B have also planned large constellation of satellites in LEO and MEO – but these projects are very small compared to Starlink.
- **Comparing Geostationary vs LEO satellites** for providing internet services [Advantages of LEO – Low latency-> allows real time communication; Disadvantage -> need more satellites for coverage as they cover small part of earth]
- **Significance**
 - Prelable and uninterrupted internet services universally to everyone on earth.
 - Services during emergency: For e.g. During Russia Ukraine war in 2022, the Starlink played an important role in strengthening the Ukrainian military might after the European SATCOM system was cyber attacked.
 - IOT services
 - Better e-governance
- **Concerns:**
 - **Increased Space debris**
 - **Increased chances of collision of satellites**
 - **Difficulty in Space Observation -> Light Pollution**
 - **Increased crowding in LEO and signal interference** in space may emerge as another problem

2. NASA INITIATIVES

1) GREAT OBSERVATORY PROGRAM

- NASA's series of Great Observatories satellite are four large, powerful space-based telescopes. The four missions were designed to examine a specific region of the electromagnetic spectrum using very different technologies. The program was developed in 1994.
- **Great Observatories**

B) THE HUBBLE SPACE TELESCOPE (HST)

- The Hubble Space Telescope was deployed on April 25, 1990 from the space shuttle Discovery.
- It primarily observes visible light and near-ultraviolet. A servicing mission in 1999 added capability in near infrared range and one last mission in 2009 was to fix and extend the life of Hubble which resulted in some of the best results to date.

- Hubble is one of the largest and most versatile, and is well known as both vital research tool and a public relation boon for astronomy.

C) THE COMPTOM GAMMA RAY OBSERVATORY (CGRO) (NOT OPERATING CURRENTLY)

- Primarily observed gamma rays, though it extended into hard x rays as well. It was launched in 1991 aboard Atlantis and was deorbited in 2000 after failure of a gyroscope.

D) THE CHANDRA X-RAY OBSERVATORY (CXO)

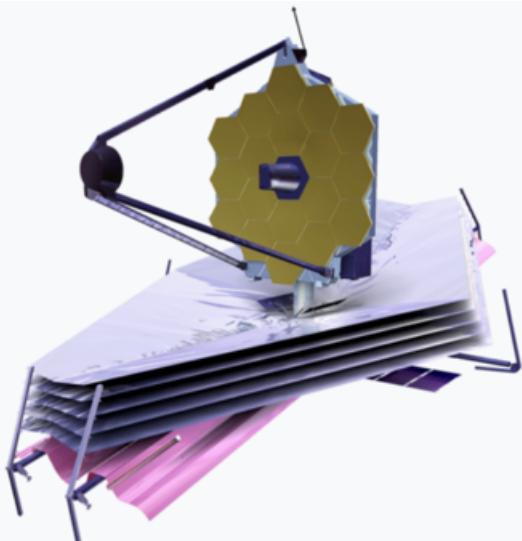
- It is primarily observing soft x-rays. It was launched in 1999 aboard Columbia and was initially named advanced X-ray Astronomical Facility (AXAF).
- Because X-Rays are absorbed by Earth's atmosphere, Chandra must orbit above it and therefore is a space-based telescope.

E) THE SPITZER SPACE TELESCOPE (SST)

It observes the infrared spectrum. It was launched in 2003 aboard a Delta II rocket and was called the Space Infrared Telescope Facility (SITF) before launch.

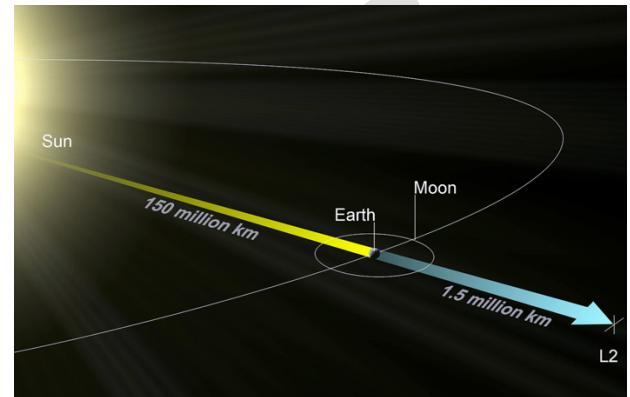
2) JAMES WEBB SPACE TELESCOPE

- It is the largest, most powerful, and complex space telescope ever built and launched into space. It is an infrared telescope with a 6.5-meter primary mirror.
- **International Collaboration:** JWST is an international collaboration between NASA, European Space Agency (ESA), and the Canadian Space Agency (CSA).
- **Some innovative technologies**
 - Primary Mirror made of 18 separate hexagonal segments that unfolded and adjusted to the shape after launch. The mirrors are made of ultra-lightweight beryllium and are gold coated. A single large mirror would have been too large for existing rockets to carry.
 - Biggest feature is a tennis court sized five-layer sunshield that attenuates heat from the Sun more than a million times. This sunshield is constructed from Kapton E, a commercially available polyimide film with membranes especially coated with aluminium on both sides and a layer of doped silicon on the sun facing die of the two hottest layers to reflect the sun's heat back into space.
- **Two basic reasons for it being more powerful than Hubble:**
 - It has the **biggest telescope mirror** to fly in space.



A rendering of the James Webb Space Telescope with its components fully deployed.

- 7 times light will be caught than collecting area of Hubble
- It is **designed to collect infrared light**, which **Hubble is not very sensitive to**.
 - **Why infrared observation?**
 - **High redshift (very old and distant)** objects have **their visible emissions shifted into the infrared**, and therefore their light can only be **observed today via infrared astronomy**.
 - **Colder objects** and planets **emit strongly in the infrared**.
 - Infrared rays can **better pierce cosmic dusts** and thus would be able to give **details about the earliest and furthest galaxies**. (Infrared wavelength can penetrate gas and dust)
 - **Why from L2 and what is the purpose of sunshield?**
 - **Earth's atmosphere glows in the infrared**, so measurement can't be made from the ground.
 - **Hubble emits its own heat**, which could obscure infrared readings.
 - JWST will **run close to absolute zero (around 50K or -232.2 degree C) in temperature** otherwise, infrared radiation from the telescope itself would overwhelm its instruments. For this, it would rest at a point in space called the **Lagrange Point 2**, which is **directly behind earth from the sun's perspective**. Further, the **five-layer sunshield** would attenuate heat from sun more than **a million times**.
- It was launched in 2021, and it reached **its final orbit at a distance of around 1.5 million km from the Earth in early 2022** and it took the engineers and scientists another six months to **ready the instruments before it could be used**.



3) NASA'S ARTEMIS ACCORD

- **Why in news?**
 - India signs US-led Artemis Accord. With this **India has become 27th signatory to the accord (June 2023)**
- **What is Artemis Accord?**
 - Artemis accord was **announced by NASA in Oct 2020** with an initial group of **eight signatories (USA, Canada, UK, Luxemburg, Italy, UAE, Japan, and Australia)**. Later, more countries joined the accord. **India became 27th country to sign the accord in June 2023**.
 - **Note:** China and Russia are not part of the accord.
 - It is a **set of 13 principles** which seek to promote **peaceful and cooperative exploration of space**. Signatory countries agree to abide by these principles which are **mostly a reiteration of established international law on space exploration** (for e.g. the OST of 1967).

- The parties who sign this would be able to participate in NASA's Artemis Program of crewed Lunar Exploration.
- The accord serves as preamble to bilateral, government-to-government agreements that participating nations will sign with the USA.
- **Key Provisions:**
 - **Peaceful purposes:** Conduct all space activities peacefully and in accordance with international law.
 - **Heritage Protection:** Help protect space heritage, such as Apollo landing sites.
 - **Transparency:** Publicly release scientific data in a timely manner
 - **Emergency Assistance:** Render aid to astronaut who need it.
 - **Interoperability:** Make their (signatory countries) hardware and other systems "interoperable" to maximize cooperative system.
 - **Registration of Space Objects:** The Artemis accord reinforces the critical nature of registration and urges any partner which isn't already a member of the Registration Convention to join ASAP.
 - **Space Resource:** Space resource extraction and utilization can and will be conducted under the auspices of the Outer Space Treaty, with specific emphasis on Article II, VI, and XI.
 - **Deconfliction of Activities:** NASA and partner nations will provide public information regarding the location and general nature of operations which will inform the scale and scope of 'Safety Zones'.
- **Analysis:**
 - **Why the project is collaborative?**
 - Huge costs involved in these projects -> so countries like USA are keen to take forward a collaborative agenda.
 - **Geopolitical dimension:** China and Russia are also planning a research station on Moon (surface or orbit), and they are also seeking partners.
 - **India's joining:**
 - India's joining of Artemis accord doesn't mean automatic participation in the Artemis program, but it does open up possibilities of much closer cooperation between the space agencies of the two countries. In fact, the text of the accord clearly mentions that its purpose is to establish a common vision and enhance the governance of civil exploration of outer space "with the intention of advancing the Artemis Program".

4) NASA'S ARTEMIS LUNAR PROGRAM

- This is NASA's program for Crewed Lunar Exploration. Under this NASA aims to land two astronauts (including 1 women) near the Lunar south pole in 2024 and establish a sustainable human presence on and around the moon by the end of the decade.

- Perhaps the most ambitious of the Artemis mission's objectives involve using the moon as a **stepping stone for a mission to Mars**. Robots have done all the detective work on Mars so far, but NASA aims to send astronauts there by 2030s.
- NASA is collaborating with other countries and Private sector for this project.
- **Rockets and Spacecrafts:**
 - At the center of the Artemis Program are NASA's new megarocket, the **Space Launch Rocket (SLS)** and the **Orion Spacecraft**.
 - The **SLS** is a 322 foot tall (98 meters) rocket consisting of a core stage, upper stage, and twin five segment solid rocket boosters to launch payload into space. This rocket will launch the Orion Spacecraft to the moon.
 - **Orion** is a space capsule larger than the Apollo command modules that are designed to carry four astronauts on missions to the moon.

A) ARTEMIS-1 MISSION

- Artemis-1 is the first integrated test of NASA's deep space exploration systems: the Orion spacecraft, Space Launch System (SLS) rocket and the ground system at Kennedy Space Centre in Cape Canaveral, Florida. It was launched in Nov 2022 from NASA's Kennedy Space Centre in Florida.
- It tests the safety of the SLS rocket, and the Orion capsule's ability to reach moon, perform in lunar orbit and return to Earth for an ocean splashdown.
- It is an uncrewed flight test that will provide foundation for human deep space exploration and demonstrate NASA's commitment and capability to extend human existence to the Moon and beyond. It will pave the way for many moon missions including ones that will land the first woman and the first person of color on the Moon.

ORION SURPASSES APOLLO 13 RECORD DISTANCE FROM EARTH (NOV 2022)

- On day 11 of the Artemis 1 mission, Orion continued its journey beyond Moon after entering a distance retrograde orbit. Orion remained in this orbit for six days before exiting lunar orbit to put the spacecraft on a trajectory back to earth.
- **Orion surpassed** the distance record for a mission with a spacecraft designed to carry humans to deep space and back to Earth, on Nov 26, 2020.

B) ARTEMIS-2: 2024

- Carrying the first four Artemis astronauts, the Orion Capsule will take the crew farther from earth than humans have ever travelled before.
- Over the approximately 10-day mission, the crew will complete a lunar flyby and return to Earth, evaluating the spacecraft's systems while carrying humans.

C) ARTEMIS-3: 2025

- It will see the **next man and first woman step onto the lunar surface**. Astronauts will land on the South pole of the moon using lunar lander. They will remain on the moon for around a week.

D) NASA'S GATEWAY LUNAR ORBIT OUTPOST

- Details

- Gateway Lunar Orbit Outpost is basically a **spaceship that will orbit the Moon**. It will act as an airport, where spacecraft bound for lunar surface or surface of Mars can refuel or replace parts and resupply things like food, oxygen. It will also act as a temporary office and living quarters and lab for astronauts around 2,50,000 kms away from earth.

