Carbon Dating

For Prelims: Carbon Dating, ASI, Gyanvapi Mosque, **Shivlinga, Carbon-14,** The Places of Worship Act of 1991.

For Mains: Carbon Dating and other methods to determine the age of Inmate things.

Why in News?

Recently, the Allahabad High Court allowed the **Archeological Survey of India (ASI)** to conduct Carbon Dating of a 'Shivling' inside the **Gyanvapi Mosque** in Varanasi, Uttar Pradesh.

- The petitioners have claimed the object inside the Gyanvapi mosque to be a "Shivling". The claim was disputed by the Muslim side, which said the object was part of a "fountain".
- It set aside an order of the **Varanasi District Court** that rejected a plea for scientific investigation, including carbon dating, of the structure.

What is Carbon Dating?

- **About:**
  - Carbon dating is a widely used method to **establish the age of organic materials,** things that were once living.
  - Living things **have carbon in them in various forms.**
  - The dating method is based on the fact that **Carbon-14 (C-14) is radioactive,** and decays at a well-known rate.
    - C-14 is an isotope of carbon with an **atomic mass of 14.**
    - The most abundant isotope of **carbon in the atmosphere is C-12.**
    - A very small amount of C-14 is also present.
      - The ratio of C-12 to C-14 in the atmosphere is almost static and **is known.**
- **Half Life:**
  - Plants get their carbon through photosynthesis; **animals get it mainly through food.** Because plants and animals get their carbon from the atmosphere, they **too acquire C-12 and C-14 in roughly the same proportion** as is available in the atmosphere.
  - When they die, **their interactions with the atmosphere stop.** While C-12 is stable, the radioactive C-14 reduces to one half of itself in about 5,730 years — known as its 'half-life'.
  - The changing ratio of C-12 to C-14 in the remains **of a plant or animal after it dies can be measured and** can be used to deduce the approximate time when the organism died.
- **Age Determination of Inanimate Things:**
  - Carbon dating **cannot be applied in all circumstances.** It cannot be used to determine the age of non-living things like rocks, for example.
  - Also, the age of things that are more than **40,000-50,000 years old cannot be arrived at through** carbon dating.
    - This is because **after 8-10 cycles of half-lives,** the amount of C-14 becomes almost very small and is almost undetectable.
- For determining the age of inanimate things, instead of carbon, **decays of other radioactive elements that might be present** in the material become the basis for the dating method.

- These are known as **Radiometric Dating Methods.** Many of these involve elements with **half-lives of billions of years,** which enable scientists to reliably estimate the age of very old objects.

What are the Radiometric Methods for Age Determination of Nonliving Things?

- **Potassium-Argon and Uranium-Thorium-Lead:** Two commonly employed methods for **dating rocks are Potassium-Argon dating** and **Uranium-Thorium-Lead** dating.
  - The radioactive isotope of potassium **decays into argon,** and their ratios can **give a clue about the age** of rocks.
  - Uranium and thorium have several radioactive isotopes, and all of them decay into the **stable lead atom.** The ratios of these elements present in the material **can be measured and used to make estimates about age.**
- **Exposure to Sunlight:** There are also methods to determine how long an object has remained exposed to sunlight. These apply different techniques but are **again based on radioactive decay and are particularly useful** in studying buried objects or changes in topology.
  - The most common of these is called **cosmogenic nuclide dating**, or CRN, and is regularly applied to study the **age of ice cores in polar regions.**
- **Indirect Carbon Dating:** In some situations, carbon dating can be used indirectly as well.
  - A way in which the **age of ice cores in glaciers and polar regions is determined** by studying carbon dioxide molecules trapped inside large ice sheets.
    - The trapped molecules have no interaction with the outside atmosphere and are found in the **same state as when they were trapped.** Determining their age gives a rough estimate of the time when the ice sheets were formed.