5) NASA'S MARS 2020 MISSION - PERSEVERANCE ROVER

- Details

- Perseverance (six-wheeled robot) is NASA's Martian rover. In Feb 2021, it touched down on the Martial soil when it successfully landed in Mar's Jezero Crater.
- Its design is similar to its predecessor rover- curiosity, from which it was moderately upgraded. It carries seven primary payload instruments, 19 cameras, and two microphones. It also carries a mini-helicopter Ingenuity, which in April 2021 made the **first ever powered flight on another planet**.
- The rover has **four science objectives** that support the **Mars Exploration Program's Science goals**:
 - » **Looking for habitability**
 - » **Astrobiology: Seeking biosignatures** – of possible past microbial life in those habitable environments, particularly in specific rock types known to preserve signs overtime.
 - » **Caching samples** – Collect core rocks and soil samples and store them on Martian surface which can be extracted by future programs.
 - » **Preparing for crewed missions** – Test oxygen production form the Martian atmosphere.
- The two microphones would listen to Martian sounds like the wind or the rover moving on the Martian soil.
- **Why Jajero Crater:**
 - » Jajero **crater preserves the evidence that it was once a lake** with an inflow channel and an outflow channel. There are good chances that if life existed on Mars in the past, the microorganisms could have lived here and preserved in the form of fossil here.
 - » **In Aug 2022**, NASA's perseverance found surprising volcanic rocks in Mars' Jezero Crater. The discovery was a complete surprise as the researchers initially expected to find sedimentary rocks formed by mud and detritus laid down by the ancient lake. These water altered rocks indicate the presence of water, which is an essential ingredient for a habitable environment.

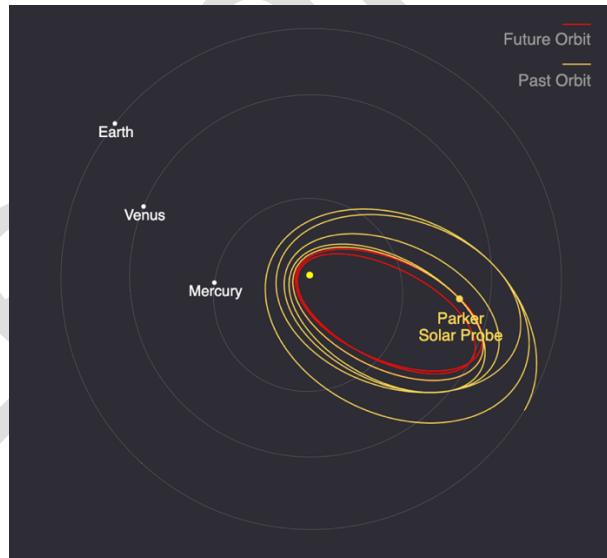
- In April 2021, NASA's Ingenuity Mars Helicopter became the first aircraft in history to make a powered, controlled flight on another planet.
 - » It is a **solar powered** helicopter.
 - » **Why flying on Mars is a challenge?**
 - Atmosphere density is only 1% of Earth's atmosphere.
 - To sustain flight, helicopter blades have to rotate at 2400 rpm (rotation per minute). For a helicopter to fly few meters from the ground on Mars, is equivalent for a helicopter to fly 2-3 times the height of Mt Everest.



6) PARKER SOLAR PROBE

- Introduction

- The parker solar probe was launched in Aug 2018. It is designed to swoop through the sun's super-hot outer atmosphere and help scientists understand the way our star shapes the solar system.
 - **Using Venus' Gravity:** The parker probe has used Venus' gravity during seven flybys over nearly seven years to gradually bring its orbit closer to sun. It is done to slowdown the spacecraft to reduce gravitational pull of the Sun.
 - In June 2020, the probe reached as close as 832 kms above the planet's surface.
 - **Launch Site:** NASA's Kennedy Space Center, Florida
 - **Launch Vehicle:** Delta IV – Heavy with upper stage.



- It is designed to go closer to the sun (3.8 million miles from the solar surface), seven times closer than any other spacecraft before, facing brutal heat and radiation conditions – and ultimately provide humanity with the closest ever observation of the star. **In 2021 it has entered into the outermost part of sun's atmosphere**, known as the Corona. It is using in situ measurements and

imaging to revolutionize our understanding of the Corona. It is a monumental moment for solar science and a truly remarkable feat.

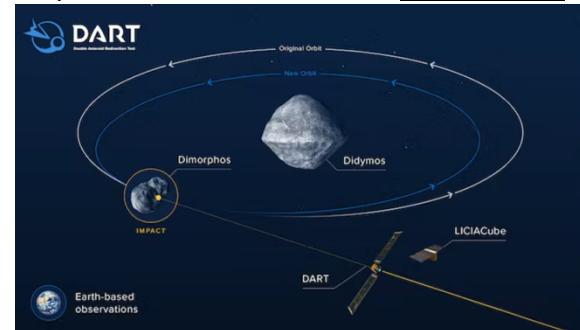
- The first passage through Corona – and the promise of more flybys to come – will continue to provide data on phenomena that are impossible to study from afar.

7) LUCY MISSION

- NASA has launched the LUCY spacecraft in Oct 2021, on a 12-year cruise to the Jupiter Trojan asteroids. It will fly by eight asteroids – 7 trojans and one main belt asteroid – over the next 12 years. It is NASA's first single aircraft mission which will explore so many asteroids at one go.
- LUCY will run on solar power out to 850 million kms away from sun. This makes it the farthest-flung solar powered spacecraft ever.
- **Significance:** It will look back into the origins and evolution of the solar system formed over 4 billion years ago through these celestial bodies.
- **Why named Lucy?**
 - Lucy is the name given to a hominin that lived 3.2 million years ago. She is known to be one of the most famous pre-human fossil in history.
 - Nearly, 40% of the fossilized skeleton of this hominin was discovered in 1974 by a team of Paleoanthropologists led by Donald Johanson. The name was inspired from the famous Beatles song "Lucy in the Sky with Diamonds", which Johanson's team listened to at camp the night of their discovery.

8) DART MISSION

- **Introduction**
 - DART is a planetary defense-driven test of technologies for preventing an impact of Earth by a hazardous asteroid.
 - Under this NASA launched a mission in Nov 2021, aboard Space X Falcon 9 rocket. It sent a space capsule of the size of a fridge towards an asteroid to shoot it off course. The target asteroids were 11 million kms away from Earth and DART mission reached here after 11 months of journey.
- **Target Asteroid:**
 - DART's test target was an asteroid (Dimorphos/Didymos B) that passed the earth in 2022 and will come back two years later.
 - Its primary body (Didymos A) is approx. 780 meters across, its secondary body (or “moonlet”) – Didymos B is about 160 meter in size, which is more typical of the size of asteroids that could pose the most likely significant threat to Earth.
 - NOTE: DART's target asteroid was **NOT** a threat to earth, and it is only a test mission.



- In Sep 2022, this space capsule was crashed into **Dimorphous/Didymos-B**.
- It used **autonomous targeting**, using images of the asteroids it acquires as it approaches. DART needed to recognize the asteroid itself, automatically lock onto Dimorphous, and adjust its trajectory to hit it. This is while it was moving at a speed of 24,000 km per hour.

- **Technology: Kinetic Impact Technique:**

- **Why Didymos system was chosen:** Easy to measure impact (binary pair); No risk to humans.
- **How observations were made:**
 - Measurements from telescopes on Earth.
 - **LICIACube:** It is an Italian Space Agency CubeSat (a small type of satellite) that was deployed from a spring-loaded box aboard the craft on 11th Sep. LICIACube followed along and photographed the collision and its aftermath.

- **Outcome:**
 - **For the first time**, human has changed the orbit of a planetary body. The impact shortened Dimorphos' orbit time by 32 minutes.
 - **Proof:** The test was a proof of concept for many technologies, that NASA has invested over the last few years.
 - **DART** has also given some fascinating data about both asteroid properties and the effectiveness of a kinetic impactor as a planetary defence technology.

9) VOYAGER-2

- **Why in news?**
 - NASA's Voyager 2 spacecraft, which is now travelling in interstellar space, has gotten a new lease of life after mission engineers developed a new plan to keep its instruments running for longer (April 2023)
- **About Voyager 2**
 - Voyager 2 is a **space probe launched by NASA in 1977 to study the outer planets**.
 - Its primary mission ended with the exploration of the Neptunian system in 1989. It had visited Jupiter, Saturn and Uranus earlier.
 - It is second spacecraft to enter interstellar space. On 10th Dec 2018, the spacecraft joined its twin – Voyager 1 – as the only human-made objects to enter the space between the stars.
- **Power:** The spacecraft is equipped with **3 Multi-hundred-Watt radioisotope thermoelectric generators (MHW RTG)**.
- **April 2023 Updates:**
 - The ageing voyager 2 spacecraft has begun using a small reservoir of backup power to keep its instruments working despite a reduced power supply. This backup power was set aside as part of an onboard safety mechanism. The spacecraft was scheduled to shut down its science instruments in 2023, but with this move, it can continue operating them until 2026.

- **Achievements**
 - It is the **only spacecraft to study all four of the solar system's giant planets** at close range.

- The craft is now travelling more than 11.6 billion miles from earth. It is **beyond heliopause**, or boundary region, where the sun's influence ends and the **interstellar medium begins**.
- Note:** Although both the Voyager probes – Voyager-1, launched on Sep 5, 1977, and Voyager 2, launched 16 days before its twin – have left the heliosphere, neither spacecraft has yet left the solar system, and won't be leaving anytime soon. The boundary of the solar system is considered to be beyond the outer edge of the Oort Cloud, a collection of small objects that are still under the influence of sun's gravity.

The width of the Oort Cloud is not known precisely, but it is estimated to begin at about 1,000 astronomical units from the sun and to extend to about 100,000 AU (1 AU is the distance from the sun to Earth). It will take about 300 years for Voyager 2 to reach the inner edge of the Oort Cloud and possibly 30,000 years to fly beyond it.

3. PEREGRINE MISSION-1: FIRST US SPACECRAFT DUE TO LAND ON MOON SINCE THE APOLLO MISSIONS IN THE 1970S LIFTS OFF

Why in news?

Peregrine Mission-1 is the first US attempt to land on Moon in more than half a century (since Apollo 17 in 1972). It lifted off in space as planned (Jan 2024)

Soft Landing on Moon So Far:

As of Jan 2024, **Soft landing on moon** has been achieved by **only four national space agencies**:

Soviet Union was first in 1966.

It was followed by USA's NASA which still remains the only space agency to put humans on Moon.

In the last decade, China soft landed on moon thrice in its Chang'e-3, Chang'e-4, and Chang'e-5 missions.

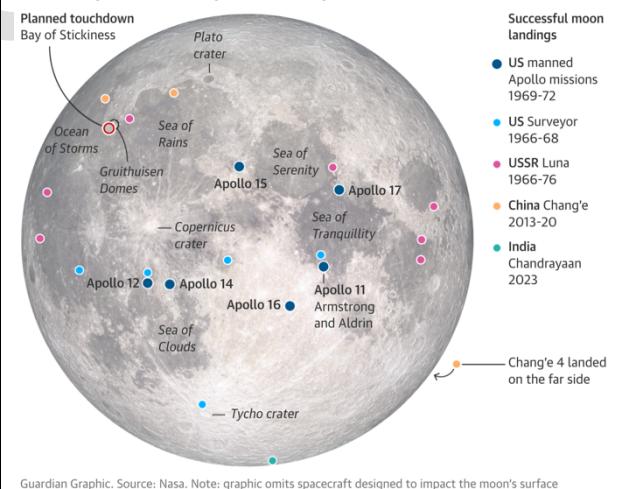
India achieved soft landing in 2023 in its Chandrayaan-3 mission.

Failures:

Private Missions by Israel and Japan, as well as an attempt by the Russian Space Agency – have all ended in failures.

Why limited successes? Controlled touchdown on moon is a challenging task due to absence of atmosphere and treacherous terrain.

The Peregrine lunar lander is expected to touch down on **23 February** in the newly named Bay of Stickiness



Guardian Graphic. Source: Nasa. Note: graphic omits spacecraft designed to impact the moon's surface

Details Of Peregrine Mission-1

Rocket Used: Vulcan Centaur: It's a brand-new rocket of United Launch Alliance. Peregrine Mission-1 is its maiden launch.

- » The rocket has reusable first stage booster engines which is expected to reduce cost of launches.
- » **Note:** ULA is a joint venture between Lockheed Martin and Boeing.

Peregrine Lander: It has been developed by a US company Astrobotic, which has been selected for NASA's Commercial Lunar Payload Services (CLPS) programme.

Launch site: Cape Canaveral Space Force Station, Florida.

Touchdown: Peregrine is schedule to touch on a mid-latitude region of the Moon called Sinus Viscositas.

NASA has contracted private players under Commercial Lunar Payload Services (CLPS) programme.

Payload Carried:

A suite of scientific instruments by NASA to probe radiation and surface composition – helping to pave the way for return of the astronauts.

Some Unique Cargos: A shoebox-sized rover built by Carnegie Mellon University (CMU), a physical bitcoin, and cremated remains and DNA including those of Star Trek creator Gene Roddenberry, legendary sci-fi author, scientist Arthur C. Clarke, and a dog.

Note: The Navajo Nation, the USA's largest indigenous tribe, had opposed it as sending these to the moon desecrates a body they consider sacred to their culture.

Significance:

- » **Stimulate Broader Lunar Economy:** USA has turned to commercial sector to stimulate broader lunar economy.
- » **Cost Reduction:** NASA has paid the startup just \$180 million for five scientific instruments to be carried to the moon – a fraction of cost of launching its own mission.

Future Commercial Launches:

Another US company, which NASA has contracted, Houston-based Intuitive Machines, is looking to launch in Feb 2024 and land near the south pole.

4. CHINA

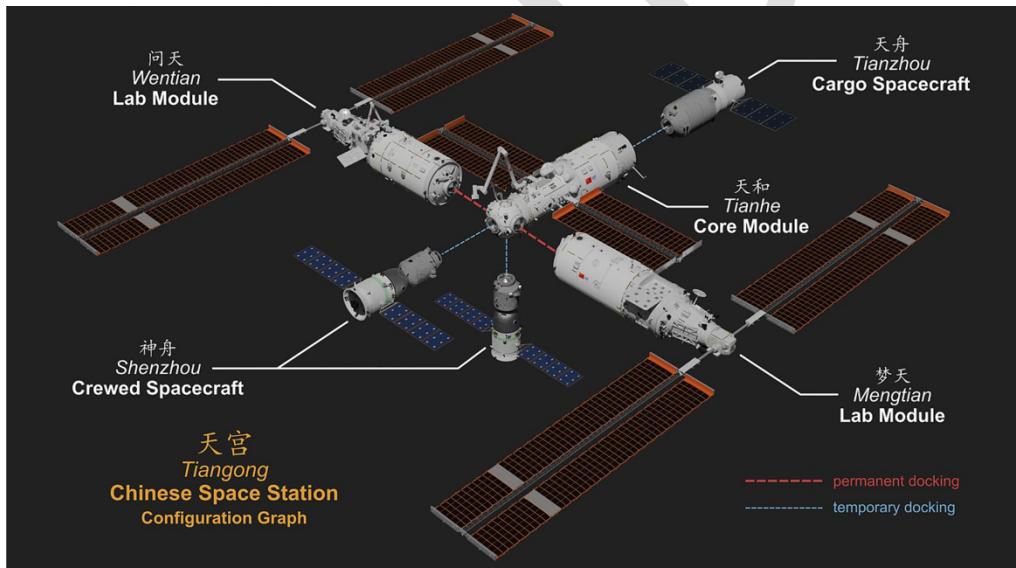
1) CHINA'S SPACE STATION: TIANGONG

- **Details**

- **Background:**

- China's crewed space program is officially three decades old. It truly got underway, when in 2003, China became only third country in the world, after USA and Russia, to put a human into space using its own resources.

- Work on the space station programme began a decade ago with the launch of a **space lab Tiangong-1** in 2011, and later, **Tiangong-2** in 2016.
- **Details of the Space Station - Tiangong:** It is a **T-Shaped space station** which will be able to accommodate 25 lab cabinets, each a micro lab that can be used to conduct experiments. The space station will weigh 66 tonnes – a fraction of ISS which weighs 465 tonnes.
 - It will have **three modules**
 - **Tianhe Module** (launched in April 2021) on Long March-5B.
 - **Wentian Module** (launched in July 2022) will be equipped to support life science research. It will also have airlock cabins for extravehicular trips, as well as short-term living quarters for astronauts during crew rotation.
 - **Mengtian Module** (launched in Oct 2022) will focus on microgravity experiment. It is the third and final module which docked with the station in Nov 2022.
 - The space station is designed for a lifespan of at least a decade.
 - It has facilities for long term accommodation of just three astronauts (compared to 7 of ISS). Still China has invited foreign astronauts in an effort to internationalize the space station.
 - **Scope of expansion in future:** The Three module T Shaped station could be expanded into a four-module cross shaped configuration in future.



2) CHANG'E-5

- **Details**
 - The Chang'e-5 probe, comprising an orbiter, a lander, an ascender, and a returner was launched on Nov 24, 2020, and its lander-ascender combination touched down on the north of the Mons Rumker in Oceanus Procellarum, also known as the ocean of Storms, on the near side of the Moon on 1st Dec 2020.
 - It was the third Chinese mission to land on the moon.

- The Chang'e-5 probe returned to earth in Dec 2020 and it brought along with it about 1,731 grams of samples. Scientists will carry out the storage, analysis, and research of the country's first samples collected from the extra-terrestrial object.

The Chang'e-5 mission marks a successful conclusion of China's current three-step lunar exploration programme of orbiting and landing and bringing back samples which began in 2004.

5. SPACE TOURISM

- **Why in news?**
 - » ISRO is planning space tourism by 2030
- **What is suborbital Flight?**
 - » Suborbital flights don't have enough speed to escape into orbit. Any orbit without enough energy to reach orbit will instead follow a parabolic trajectory, looping up and then back down again. This will be a suborbital space mission or suborbital flight.
 - » Such flights are short, but passengers can experience mind-blowing view of Earth and will also experience several minutes of weightlessness. This thus can attract space tourists.
 - » **Why weightlessness?**
 - During downward path, a section of the flight is a free fall.
 - » **Other Significances:**
 - Microgravity experiments can also be carried out on these flights. This would be much cheaper than doing these experiments in International Space Stations.
 - It could also be a cheaper way of testing space flight technologies or experiments before they are sent on more expensive orbital or deep space missions.
- **Space Tourism**
 - » Space Tourism is the segment of space travel which provides non-astronauts the ability to go to space for recreational, leisure or business purposes. The idea is to make space more accessible for anyone who can afford it.
 - » In the past, NASA and Russian Space Agency used to take tourists for space travel. For e.g. Dennis Tito was the first commercial spaceflight passenger before which only astronauts used to go to space. He went to space on Russian Soyuz TMA Launch Vehicle in April 2001. After him, between 2001-2009, few other space tourists went to space, aboard a Russian Soyuz space to ISS, brokered by Space Adventures (an American Space Tourist company) in conjunction with Roscosmos.
- **Recent tourism space flights:**
 - » Virgin Galactic is a company which was established by British Entrepreneur Richard Branson in 2004.
 - In July 2021, Richard Branson and five others undertook a brief trip to the edge of the space, taking off on a VSS unity spaceship.



- » **Blue Origin** was established by Jeff Bezos in 2000. It's reusable rocket **New Shepherd** successfully completed first human flight to space recently (**20th July 2021**) with **four private citizens onboard**. The flight went about **107 km** high.
- **SpaceX's Inspiration4** – debut of SpaceX's tourism business (Sep 2021)
 - » Falcon 9 rocket took a crew Dragon spacecraft with 4 civilians (first all civilian space flight) into space. They travelled to an altitude of 575 km, even higher than HST and ISS.
 - » **Isaacman**, the founder and CEO of Shift4 payments, is largely responsible for the mission's planning from birth to launch.
- Other than these three, companies such as Virgin Atlantic, XCOR Aerospace, Armadillo Aerospace are working on providing space tourism services to people.
- **Concerns**
 - » **Climate change** may be aggravated by Space Tourism.
 - » **Available only for highly rich people**

6. RUSSIA:

1) LUNA-25

- **Why in news?**
 - Russia's LUNA-25 failed to land on Moon and crashed onto Moon's surface (Aug 2023)
- **Details**
 - **Why the failure?**
An anomalous engine burn-> Instead of a planned propulsive nudge of 84 seconds, the engine operated for 127 seconds, more than the "required value" in readying the probe for its descent burn. This added impulse caused Luna-25 to smash into the moon.
 - **More about Luna-25:**

- i. It was modern Russia's first Moon mission. It was heralded as the first domestically produced moon probe in Modern Russia history. Luna-25's flight was important in both political and scientific terms. The implication of its failure is likely to be considerable.
- ii. The final soviet moon mission, Luna-24, successfully hauled home to Earth about 170 grams of lunar samples in 1976.

7. GENERAL SPACE ISSUES

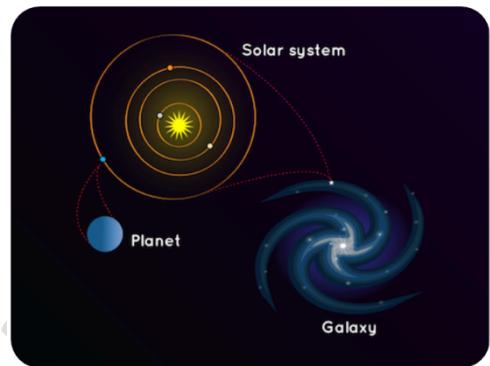
1) SPACE DEBRIS

- **Introduction**
 - The term “space debris” refers to **defunct human made objects which are moving in orbit around earth**. It includes big and small things like discarded boosters, retired satellites, leftover bits and pieces from spacecrafts, screwdrivers, tools, nuts, bolts, lost gloves, flecks of paints etc.
 - There are more than 20,000 pieces of debris that are larger than 5-10 cms and can be tracked and catalogued. There are hundreds of millions that we cannot because of their small size. They are all dangerous as they are moving at very high speeds.
- **How are Space Debris created?**
 - **Breakup of older spacecrafts:** For e.g., breakup of US' spacecraft called USA 109 in 2015, created 100 debris pieces and 50,000 shards larger than 1 mm.
 - **Accidently left-over objects**
 - **Testing of Space Weapons**
 - For e.g., China's testing of A-SAT missile in 2007 created more than 34,000 debris.
 - **Further breakup of space debris:** More debris increase the chance of collision – a cascade effect known as the **Kessler Syndrome**. The fear is that the space could eventually become inoperable.
 - **Mega constellations** (e.g., Starlink satellite internet constellation) would launch thousands of satellites in coming years and would make space more vulnerable to collision and debris creation.
- **Key Concerns Raised by Space Debris**
 - **Endanger the prospects for Space Missions** (Civilian, Commercial or military)
 - **Sometimes crash land on earth** harming life and livelihood of people
 - Recently parts of Zenit rocket debris are reported to have ended up crash-landing in Peru.

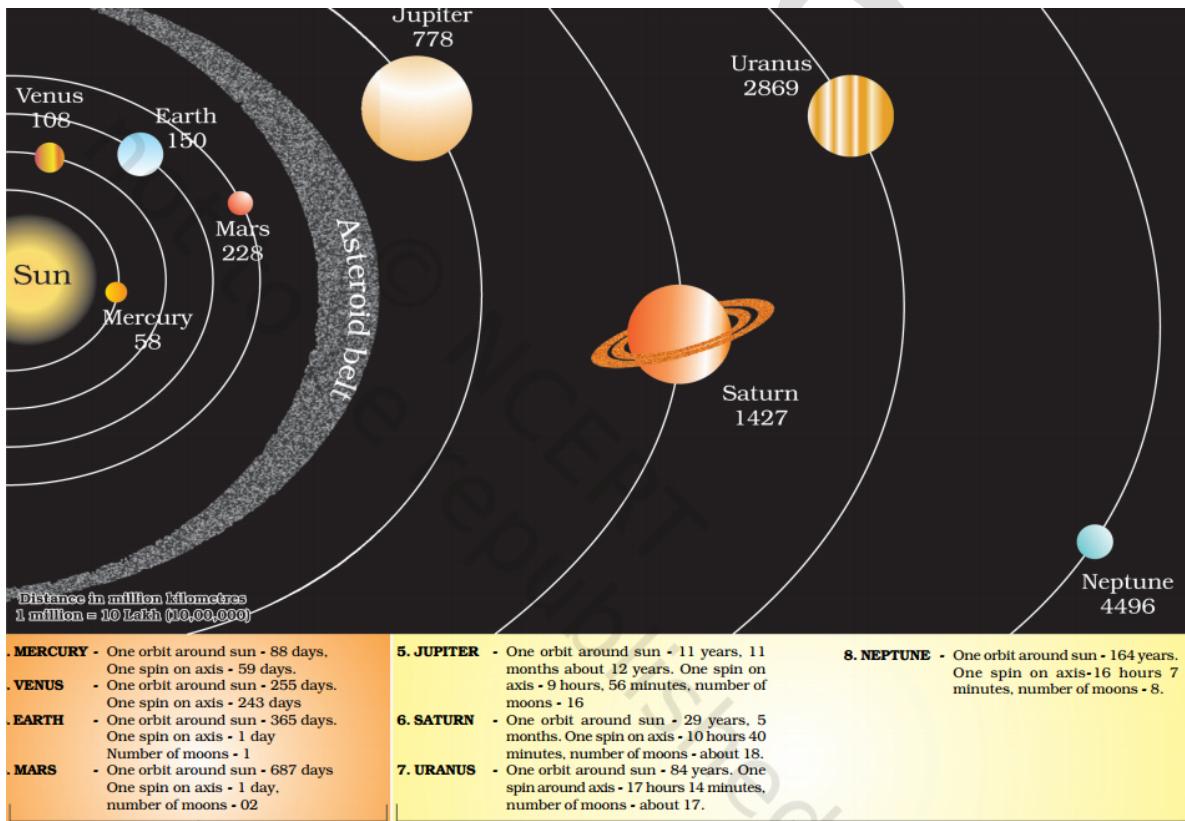
8. BASICS OF ASTRONOMY

1) GALAXY

- » Galaxies are like building blocks of Universe.
- » A galaxy is huge collection of gas, dust, and billions of stars and their solar systems. A galaxy is held together by their gravity. Our galaxy, the Milky Way, also has a supermassive black hole in the middle.
- » When we look up at the stars in the night sky, we see other stars in the Milky Way.
- » There are many galaxies besides ours. Some scientists estimate the total number of galaxies to be as much as one hundred billion.