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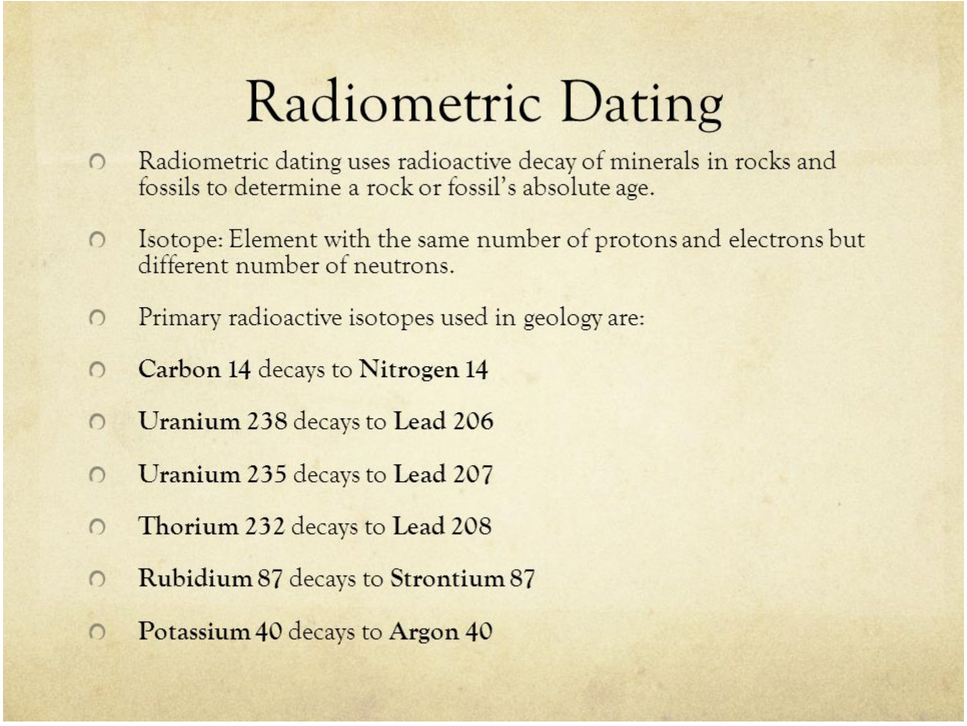

What are the Limitations of Determining Age of Gyanvapi Shivling?

- There are specific limitations in the case that **prevent disruptive methods or uprooting** of the structure, as directed by the SC.
- Therefore, traditional methods like carbon dating, which involve analyzing trapped organic material beneath the structure, **may not be feasible in this particular situation.**

What is the Gyanvapi Dispute?

- The Gyanvapi dispute revolves around the **Gyanvapi Mosque complex in Varanasi.** Hindu petitioners claim that the mosque was built on the site of an ancient Hindu temple. They argue that the presence of a **"Shivling" serves as evidence of the temple's existence.** The Petitioners have sought the **right to worship Maa Shringar Gauri** on the outer wall of the mosque complex.

- The management committee of the mosque, however, maintains that the land is Waqf property and argues that The Places of Worship Act of 1991 **prohibits** any changes to the character of the mosque.
- Historically, the Gyanvapi Mosque was built in **1669 during the reign of Mughal emperor Aurangzeb.** It was constructed after the demolition of the existing Vishweshwar temple. The plinth of the temple was **left intact and served as the courtyard of the mosque,** while one wall was preserved as the qibla wall facing Mecca. The present Kashi Vishwanath Temple, dedicated to Lord Shiva, was later built adjacent to the mosque by Rani Ahilyabai Holkar in the 18th century.
- Various claims have been made over the years, with some asserting that the mosque remains the original sacred place of Hindu worship.

Source: IE

Water Footprint of AI

For Prelims: ChatGPT**,** Artificial Intelligence**,** GPT-4, AI models

For Mains: Balancing technological advancements with resource conservation, Impact of AI on water resources

Why in News?

As AI tools like **OpenAI's ChatGPT** continue to gain popularity for their versatility and automation capabilities, concerns are being raised regarding their environmental impact.

- A recent study has shed light on the water footprint of Artificial Intelligence(AI) models, highlighting the significant amounts of water required to maintain data centers and train these models.

What is the Water Footprint of AI?

- The water footprint of AI is the **amount of water that is used to generate electricity and provide cooling for the data centers** that run AI models.
- The water footprint of AI can be divided into two components: direct water consumption and indirect water consumption.
  - Direct water consumption refers to the **water that is evaporated or discharged as waste during the cooling process** of data center servers.
  - Indirect water consumption refers to the water that is used to produce the **electricity that powers data center servers.**
- The water footprint of AI can vary depending on several factors, such as the type and size of the AI model, the location and efficiency of the data center, and the source and mix of electricity generation.

How Much Water Does AI Consume?