2) OUR SOLAR SYSTEM



- Planets

- » **8 (My Very efficient mother just served us nuts)**
- » Venus is considered as 'Earth's twin' because its size and shape are very much similar to that of earth

- » **Pluto:** Till recently (August 2006) was called a planet. However, in a meeting of **International Astronomical Union**, a decision was taken that Pluto like other celestial objects (Ceres, 2003 UB₃₁₃) discovered in recent past may be called a dwarf planet¹.

Inner Planet : Mercury, Venus, Earth, Mars (*very close to sun, made of rocks*). They are called *inner planets* as they lie between the sun and the belt of asteroids. They are also called **terrestrial planets**, meaning earth like as they are made up of rock and metals, and have relatively high densities.

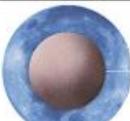
Outer Planet: Jupiter, Saturn, Uranus, Neptune. They are called outer planets. They are also known as **Jovian or Gas** planets. Jovian means Jupiter like. Most of them are much larger than the terrestrial planet and have a thick atmosphere, mostly of helium and hydrogen.

- **The difference between terrestrial and Jovian planets can be attributed to the following conditions**
 - i. The terrestrial planets were formed in the close vicinity of the parent star where it was too warm for gases to condense to solid particles. Jovian planets were formed at quite a distant location. ()
 - ii. The solar wind was most intense nearer the sun; so, it blew off lots of gas and dust from the terrestrial planets. The solar winds are not all that intense to cause similar removal of gases from the Jovian planets.

The terrestrial planets are smaller and their lower gravity could not hold the escaping gas.

3) PLANETS, DWARF PLANTS AND OTHER CELESTIAL BODIES

DWARFS, THEIR DIAMETERS

	CERES	950 km
Between Mars and Jupiter		
	PLUTO	2,400 km
Beyond Neptune, once seen as planet		
	ERIS	2,300 km
Beyond Neptune, close to Pluto in size		
	MAKEMAKE	1,400 km
Beyond Neptune, discovered in 2005		
	HAUMEA	1,400 km
Beyond Neptune; measurements vary		

4) MOON

- » It is Earth's only natural satellite
- » **Size:** 1737.1 km (Radius)
- » **Distance:** 3,84,400 km away from earth
- » **Only one side visible**
 - The moon moves around the earth in about **27 days**. It takes exactly the same time to complete one spin. As a result, only one side of the moon is visible to us on earth.

5) PLANETS WITH HIGHEST NUMBER OF MOON

- SATURN

6) ASTEROIDS

- Apart from the stars, planets and satellite, there are numerous tiny bodies which also move around sun. These bodies are called asteroids. They are found between **orbits of Mars and Jupiter**. Scientists are of the view that asteroids are parts of a planet which exploded many years back.

A) NEAR EARTH ASTEROID:

- **About Near Earth Objects**
 - NEOs are comets and asteroids nudged by the gravitational attraction of nearby planets into orbits which allows them to enter the Earth's neighborhood. They occasionally approach close to the Earth as they orbit the sun.
 - NASA's Center for Near-Earth Object Study (CNEOS) determines the times and distances of these objects as and when their approach to the Earth is close.
- **Significance of Near-Earth Objects:**
 - Scientific interest in comets and asteroids is largely due to their status as relatively unchanged remnant debris from the solar system formation process over 4.6 billion years ago. Therefore, they can give clue regarding original conditions which led to formation of planets.
 - Further, **an asteroid** is considered as one of the existential dangers for life on earth. Therefore, it's important to study these near-earth objects and prepare to ward off any future hit.
- **When is an Asteroid considered PHA (Potentially hazardous asteroid)?**
 - Asteroids with a minimum orbit intersection distance (MOID) of about 0.05 AU (i.e. roughly 7,480,000 km or less and a diameter more than 150 meters) is considered PHAs.
 - **Note:** It is not necessary that asteroids classified as PHAs will necessarily impact the earth. It only means that there is a possibility of such threat.

B) PSYCHE

- **Example Questions:**
 - Launched on 13th October 2023, Psyche Mission has been much in news since then. What are the key goals of the mission? What potential benefit does it hold for human race? [10 marks, 150 words]
- **About Psyche Asteroid:**
 - Psyche is one of the asteroids in the asteroid belt. What makes the asteroid unique is that it appears to be the exposed nickel-iron core of an early planet, one of the building blocks of our solar system.
- **About Psyche Mission:**
 - The Psyche Mission is a NASA space mission launched on 13th Oct 2023 to explore origin of planetary cores by orbiting and studying the metallic asteroid Psyche in 2029. The mission consists of Psyche Aircraft.
- **Significance:**
 - **Understanding the Core of a Planet:** Deep within rocky terrestrial planets – including Earth – scientists infer the presence of metallic cores. But these remain unreachably far below the planets' rocky mantles and crusts. Psyche offers a unique window into the violent history of collisions and acceleration that created terrestrial planets.
 - **Science Goals include:**
 - **Understand a previously unexplored building block of planet formation:** Iron cores.
 - **Look inside terrestrial planets, including Earth,** by directly examining the interior of a different body, which otherwise couldn't be seen.
 - **Explore a new type of world** made of metal (and not of rock and ice)
 - **Science Objectives:**
 - Understanding Psyche – Whether it is a core, or if it is an unmelted material, relative ages of psyche's surface etc.
 - **Deep Space Optical Communication (DSOC):** The Psyche mission is also testing a sophisticated new laser communication technology that encodes data in photons at near-infrared wavelength (rather than radio waves) to communicate between a probe in deep space and Earth.

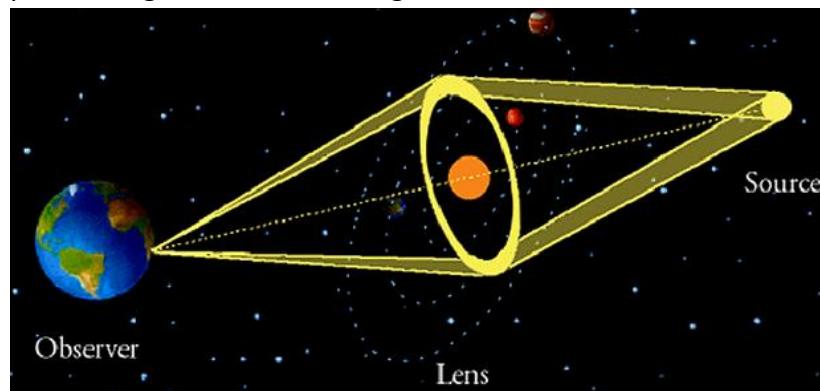
7) JUPITER TROJANS (CLASS DISCUSSION)

8) EXOPLANETS (CLASS DISCUSSION)

9) GRAVITATIONAL LENSING

» Basics

- Gravity bends the time-space around us. And since light travels through space, it also bends while passing through this bent time space.
- This bending of light creates the same effect as the bending of light through a glass lens and the phenomenon is called gravitational lensing (i.e. lensing effect created by gravity). **Einstein** first predicted gravitational lensing in 1912 and is an effect of his theory of general relativity.



- It is clearly observable when gravitational force is high (i.e. bending of space-time is high) such as in case of large galaxies or cluster of galaxies. Thus, large galaxies can behave like large natural telescopes.

» Applications

- Scientists use this phenomenon to **study distant stars/galaxies** in Universe which would otherwise have been difficult to see even by the most powerful space telescopes. The image of the distant object would be magnified if there is a gravitational source (like a large galaxy) in the path.
- The phenomenon also helps us in **understanding the origin of a galaxy/star** as we can observe light from distant stars when there were still getting formed.
 - For e.g. NASA under its **TEMPLATES** initiative is using gravitational lensing to study how galaxies are forming stars and how the star formation is distributed across galaxies.

- » It also helps us in studying of super massive blackholes at cosmological distance.

9. SUN

A) BASICS ABOUT SUN

- Distance: 150 million km away from earth
- Radius: 696,000 km

B) SUN'S STRUCTURE – 3 ATMOSPHERIC LAYERS

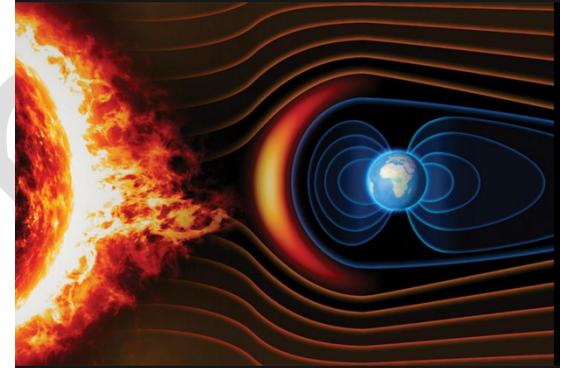
- Sun has **six layers**. The **core, radiative zone and convection zone** consist of the inner layers or the parts of the sun which is not visible. **Photosphere, Chromosphere and Corona** comprise of the sun's atmosphere or outer layer.
- **Inner Layer**
 - Core:** It is the innermost layer of sun. The Core is Plasma, but its movement is extremely similar to gas. The temperature in Sun's core is nearly 15-million-degree Celsius.
 - Radiative Zone:** It is the second layer of sun and sits outside the core. This zone has temperature of millions degree Celsius. The layer serves as a passage for all the energy that is released by the core.
 - Convection Zone:** It is the outermost layer and completely surrounds Radiative zone. In this layer, all the hot material found near the center of the Sun rises cools down and drops back into the radiative zone to get more heat. This is the movement that creates sunspot and Solar flares.
- **Outer Layers:**
 - Photosphere** is the deepest layer of the sun that we can observe directly. It reaches from the surface to about 250 miles above that. Temperature varies from about 6700-degree Celsius to 3,700-degree celsius. Most of the photosphere is covered by granulations (caused by convection current) of the plasma within the Sun's convective zones.
 - Chromosphere:** The chromosphere is a layer in the Sun between about 250 miles and 1300 miles above the solar surface (the photosphere). The temperature in the chromosphere varies between (3700 (**lowest temperature**) at the bottom to 7700-degree C at the top), so in this layer (and higher layers) it actually gets hotter if you go further away from the sun, unlike in the lower layers, where it gets hotter if you go closer to the centre of the sun.
 - Transition Zone:** The transition region is very narrow (60 miles / 100 km) layer between the chromosphere and the corona where the **temperature rises abruptly** from about 7700-degree celsius to 5,00,000-degree C
 - Corona:** It is the outermost layer of the Sun, starting at about 13,00 miles above the solar surface (the photosphere). The temperature in the Corona is 5,00,000-degree celsius or



more upto a few million-degree celsius. It can't be seen with naked eyes except during a total solar eclipse or with use of a coronagraph. It doesn't have any upper limit.

C) UNDERSTANDING SOLAR WINDS

- The solar wind is a **stream of charged particles released from the upper atmosphere of the sun, the Corona**. The solar wind streams plasma (a mix of positively and negatively charged particles) and particles from the sun out into space.
- **Cause**
 - The temperature of Corona reaches upto 1.1-million-degree celsius (2-million-degree Fahrenheit).
 - As rising heat and pressure push that material away from the Sun, it reaches a point where gravity and magnetic field are too weak to contain it. That point, known as the **Alfven Critical Surface**, marks the end of Solar Atmosphere and beginning of Solar Wind.
- **Why does the property of solar winds change with time?**
 - The sun's activity shifts over the course of its 11 year cycle, with sun spot numbers, radiation levels, and ejected material changing over time.
 - The wind also differs based on where on the sun it comes from and how quickly that portion is rotating.
 - As the plasma material leaves the sun, carried by solar wind, it becomes more gas-like.
- **How does it affect the earth?**
 - As the wind travels off the sun, it carries charged particles and magnetic clouds. This is constantly hitting our planet with interesting effects.
 - If the solar wind reached the earth's surface, its radiation would do severe damage to any life that might exist. They can affect Earth's satellite and the Global Positioning Systems (GPS).
 - But earth's magnetic field acts as shield, redirecting the material around the planet so that it streams beyond it.
 - The force of the wind stretches out the magnetic field so that it is smooshed inward on the sun-side and stretched out on the night side.
 - **Solar Storms (Coronal Mass Ejections - CMEs)**
 - » Sometimes, especially during the active period of the cycle - known as the solar maximum, the sun spits out large burst of plasma known as Coronal mass ejections (CMEs). These have stronger effect than the standard solar wind.



- » When the solar wind carries CMEs and other powerful bursts of radiation into a planet's magnetic field, it can cause the **magnetic field on the back side to press together**, a process known as **Magnetic Reconnection**.
- » Charged particles in case of magnetic reconnection stream back towards the **planet's magnetic poles**, causing beautiful displays known as the **aurora borealis** in the upper atmosphere.

▫ **About Auroras**

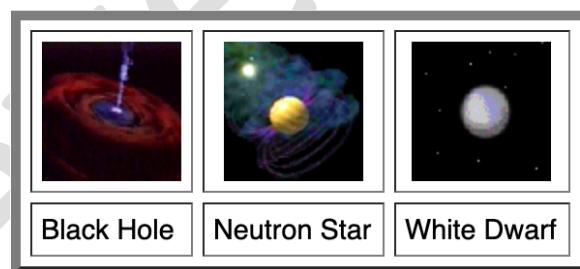
- » In the north the phenomenon is called the **aurora borealis** or the **northern light**. In the southern hemisphere, it's the **aurora australis**, or southern lights.
- » Even though the **earth's magnetic field stretches symmetrically from the north to the south**, recent satellite images of the entire planet showed **mismatched auroras happening at the same time in the two hemispheres**.
- » **Why?** Our **magnetic field is squeezed asymmetrically by solar winds approaching from an angle**, twisting and displacing the northern and southern lights in different forms and locations.

▫ **Useful video to understand Auroras:** <https://youtu.be/PgIKsuZ3RZU>

1) LIFE CYCLE OF STARS: STARS – DWARF STARS – NEUTRON STARS – BLACK HOLES

A) LIFE CYCLE OF A STAR

- Where a star ends up at the end of its life depends on the mass it was born with.
 - **Stars with lots of mass** may end their lives as **black holes or neutron stars**.
 - **A low or medium mass star** (with mass less than 8 times the mass of sun) will become a **white dwarf**.



B) MEDIUM STARS - > RED GIANT -> WHITE DWARF -> BLACK DWARF

- Class Discussion

CHANDRASHEKHAR LIMIT

- The Chandrasekhar Limit, named after the Indian astrophysicist Subrahmanyan Chandrasekhar, is the **maximum mass that a stable white dwarf star can have**. It is an **important concept in astrophysics**, particularly in the study of stellar evolution. Chandrasekhar discovered that if a white dwarf's mass exceeds approximately **1.4 times**

the mass of Sun (Known as Chandrasekhar mass), the pressure generated by the electrons is no longer sufficient to counteract gravity. As a result white dwarf becomes unstable and collapse under its own weight.

c) NEUTRON STAR

- **Neutron Star:** It is formed by catastrophic collapse of the core of a massive star. While a white dwarf is supported by electron degeneracy pressure, neutron stars are supported by neutron degeneracy pressure.
- **How is Neutron Star formed:** In its dying phase, when a star with a core containing mainly iron exhausts all its fuel, it collapses under gravity and explodes as supernova. The extreme high pressure causes protons and electrons to combine together to form neutron (thus forming a neutron star). They energy released during the process blows away the outer layer of the star.
- **Would a neutron star further collapse into blackhole?** -> It would depend on the mass of the neutron star's core. If the mass is less than three solar masses it remains as a neutron star, but if the star's mass more than about 3 solar masses, then it collapses further to form a black hole.
- **The highest possible mass** of a neutron star is not very well known, but it can't be theoretically more than 3 solar masses (beyond which, it should be a black hole). The **maximum mass** for a neutron star, which has been precisely measured so far, is around 2.1 solar mass.
- The neutron stars are among the densest objects in the universe. They have a radius of 10-20 km but carry a weight of upto 2.5 times the mass of Sun.
- A **big difference between Neutron star and Black Hole** is that neutron star has a hard surface unlike that of a black hole.

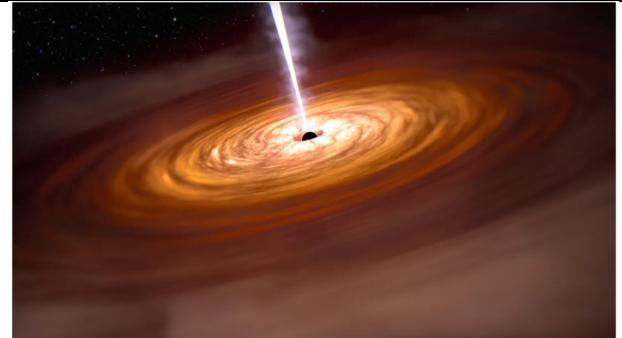
D) BLACK HOLE

- **Why in news?**
 - » Ferocious black holes reveal 'time dilation' in early universe (July 2023: Source: The Hindu)
 - » Spotting black holes (Sep 2023: Source – The Hindu)
- **What is a Black Hole?**
 - » A Black hole is a place in space where gravity pulls so much that even light can't get out. This strong gravity is because matter has been squeezed into a tiny space. This can happen when a star is dying.
 - » Since, no light is emitted from them, they are invisible.
 - » They are generally **detected** by telescopes by analyzing the behavior of stars that are very close to this black hole.
 - » **How large is a black hole?**
 - A black hole can be as small as an atom (but having the mass of a mountain) and they can be very large as well.

- **Stellar** is a kind of blackhole whose mass is around 20 times the mass of sun. There are many many stellar blackholes in our Milky Way Galaxy.
- “**Supermassive**” are the largest black holes. These black holes have masses that are more than 1 million suns together. Every large galaxy contains a supermassive blackhole at its center. The Supermassive blackhole at the center of the **Milky Way galaxy** is called **Sagittarius**. It has a mass of 4 million suns and would fit inside a very large ball that could hold a few million earths.

Quasars: Quasars are a subclass of active galactic nuclei (AGNs), extremely luminous galactic cores where gas and dust falling into a supermassive black hole emit electromagnetic radiation across the entire electromagnetic spectrum. They are among the brightest objects in the Universe.

Note: All Quasars are AGN, but not all AGN are Quasar



- » The boundary of black hole is called **event horizon** which acts as one way towards the black hole and allows nothing to get out of it.
- **Singularities and Blackhole**
 - » In 1915 Karl Schwarzschild noticed that Einstein's then new-general theory of relativity predicted the existence of strange objects known as “**singularities**”. They were places where his new equation describing gravity seemed to go haywire. Inside them there was a bizarre place where time stopped, and space became infinite. Over the years evidence have piled up explaining that singularities do exist in our universe as **black holes**.
- **Spotting black holes: How do we identify blackholes?**
 - » A blackhole is identified by the **gravitational force** it exerts on nearby stars.

Astronomers have found systems in which a visible star orbits around an unseen companion. One cannot conclude that the companion is blackhole always; it might merely be a star that is too faint.

- If the unseen companion happens to be a black hole, then because of its high gravity it will start pulling matter off the surface of the visible star. This matter start falling towards the blackhole in a characteristic spiral path. In the process it also emits X-Rays which can be detected from earth.
- From the observed orbit of visible star one can determine the lowest possible mass of the black hole.

- Recent Updates about Blackholes
 - a. Scientists have discovered oldest black hole yet (Nov 2023)
 - A study published in Nov 2023 have confirmed that supermassive blackholes existed at the dawn of the universe. NASA's JWST and Chandra X-Ray Observatory have teamed up to confirm this observation.
 - Given the age of the Universe is 13.7 billion years old, the age of this black hole is 13.2 billion years. Further, this blackhole is whopper – 10 times bigger than the black hole in our milky way galaxy. It is believed to weigh from 10% to 100% the mass of all the stars in its galaxy.
 - How was it formed?
 - a. The researchers believed that the black hole was formed from colossal clouds of gas that collapsed in a galaxy next door to one with stars. The two galaxies merged, and the black hole was formed.
 - Role of Chandra X-Ray Observatory: The fact that Chandra X-Ray detected it confirms without doubt that it is a black hole. With X-rays you discover the gas that is being gravitationally pulled into the black hole, sped up and it starts glowing int the X-Ray.
 - This one is considered quasar since it is actively growing, and the gas is blindingly bright.

b. Ferocious Blackholes reveal time dilation in Early Universe (July 2023)

- Scientists have used observation of a ferocious class of black holes called quasars to demonstrate “time dilation” in the early Universe, showing how time then passed only about a fifth as quickly as it does today. The observation stretches back to about 12.3 billion years ago, when the universe was roughly 1/10th of its present age.

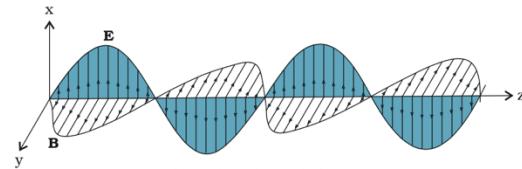
Quasars were used as a “clock” in the study to measure time in the deep past. The researchers used observations involving the brightness of 190 quasars across the universe dating to about 1.5 billion years after the Big Bang even that gave rise to the Cosmos. **They compared the brightness of these quasars at various wavelengths to that of quasars existing today**, finding that certain fluctuations that occur in a particular amount of time today did five times more slowly in the most ancient quasars.

10. ELECTROMAGNETIC WAVES AND WIRELESS COMMUNICATION

- As per Maxwell's theory accelerated charges radiate electromagnetic waves.
- Key contribution of various scientists:
 - **Hertz:** He experimentally demonstrated that accelerated charged particles emitted electromagnetic waves. [Hertz Experiment 1887] (He did it for low frequency – Radio waves)
 - **JC Bose** working at Kolkata succeeded in producing and observing electromagnetic waves of much shorter wavelength (25 mm to 5mm). His experiment like that of Hertz was confined to the laboratory.

- **Guglielmo Marconi** followed Hertz work and succeeded in transmitting electromagnetic waves over distances of many kilometers. Marconi's experiment marked the beginning of the field of communication using electromagnetic waves.

- Key Features of Electromagnetic Waves:

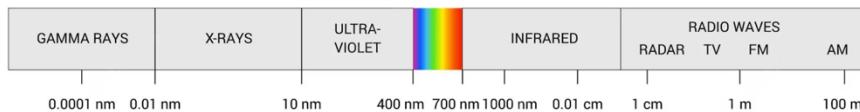
- Electric and Magnetic field are perpendicular to each other, and to the direction of propagation.
- The adjacent figure shows a linearly polarized electromagnetic wave propagating in the z-direction with the oscillating electric field **E** along the x direction and the oscillating magnetic field **B** along the y-direction.
- 
- They are self-sustaining oscillations of electric and magnetic fields in free space or vacuum.
 - It can travel in vacuum and no material medium is involved in the vibrations of the electric and magnetic fields.
 - In vacuum (free space), electromagnetic wave travels with a speed of light 2.99792458×10^8 m/s (or roughly 3×10^8 m/s).
 - » The constancy of the velocity is EM waves in vacuum is so strongly supported by experiments and the actual value is so well known now that this is used to define a standard of length.
 - Hertz has also established wave nature of the radiation. He demonstrated that the waves, which had wavelength ten million times that of the light waves, could be diffracted, refracted, and polarized.