- According to a recent study titled **"Making AI Less 'Thirsty:' Uncovering and Addressing the Secret Water Footprint of AI Models",** training a large AI model such as **GPT-3** can directly consume up to **700,000 liters of clean freshwater,** which is enough to produce **370 BMW cars or 320 Tesla electric vehicles.**
- The same study also estimated that a conversation with an AI chatbot such as **ChatGPT can consume up to 500 ml of water for 20-50 questions and answers,** which may not seem like much until you consider that **ChatGPT has more than 100 million active users** who engage in multiple conversations.
- The **GPT-4**, expected to have a larger model size, is predicted to further amplify these water consumption statistics.
  - However, estimating the water footprint of GPT-4 is challenging due to the lack of publicly available data for calculation.
- Although online activities using AI models occur digitally, the **physical storage and processing of data take place in data centers.**
  - Data centers **generate considerable heat,** necessitating water-intensive cooling systems, often utilizing evaporative cooling towers.
  - To maintain system integrity, the **water used must be pure freshwater, and data centers also require significant water for power generation.**

What are the Concerns with the Water Footprint of AI?

- **Water Scarcity:**
  - Water scarcity is a global issue, and **AI technologies contribute to the problem.** AI infrastructure requires significant amounts of freshwater for cooling, which strains limited water resources.
- **Environmental Impact:**
  - Extraction of freshwater for AI operations can harm **aquatic biodiversity.**
  - Energy required for water treatment and transport for AI operations contributes to carbon emissions and climate change.
- **Unsustainable Resource Management:**
  - Diverting water for AI operations can hinder access to water for **human consumption, agriculture, and other critical needs.**
- **Equity and Social Implications:**
  - Water scarcity disproportionately affects **vulnerable communities** that rely on limited water supplies for their livelihoods.
  - The water-intensive nature of AI can further exacerbate inequities by diverting water away from communities that need it the most.
- **Long-term Sustainability:**
  - The expanding AI industry could place additional strain on water resources without addressing the water footprint issue.
  - Addressing the water footprint is crucial for the long-term sustainability of both AI development and water availability.

How Can the Water Footprint of AI be Reduced?

- **Use Renewable Energy Sources:**
  - By using renewable energy sources like **wind or** solar power **to generate electricity,** we can significantly reduce the amount of water needed.
- **Implement Water-Efficient Cooling Systems:**
  - Most data centers, which house the servers and other hardware that power AI systems, use water-based cooling systems. Implementing **water-efficient cooling technologies like air cooling or direct-to-chip liquid cooling** can help reduce the amount of water used.
- **Develop Water-Efficient Algorithms:**
  - AI algorithms can be designed to be more water-efficient by **reducing the need for computational power or by optimizing algorithms** to use less water-intensive processes.
- **Increase Hardware Lifespan:**
  - **Extending the lifespan of hardware can reduce the amount of water used** in its production. By designing hardware that lasts longer and is upgradeable, we can reduce the

need to replace hardware frequently.

- **Promote Responsible Water Management:**
  - Encouraging responsible **water management practices by data centres** and other AI companies can help reduce the water footprint of AI.
    - This includes measures like recycling wastewater, using rainwater harvesting systems, and implementing water-efficient landscaping practices.
  - Adopting policies and regulations that incentivize or mandate the reduction of the water footprint of AI by setting standards, targets, or taxes.

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

Q1. With the present state of development, Artificial Intelligence can effectively do which of the following? (2020)

1. Bring down electricity consumption in industrial units
2. Create meaningful short stories and songs
3. Disease diagnosis
4. Text-to-Speech Conversion
5. Wireless transmission of electrical energy

Select the correct answer using the code given below:

(a) 1, 2, 3 and 5 only
(b) 1, 3 and 4 only
(c) 2, 4 and 5 only
(d) 1, 2, 3, 4 and 5

Ans: (b)

Source: DTE

4th Positive Indigenisation List

For Prelims: Defence Public Sector Undertakings (DPSUs), Positive Indigenisation List (PIL), Micro, Small, and Medium Enterprises (MSMEs), Mission DefSpace, iDEX scheme**,** Defense Industrial Corridors**,** NETRA

For Mains: Status of Indigenization of the Defence Sector in India.

Why in News?

In a significant move towards promoting self-reliance in the defence sector and reducing imports, **India's** Defence Public Sector Undertakings (DPSUs) have received approval for the **fourth** Positive Indigenisation List (PIL).

- The list comprises **928 strategically-important Line Replacement Units (LRUs),** sub-systems, spares, and components, with an import substitution value of approximately **Rs 715**

crore.

What is a Positive Indigenisation List?