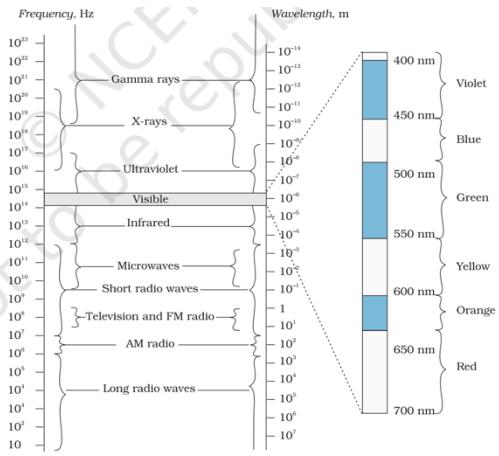
1) ELECTROMAGNETIC SPECTRUM

At the time Maxwell predicted the existence of electromagnetic waves, the only familiar electromagnetic waves were the visible light waves. The existence of ultraviolet and infrared waves was barely established. By the end of the nineteenth century, X-rays and gamma rays had also been discovered

- Electromagnetic Waves include radio waves, microwaves, infrared, visible light, ultraviolet, x rays and gamma rays. The classification of EM waves according to frequency is the **electromagnetic spectrum**. Note, that there is no sharp division between one kind of wave and the next. The classification is based on roughly on how the waves are produced and/or detected.

SPECTRUM





Different Types of Electromagnetic waves, in order of increasing frequency/decreasing wavelength:

A) RADIO WAVES:

- B) They are produced by accelerated motion of charges in the conducting wires.
- C) **Uses:** They are used in Radio and Television communication.
- D) **Wavelength:** They range from around a foot long to several kms.
- E) **Frequency ~: 500 KHz to 1000 MHz**
 - The AM (Amplitude Modulated) band is from 530 KHz to 1710 KHz.
 - The FM (Frequency Modulated) band is from 88 MHz to 108 MHz.
 - The TV waves range from 54 MHz to 89 MHz.
 - Cellular phones use radio waves to transmit voice communication in the Ultra High Frequency (UHF) band.
 - For e.g., in 2014, the DoT auctioned 2G telecom spectrum in the frequency range of 900 MHz and 1800 MHz.
 - For e.g., In 2022 auction, Jio bought frequencies in 700 MHz as well as in 1800 MHz band.
 - In 2022, 700 MHz was sold for the first time. Jio bought the spectrum,

B) MICROWAVES

- F) **Microwaves** (short wavelength radio waves) are produced by special vacuum tubes (called klystrons, magnetrons, and Gunn Diodes).
- G) **Frequency: GHz range**
- H) **Applications:**
 - **Radar:** Their short wavelength makes them suitable for Radar system in aeroplanes. Due to their short wavelength, they are suitable for Radar systems used in aircraft navigation. Radar also provides the basis for the speed guns used to time fast balls, tennis serves, and automobiles.
 - **Microwave Ovens** are an interesting application of these waves. In such ovens, the frequency of microwaves is selected to match the resonant frequency of water molecules

so that energy from the waves is transferred efficiently to kinetic energy of the molecules.
This raises the temperature of any food containing water.

Details of how microwave work:

When the temperature of a body rises, the energy of the random motion of atoms and molecules increases and the molecules travel or vibrate or rotate with higher energies.

The frequency of rotation of water molecules is about 300 crore hertz, which is 3 gigahertz (GHz). If water receives microwaves of this frequency, its molecules absorb this radiation, which is equivalent to heating up water. These molecules share this energy with neighbouring food molecules, heating up the food.

One should use porcelain vessels and not metal containers in a microwave oven because of the danger of getting a shock from accumulated electric charges. Metals may also melt from heating. The porcelain container remains unaffected and cool, because its large molecules vibrate and rotate with much smaller frequencies, and thus cannot absorb microwaves. Hence, they do not get heated up. Thus, the basic principle of a microwave oven is to generate microwave radiation of appropriate frequency in the working space of the oven where we keep food. This way energy is not wasted in heating up the vessel. In the conventional heating method, the vessel on the burner gets heated first, and then the food inside gets heated because of transfer of energy from the vessel. In the microwave oven, on the other hand, energy is directly delivered to water molecules which is shared by the entire food.

c) INFRARED WAVES

- I) Produced by hot bodies and molecules. They are sometimes also referred as heat waves. This is because, water molecules produced in most materials readily absorb infrared waves (many other molecules, for example, CO₂, NH₃, also absorb infrared waves). After absorption, their thermal motion increase i.e. they heat up and heat up their surroundings.
- J) **Infrared lamps** are used in physical therapy.
- K) Infrared waves also play a crucial role in maintaining the earth's warmth or the average temperature through Greenhouse Effect.
- L) Infrared Emitting Devices (IrEDs) are used in remotes of TV, AC etc.

D) VISIBLE RAYS

- M) Part of the spectrum detected by Human eyes.
- N) **Frequency range:** 4×10^{14} Hz to about 7×10^{14} Hz.
- O) **Wavelength:** 700 nm to 400 nm (note: Speed of light = frequency * Wavelength)
- P) **Note:** Different animals are sensitive to different electromagnetic spectrum. For e.g. snakes can detect infrared waves, and the 'visible' range of many insects extends well into ultraviolet.

E) ULTRAVIOLET RAYS

- Q) **Wavelength:** 400 nm to 0.6 nm
- R) UV radiations are produced by special lamps or very hot objects. For e.g. Sun is an important source of ultraviolet rays, but fortunately, most of the radiation is absorbed in the ozone layer. This is because UV radiation in large quantities will be harmful for human health and other forms of biodiversity.
- S) **Applications:**
- Due to very short wavelengths, UV radiation can be focused on very narrow beams for high precision application such as LASIK (Laser assisted in situ keratomileusis) eye surgery.
 - **UV lamps** are used to kill germs in water purifiers.

F) X-RAYS

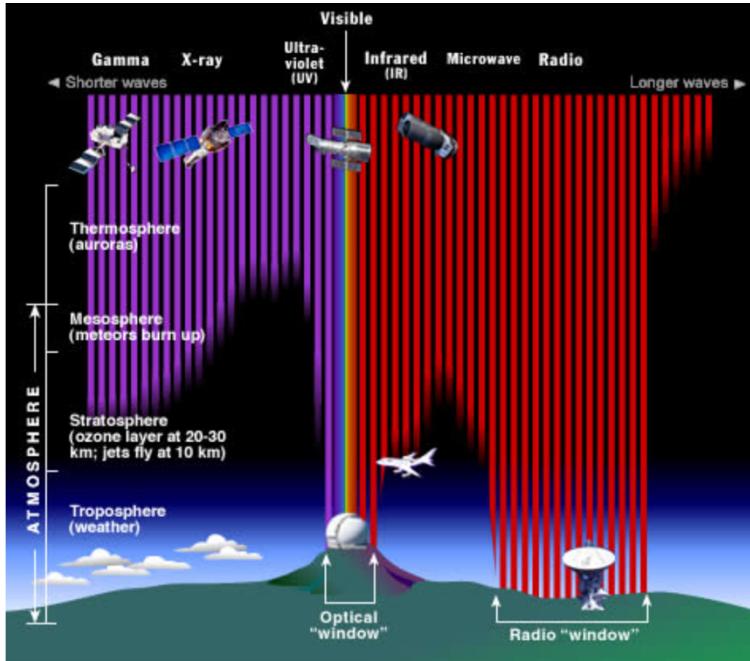
- T) **Wavelength:** 10 nm to 10^{-4} nm (10^{-13} m)
- U) One common way of generating X-Rays is to bombard a metal target by high energy electrons.
- V) **Applications:**
- They are used in diagnostic tools in medicine and as a treatment for various kinds of cancer.

G) GAMMA RAYS

- W) **Wavelength:** 10^{-10} m to 10^{-14} m
- X) Produced in nuclear reactions and also emitted by radioactive nuclei. They are used in radiative cancer therapies.

C) 2) PENETRATION OF VARIOUS EM WAVES IN EARTH'S ATMOSPHERE

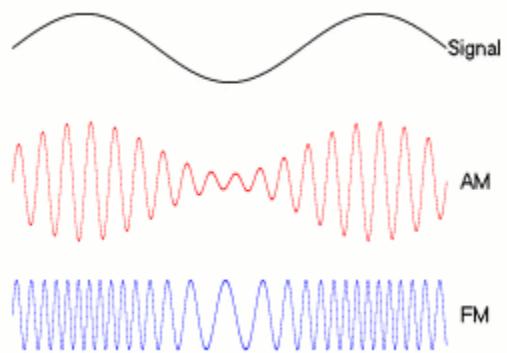
- Y) The Earth's atmosphere stops most type of EM radiation from reaching earth's surface. This illustration shows how far into the atmosphere different parts of EM spectrum can go before being absorbed. Only portions of radio and visible light reach the surface.
- Z) Radio frequencies, visible light and some part of ultraviolet lights makes it to sea level. These wavelength ranges are called atmospheric window. Ground based astronomical observation employs optical and radio telescopes that take advantage of atmospheric windows.
- AA) Astronomers can observe some infrared wavelengths by putting telescopes on mountain tops.
- BB) But, earth's atmosphere absorbs the majority of ultraviolet, X-Rays, and gamma rays. So they can only be absorbed using balloons and astronomical satellites outside the earth's atmosphere.
- CC) **Note:** Long wavelength radio waves and infrared rays also don't reach the surface.
- DD) **Note:**



2) WIRELESS COMMUNICATION – DIFFERENT FREQUENCY BANDS AND THEIR APPLICATIONS

A) RADIO WAVES (500 KHZ – 1 G HZ)

- The AM (Amplitude Modulated) band is from 530 KHz to 1710 KHz.
- The FM (Frequency Modulated) band is from 88 MHz to 108 MHz.
- The TV waves range from 54 MHz to 89 MHz
- Used for broadcasting radio and TV Programmes. Anyone with receiver can tune it to the radio frequency to pick the signal. When radio stations use similar transmission frequencies the waves sometimes interfere with each other.
- Medium wavelength radio waves are reflected from the ionosphere so they can be used for long distance communication, but not for communicating with satellite above the ionosphere. Thus, they can only be used for low earth orbit satellite communication.
- **AM vs FM**



	AM	FM
Full form	AM stands for Amplitude modulation	Frequency modulation
First used	AM method of audio transmission first carried out in the mid-1870s	FM radio was developed in the US states in the 1930s, mainly by Edwin Armstrong

Modulating difference	In AM, a radio wave known as the "carrier" or "carrier wave" is <u>modulated in amplitude by the signal that is to be transmitted</u> . The frequency and the phase remain same	In FM, <u>a radio wave known as carrier wave is modulated in frequency by the signal that is to be transmitted</u> . The <u>amplitude and phase remains the same</u> .
Pros and Cons	AM has <u>poorer sound quality</u> compared with FM but is <u>cheaper and can be transmitted over long distances</u> . It has <u>lower bandwidth</u> so it can have <u>more stations available in any frequency range</u> .	FM is <u>less prone to interference than AM</u> . However, <u>FM signals are impacted by physical barriers</u> . FM has <u>better sound quality due to higher bandwidth</u> .
Frequency Range	AM radio ranges from <u>535 to 1705 KHz (OR) Up to 1200 bits per second</u> .	FM radio ranges in a <u>higher spectrum</u> from <u>88 to 108 MHz</u> . (OR) <u>1200 to 2400 bits per second</u>
Bandwidth requirement	Twice the <u>highest modulating signal</u> . In AM radio broadcasting, the modulating signal has bandwidth of 15 KHz, and hence the bandwidth of an amplitude-modulated signal is 30 KHz	Twice the <u>sum of the modulating signal frequency and the frequency deviation</u> . If the frequency deviation is 75 KHz and the modulating signal frequency is 15 KHz, the bandwidth required is 180 KHz.
Zero crossing in modulated signal	Equidistant	Not Equidistant
Complexity	Transmitter and receiver are simple but synchronization is needed in case of SSBSC AM carrier.	Transmitter and receiver are more complex as variation of modulating signal has to be converted and detected from corresponding variation in frequencies (i.e. voltage to frequency and frequency to voltage conversion has to be done)
NOISE	AM is more <u>susceptible to noise</u> because <u>noise effects amplitude</u> , which is where information is stored in AM.	FM is <u>less susceptible to noise</u> because <u>information in an FM signal is transmitted through varying of frequency</u> , and not amplitude.

A) MICROWAVES

- Microwaves have shorter wavelength and thus can **pass through ionosphere**. They can thus be used for **long distance satellite communications**.
 - **Line of sight -> Prerequisite:**
 - Signals are sent to and from satellites, which relay signals around the Earth. This may be for TV programmes, telephone conversations or monitoring the earth, for example weather forecasting.
 - **Types**
-

L BAND: 1-2 GHZ

- Low bandwidth -> not suitable for streaming applications like video, voice, and broadband connectivity.
 - Radars, GPS signals
 - **Other advantages** -> least expensive and easiest to implement.
-

S BAND:

- It is a part of microwave band of the electromagnetic spectrum. It is defined by IEEE standard of radio waves with frequencies that range from **2 to 4 GHz**, crossing the conventional boundary between UHF (Ultra High Frequency) and SHF (Super High frequency) at 3.0 GHz.
 - **Used by**
 - » Weather radar
 - » Surface ship radar
 - » Some Communication Satellites
-

C BAND

- The C Band is the name given to certain portions of the electromagnetic spectrum, including wavelength of microwaves that are used for long-distance radio-telecommunication.
 - The IEEE C Band (**4 - 8 GHz**) and its slight variations contain frequency ranges that are used for many satellite communication transmission, some Wi-Fi devices, some cordless telephones, and some weather radar system.
-

Ku BAND

- Name given to **12-18 GHz** portion of electromagnetic spectrum in the microwave range of frequencies.
 - Uses
 - » Primarily used for satellite communication, most notably for fixed and broadcast services
-

K BAND (18-27 GHZ)

KA BAND (27 – 40 GHZ)

V BAND (40 – 75 GHZ)

W BAND (75-110 GHZ)

MILLIMETER BAND (110-300 GHZ)

D) DEEP SPACE OPTICAL COMMUNICATION

1. Why in news?
 - a. NASA's Deep Space Optical Communication Demo sends, receives first data (Nov 2023)
2. Need of Deep Space Optical Communication:
 - a. **Low bandwidth of radio frequency communications:** Future space missions are going to require higher bandwidth of communication as they will need to transmit higher volumes of science data, images, videos etc.
 - b. **Higher frequencies (shorter wavelengths)** which can carry more data suffer from the problems of getting blocked by atmosphere, and higher scattering when it is contacted with any interference.
3. NASA's Psyche Spacecraft is on its way to Psyche asteroid and will reach there by 2029. But in between it is involved in experiments related to Deep Space Optical Communication (DSOC).
4. Primary Objective of DSOC is to give tools and technology to future NASA initiatives to communicate at much higher bandwidth.
5. Demo:
 - a. DSOC has achieved 'first light' sending data via laser to and from far beyond the Moon for the first time.
 - b. NASA's DSOC experiment has beamed a near-infrared laser encoded with test data from nearly 16 million kms away – about 40 times further than the Moon is from Earth – to the Hale Telescope at Caltech's Palomar Observatory in San Diego County, California. This is the farthest ever demonstration of optical communication.
6. Key features:
 - a. It is pioneering the use of near-infrared laser signal for communication with spacecraft.
 - b. Its bandwidth is more than 10 times higher than the state of art radio-telecommunication system of comparable size and power. This enables higher resolution images, larger volumes of science data, and streaming of videos.
7. Advantages: Higher Bandwidth, faster data transmission, improved image resolution, reduced power consumption, potential for streaming video and real-time communication
8. How were the limitations of high frequency communication overcome?
 - a. Extremely precise pointing: To achieve this, the transceiver aboard the spacecraft needs to be isolated from the craft's vibration.
 - b. Compensating for movements of spacecraft and Earth: The targeting has to adjust for this continuous movement.

- c. **Extracting information from weak signal**: Since the signal will travel several million kms, the received signal will be very weak. New Signal processing tools have to be utilized to extract precise information from the communication.
9. Psyche spacecraft is the first to carry a DSOC transceiver and will be testing high bandwidth optical communications to Earth during the first two years of the spacecraft's journey to the main asteroid belt.
- a. Achieving the first light is one of many critical DSOC milestones in the coming months, paving the way toward higher-data-rate communication.
10. Has Space based optical communication happened in past?
- a. In 2013, NASA's Lunar Laser Communications Demonstration tested record breaking uplink and downlink rates between Earth and the Moon using similar technology.
 - b. But DSOC is taking optical communication to Deep Space, paving the way for high-bandwidth communication far beyond the Moon and over 1,000 times farther than any optical communication test to date.
11. **Significance:**
- a. The DSOC holds the key for future space missions. As humans travel deep into space, they would want fast way of sending and receiving large amount of data from earth.
 - b. It would pave the way for high data rate communications capable of sending scientific information, high-definition imagery, and streaming video in support of humanity's next giant leap: Sending humans to Mars.

PYQS

1	<p>Cryogenic Engines find applications in: [Prelims 1995]</p> <ul style="list-style-type: none"> A. Sub-marine propulsion B. Frost-free refrigerator C. Rocket technology D. Research and Superconductivity
2	<p>Consider the following statements: [Prelims 1996]</p> <p>A person in a spaceship located halfway between the earth and the sun will notice that the:</p> <ol style="list-style-type: none"> 1. Sky is jet black 2. Stars don't twinkle 3. Temperature outside the spaceship is much higher than that on the surface of earth <p>Which of the above statements is/are correct?</p> <ul style="list-style-type: none"> A. 3 only B. 1 and 2 only C. 1 and 3 only D. 1, 2 and 3 only

3	<p>The tail of a comet is directed away from the sun because: [Prelims 1997]</p> <ul style="list-style-type: none"> (a) As the comet rotates around the sun, the lighter mass of the comet is pushed away due to the centrifugal force alone. (b) As the comet rotates, the lighter mass of the comet is attracted by some stars situated in the direction of its tail (c) The radiation emitted by the sun exerts a radial pressure on the comet throwing its tail away from sun (d) The tail of the comet always exists in the same orientation
4	<p>A 'black hole' is a body in space which doesn't allow any radiation to come out. This property is due to its: [Prelims 2000]</p> <ul style="list-style-type: none"> (a) very small size (b) very large size (c) very high density (d) very low size
5	<p>Assertion (A): Artificial Satellites are always launched from the earth in the eastward direction. [2002] Reason (R): The earth rotates from west to east and so the satellite retains the escape velocity.</p> <ul style="list-style-type: none"> (a) Both A and R are true and R is the correct explanation of A (b) Both A and R are true but R is not a correct explanation of A (c) A is true but R is false (d) A is false but R is true
6	<p>Consider the following statements: [Prelims 2005]</p> <ol style="list-style-type: none"> 1. A Geostationary satellite is at an approximate height of 10000 km 2. FM transmission of music is of very good quality because the atmospheric or manmade noises can do little harm. <ul style="list-style-type: none"> a. 1 only b. 2 only c. Both 1 and 2 d. Neither 1 nor 2
7	<p>Consider the following statements in respect of a jet engine and a rocket: [Prelims 2008]</p> <ol style="list-style-type: none"> 1. A jet engine uses the surrounding air for its oxygen supply and so is unsuitable for motion in space 2. A rocket carries its own supply of oxygen in the gas form, and fuel <p>Which of the statements given above is/are correct?</p> <ul style="list-style-type: none"> A. 1 only B. 2 only

	<p>C. Both 1 and 2 D. Neither 1 nor 2</p>
8	<p>Satellites used for telecommunication relay are kept in a geostationary orbit. A satellite is said to be in such an orbit when: [Prelims 2011]</p> <ol style="list-style-type: none"> 1. The orbit is geosynchronous. 2. The orbit is circular 3. The orbit lies above the earth's equator 4. The orbit is an altitude of 22,236 km <p>Choose the correct answer using the code given below:</p> <ol style="list-style-type: none"> a. 1, 2 and 3 only b. 1,3 and 4 only c. 2 and 4 only d. 1,2,3 and 4
9	<p>Cape Canaveral, the site from which space shuttles are launched is located on the coast of: [Prelims 2011]</p> <ol style="list-style-type: none"> 1. Florida 2. Virginia 3. North Carolina 4. South Carolina
10	<p>An artificial satellite orbiting around the earth does not fall down. This is so because the attraction of earth: [Prelims 2011]</p> <ol style="list-style-type: none"> a. Doesn't exist at such distance b. Is neutralized by the attraction of the moon c. Provides the necessary speed for its steady motion d. Provides the necessary acceleration for its motion
12	<p>In which of the following activities are Indian Remote Sensing (IRS) satellite used? [Prelims 2015]</p>

1. Assessment of crop productivity
2. Locating groundwater resources
3. Mineral Exploration
4. Telecommunication
5. Traffic studies

Select the correct answer using the code given below:

- a. 1, 2 and 3 only
- b. 4 and 5 only
- c. 1 and 2 only
- d. 1,2, 3, 4 and 5

13

Consider the following statements: [2016]

The Mangalyaan launched by ISRO

1. Is also called the Mars Orbiter Mission
2. Made India the second country to have a spacecraft orbit the Mars after the USA
3. Made India the only country to be successful in making its spacecraft orbit the Mars in its very first attempt

Which of the statements given above is/are correct?

- a) 1 only
- b) 2 and 3 only
- c) 1 and 3 only
- d) 1,2 and 3 only

14

The terms 'Event Horizon', 'Singularity', 'String Theory' and Standard Model are sometimes seen in the news in the context of [Prelims 2017]

- (a) Observation and Understanding of the Universe
- (b) Study of the Solar and Lunar Eclipse
- (c) Placing Satellite in the orbit of the earth
- (d) Origin and Evolution of Living Organisms on Earth

15

With reference to India's satellite launch vehicles, consider the following statements: (Pre 2018)

- PSLVs launch the satellites useful for Earth resources monitoring whereas GSLVs are designed mainly to launch communication satellites.
- Satellites launched by PSLV appear to remain permanently fixed in the same position in the sky, as viewed from a particular location on Earth.
- GSLV Mk III is a four-staged launch I vehicle with the first and third stages using solid rocket motors; and the second and fourth stages using liquid rocket engines.

Which of the statements given above is/are correct?

- A. 1 only
- B. 2 and 3
- C. 1 and 2
- D. 3 only

16 In which of the following areas can GPS technology be used? (Pre 2018)

- Mobile phone operations
- Banking operations
- Controlling the power grids

Select the correct answer using the code given below:

- a. 1 only
- b. 2 and 3 only
- c. 1 and 3 only
- d. 1, 2 and 3

17 With reference to the Indian Regional Navigation Satellite System (IRNSS), consider the following statements: (PRE 2018)

- IRNSS has three satellites in geostationary and four satellites in geosynchronous orbits.
- IRNSS covers entire India and about 5500 sq. km beyond its borders.
- India will have its own satellite navigation system with full global coverage by the middle of 2020.

Which of the statements given above is/are correct?

- a. 1 only
- b. 1 and 2 only
- c. 2 and 3 only
- d. None

18 For the measurement/estimation of which of the following are satellite images/remote sensing data used?

- Chlorophyll content in the vegetation of a specific location
- Greenhouse gas emissions from rice paddies of a specific location
- Land Surface temperature of a specific location

Select the correct answer using the codes given below:

- (a) 1 only

	(b) 2 and 3 only (c) 3 only (d) 1, 2 and 3
19	Which one of the following countries has its own Satellite Navigation System? [Prelims 2023] (a) Australia (b) Canada (c) Australia (d) Japan



TARGET PRELIMS 2024

BOOKLET-3; S&T-3

NUCLEAR SCIENCE AND TECHNOLOGY

1. TABLE OF CONTENTS

1. <i>Table of Contents</i>	0
2. <i>Nuclear Science and Technology</i>	1
1) Nuclear Energy Basics.....	1
2) Fusion Reaction (Thermonuclear Reactions).....	1
A) USA's Attempt:	2
B) ITER (International Thermonuclear Experimental Reactor (ITER))	3
C) What is a Tokamak:	4
D) India and Fusion.....	4
3) Nuclear Binding Energy	5
4) Components of Nuclear Power Reactor	5
5) Types of Reactors	6
A) Boiling Water Reactor	6
B) Pressurized Water Reactor.....	6
C) Pressurized Heavy Water Reactor	6
D) Advanced Gas Cooled Reactors	6
E) Fast Neutron Reactor (Fast Breeder Reactor)	6
6) India's 3-Stage Nuclear Power Program.....	7
7) Thorium Reserves in India	10
8) Other Important Aspects	10
9) Nuclear Waste Management	11
A) Fukushima and the Issue of its Waste Disposal.....	11
10) CLND, 2010	12
11) Nuclear Bomb:.....	13
A) Underestimated fallout of the Trinity Nuclear Test: New Study (July 2023)	13
B) J Robert Oppenheimer: Father of Atom Bomb.....	13
12) Nuclear Energy and ENergy Security	14
13) Radioactivity Basics	15
14) Radioactive Decay	18
15) Radio-carbon Dating	18
16) Use of Nuclear Radiation Technology for providing better quality of life to its citizens	20

1) X-Ray Radiography	23
A) CT Scans Associated with Increased Risk of Blood Cancers (Dec 2023: Source – TH)	24
3. PYQs.....	25



ACE CSAT
CSAT FOUNDATION COURSE
FOR CSE 2024

LET'S DEVELOP
CRITICAL THINKING

STARTS: 8TH JAN 2024

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**PRELIMS MASTER
PROGRAM** **BATCH 2.0**
FOR CSE PRELIMS 2024



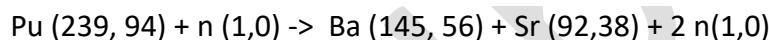
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2. NUCLEAR SCIENCE AND TECHNOLOGY

1) NUCLEAR ENERGY BASICS

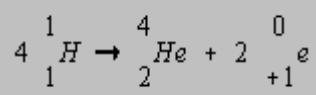
- What is nuclear energy?
 - Nuclear energy is the energy in the nucleus of an atom which is released during nuclear fission or fusion reaction.
 - During these reactions, a small amount of **mass is lost and gets converted** into energy according to Einstein's equation.
 - In **nuclear fission**, the nucleus of a heavy atom (such as uranium, plutonium or thorium), when bombarded with low - energy neutrons, can be split apart into lighter nuclei.
 - When this is done tremendous amount of energy is released, if the mass of the original nucleus is just a little more than the sum of the masses of the individual products.
- E.g. of fission reaction



In a nuclear fission, the difference in mass, Δm , between the original nucleus and the product nuclei gets converted to energy E at a rate governed by the famous equation,
$$E = \Delta m c^2$$
,

first derived by Albert Einstein in 1905, where c is the speed of light in vacuum. In nuclear science, energy is often expressed in units of electron volts (eV): $1 \text{ eV} = 1.602 \times 10^{-19} \text{ joules}$. It is easy to check from the above equation that 1 atomic mass unit (u) is equivalent to about 931 mega electron volts (MeV) of energy.

- E.g. of fusion reaction



- This is one of the common reactions taking place in sun.

2) FUSION REACTION (THERMONUCLEAR REACTIONS)

- **Introduction:**
 - **Fusion** is the energy source of the Sun and Stars.
 - At very high temperature and pressure in the core of the stars, hydrogen nuclei collide and fuse to convert into heavier helium atoms and release **tremendous amount of energy** in the process.
 - What is the **need of extremely high temperature** -> to **overcome the electrical repulsive force**

- Till date we don't have any stable fusion reaction.
 - **Development of thermonuclear energy power plants has been difficult:**
 - **Three conditions must be fulfilled** to achieve fusion in a laboratory:
 - **Very High Temperature** (of the order of 15 million degrees C)
 - **Sufficient Plasma particle density** (to increase the likelihood that collisions do occur)
 - **Sufficient confinement time** (to hold the plasma, which has the propensity to expand, within a defined volume)
- **Note:** Twentieth century fusion science identified the most efficient fusion reaction in the laboratory setting to be reaction between two hydrogen isotopes, deuterium (D) and tritium (T), as the D-T reaction produces the higher energy gain at the "lowest temperatures".
- **Why nuclear fusions are important as an energy source?**
 - Raw material easily available
 - Nuclear Fusion is a clean and green route to produce energy, as it doesn't involve any remnant waste products.
 - Long term energy security

A) USA'S ATTEMPT:

- In Dec 2022, an experiment at US National Ignition Facility (NIF), within the Livermore National Laboratory, Livermore, California, achieved a **fusion ignition** by successfully conducting a fusion test that produced 153% (1.53 gain) as much energy as went into triggering it.
- In July 2023, in a repeat of the above experiment, scientists were able to generate more energy with nearly a factor of 2 in gain compared with energy of the incoming lasers.
- **Types of Fusion Reactions:**
 - For fusion reaction to happen in reactors, the high temperature must be created artificially. There are two different ways of achieving this: **Inertial Confinement Method** and **Magnetic Confinement Method**:
 - 1) **Inertial Confinement Method:** In this method, high energy laser beams are focused onto a pellet of the fuel (D-T), which creates extreme temperatures required for fusion inside it. The outer mass of the pellet explodes and is responsible for confining the reaction.
 - E.g., **The NIF reactions**
 - 2) **Magnetic Confinement Fusion (MCF):** It uses a magnetic field to contain plasma, which prevents the particles from hitting the reactor walls which could otherwise cause them to slow down.
 - **Magnetic confinement** uses a torus-shaped reactor called tokamak, in which a hydrogen plasma is heated to a high temperature and the nuclei are guided by strong magnetic fields to fuse. **ITER** is a famous example of an experiment trying to achieve fusion using magnetic confinement.

- This is the method being used at ITER.

3) Some other variants also exist such as those which use a combination of these methods (Magnetized Target Fusion) and those that combine fission with fusion (**Hybrid Fusion**)

- **The NIF Breakthrough:**

- In Dec 2022, NIF was finally able to achieve ‘break-even’, or a net positive energy gain.
- In July 2023, it was able to replicate its efforts, but now with a bigger gain (almost 2)
- In both these achievements **inertial confinement was employed.**
 - In NIF’s set up, high-power lasers fire pulses at a 2 mm wide capsule inside a 1-cm-long cylinder called **hohlraum**, in less than 10 billionths of a second. The capsule holds deuterium and tritium atoms.
 - As the pulse strikes the hohlraum’s inside, the latter heats up and releases x-rays, which heat the nuclei to millions of degrees centigrade and compress them to **billions of Earth atmosphere**. This technique is called inertial confinement method because the nuclei’s inertia creates a short window between implosion and explosion in which the strong nuclear force dominates, fusing the nuclei.
 - Specifically, when two hydrogen-2 nuclei fuse, they yield a helium-4 nucleus, a neutron and 17.6 MeV of energy.

- **Significance:**

- **Fusion ignition** is one of the most impressive feats of the 21st century and is an engineering marvel beyond belief.

- **Some Caveats:**

- **First:** NIF experiment is highly sophisticated and required very high precision. Even small changes in the experiment may negatively impact the output. So, for long term use, they will have to reproduce these results again and again.
- **Second:** For fusion reaction to be truly gainful, the energy released by the reactions needs to be greater than the energy going into the lasers, about 300 megajoules, and not just the energy delivered to the hohlraum. This hasn’t been achieved yet. The energy transferred to plasma is just 1%, the rest is all lost in other processes. **“Future research will need to focus on reaching the next major milestone – a target gain of G > 100**, which is required to run a power plant efficiently.
- **Third:** The road to a power plant from the NIF’s current achievement isn’t well understood.

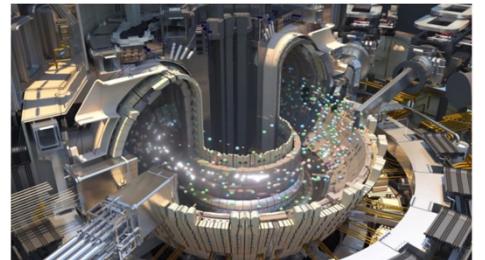
B) ITER (INTERNATIONAL THERMONUCLEAR EXPERIMENTAL REACTOR (ITER))

- ITER is an international mega project which is aimed at creating nuclear energy through nuclear fusion reaction.
- **35 countries** are collaborating to build the world’s largest tokamak, a magnetic fusion device that has been designed to prove the feasibility of fusion as a large scale and carbon free source of energy.

- The **primary objective** of the ITER is the investigation and demonstration of burning plasma – plasmas in which the energy of the helium nuclei produced by the fusion reactions is enough to maintain the temperature of plasma, thereby reducing or eliminating the need of external heating.
- **What will ITER do?**
 - » Achieve a deuterium-tritium plasma in which the fusion conditions are sustained mostly by internal fusion heating ("burning plasma").
 - » Generate **500 MW** of fusion power in plasma.
 - » **Demonstration of the integrated operation of technologies** for a fusion power plant (superconducting magnets, remote maintenance, and systems to exhaust power from the plasma)
 - » **Test tritium breeding** – One of the missions for the later stages of ITER operation is to demonstrate the feasibility of producing tritium within the vacuum vessel.
 - » **Demonstrate the safety characteristic of a fusion device.**
 - ITER achieved an important landmark in fusion history when, in 2012, the ITER Organization was licensed as a nuclear operator in France based on the rigorous and impartial examination of its safety files.
 - One of the primary goals of ITER operation is to demonstrate the control of the plasma and the fusion reactions with negligible consequences to the environment.
- **India** is also participating in ITER. PM Modi while participating in the ITER assembly said that the ITER is perfect example of the age-old India belief – **Vasudhaiva Kutumbakam** – the entire world is working together for the betterment of humankind and that India stands proud with its fair share of contributions to the cooling water, cryogenic and cry-distribution systems, auxiliary heating devices using RF and beam technologies.

C) WHAT IS A TOKAMAK:

- The Tokamak is an experimental machine which is designed to harness the energy of a fusion. Inside a tokamak, the energy produced through the fusion of atoms is absorbed as heat in the walls of the vessel. (Heat -> steam -> rotate turbine)
- First developed by Soviet research in the late 1960s, the tokamak has been adopted around the world as the most promising configuration of magnetic fusion device. **ITER will be the world's largest tokamak**—twice the size of the largest machine currently in operation, with ten times the plasma chamber volume.
- **How does Tokamak Work -> Class discussion** (not very important for exam)



D) INDIA AND FUSION

- India has become one of the major players in fusion technology and has been one of the pioneers in its development.
- The **Plasma Physics Program** was initiated by the GoI in 1982 to conduct research at MCF, which later evolved into the **Institute for Plasma Research (IPR)** in 1986 and led to the creation of India's own tokamak, ADITYA, in 1989.

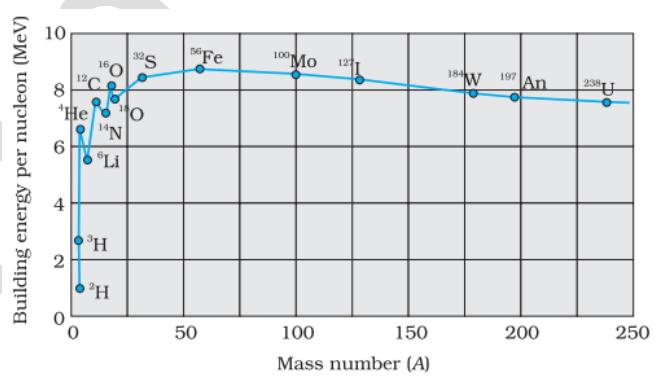
- Subsequently, it also developed a large semi-indigenous tokamak called the **Steady State Superconducting Tokamak (SST-1)** which was fully commissioned in 2013. IPR has also revealed its plans for a successor, the SST-2.
- In 2005, India became the 7th member to join the **International Thermonuclear Experiment Reactor (ITER) project**, a global initiative attempting to build the world's largest tokamak reactor.
 - ITER-India** has been set up under the supervision of IPR and is responsible for fulfilling India's commitment to the project. It has already provided the world's largest cryostat, a vacuum application stainless steel vessel, to house the reactor, along with a host of other equipment.
- Key Limitations for India:**
 - Lack of Private Investment: it is primarily because of Atomic Energy Act, 1962, which puts the brunt of developing and running nuclear power stations on the government.
 - However**, a recent government panel convened by NITI aayog has recommended overturning the ban of foreign investment and allowing greater participation of private players.

3) NUCLEAR BINDING ENERGY

The Nuclear mass M is always less than the mass of neutrons and mass of protons in the nucleus.

This **mass defect** will explain the energy required for breaking a nucleus containing protons and neutrons into individual protons and neutrons.

Similarly, if certain number of neutrons and protons are brought together to form a nucleus of certain charge and mass, an energy E_b will be released in the process. This energy E_b is called the **binding energy of the nucleus (Or Nuclear Binding Energy)**.



4) COMPONENTS OF NUCLEAR POWER REACTOR

Components of Nuclear Fission Reactor

- Fuel:** Uranium is the basic fuel. Usually pallets of **Uranium Oxide (UO_2)** are arranged in tubes to form fuel rods.
- Neutron Source:** In a new reactor with new fuel a neutron source is needed to get the reaction going. Usually this is beryllium mixed with polonium, radium or another alpha emitter. Alpha particles from the decay cause a release of neutrons from the beryllium as it turns to carbon-12. Restarting a reactor with some old fuel may not require this, as there may be enough neutrons to achieve criticality when control rods are removed.
- Moderator:** Material in the core which slows down the neutrons released from fission so that they cause more fission. It is usually water but may be heavy water or graphite.