- **About:**
  - The concept of the **positive indigenization** list entails that the **Indian Armed Forces, comprising the** Army, Navy**, and** Air Force, will exclusively source the listed items from domestic manufacturers.
    - These manufacturers may include entities from the **private sector or Defense Public Sector Undertakings (DPSUs).**
  - The fourth Positive Indigenisation List follows three previous PILs that were published in **December 2021, March 2022, and August 2022**, respectively.
    - So far, 310 items have been successfully indigenised, with the breakdown as follows: **262 items from the first PIL, 11 items from the second PIL, and 37 items from the third PIL.**
    - This initiative is in line with **India's vision of** 'Atma Nirbharta' **(self-reliance)** and aims to boost the domestic **defence industry, enhance investment, and reduce dependency on imports.**
- **Indigenisation and In-house Development:**
  - To achieve indigenization, the DPSUs will utilize different routes under the **'Make' category,** focusing on in-house development through the capabilities of Micro, **Small, and Medium Enterprises (MSMEs)** and the private Indian industry.
  - This approach will provide a boost to the economy, encourage investment in the defense sector. Additionally, this **initiative will foster the growth of design capabilities** within the domestic defense industry by actively involving academia and research institutions.
- **Procurement and Industry Participation:**
  - The DPSUs are set to initiate procurement action for the items listed in the fourth PIL. To facilitate the process, Srijan Portal Dashboard has been specifically designed for this purpose.

What is the Status of Indigenisation of the Defence Sector in India?

- **Need for Indigenization:**
  - India's arms **imports fell 11% between 2013-17 and 2018-22,** the country is still the **world's top importer of military hardware in 2022 highlighted by** a report by the Stockholm International Peace Research Institute (SIPRI).
- **Current Estimates and Targets:**
  - Current estimates place India's **defensive capital expenditure at USD 130 billion** over the next five years.
  - The defense ministry has set a **USD 25 billion (Rs 1.75 lakh crore)** turnover goal in defense manufacturing in the next **five years,** including an export target of USD 5 billion worth of military hardware.
- **Government Initiatives:**
  - **Priority Procurement: The Defense Acquisition Procedure (DAP)-2020** gives priority to the procurement of capital items from domestic sources under the Buy Indian (IDDM) category.
  - **Liberalised Foreign Direct Investment (FDI) Policy:** The FDI policy allows for **74% FDI under the automatic route in the defense industry,** and **up to 100% through Government route** wherever it is likely to result in access to modern technology.
  - **Mission DefSpace:** The Mission DefSpace has been launched to promote defense-related innovations and developments in the space sector.
  - **Innovations for Defense Excellence (iDEX) Scheme:** The iDEX scheme involves startups and MSMEs in defense innovation projects, fostering their participation and contribution.
  - **Defense Industrial Corridors:** Two **Defense Industrial Corridors** have been established in **Uttar Pradesh and Tamil Nadu,** focusing on developing defense manufacturing ecosystems and attracting investments.
- **Examples of Indigenous Defense Arsenal in India:**
  - **Tejas Aircraft:** The **Tejas** is a lightweight, multi-role supersonic aircraft designed and

developed indigenously in India.
    - **Arjun Tank:** Developed by the **[Defense Research and Development Organization (DRDO),]** the Arjun Tank is a 3rd generation main battle tank that showcases India's expertise in armored vehicle technology.
    - **NETRA:** The NETRA is an airborne early warning and control system developed domestically, providing crucial surveillance and reconnaissance capabilities.
    - **ASTRA:** India has successfully developed the **ASTRA**, an **all-weather beyond-visual-range air-to-air missile,** enhancing the country's air defense capabilities.
    - **LCH 'Prachand':** It is the first indigenous **Multi-Role Combat Helicopter** which has potent ground attack and aerial combat capability.
    - **ICG ALH Squadrons:** In a major boost to further strengthen the capabilities of the **Indian Coast Guard, ALH Mk-III squadrons** were commissioned in Porbandar and Chennai in June and December 2022.
- **Challenges:**
    - **Technological Gap:** Developing **cutting-edge defence technologies** and acquiring advanced capabilities is a significant challenge for India.
        - The country has traditionally relied on foreign suppliers for critical defence technologies, and **bridging the technological gap requires substantial investments in research and development (R&D), as well as collaboration with industry and academia.**
    - **Infrastructure and Manufacturing Base: Building a robust defence industrial base and infrastructure to support indigenous production is a major challenge.**
        - The defense manufacturing ecosystem in India needs to be modernized, with improvements in infrastructure, technology transfer, skilled workforce development, and streamlined procurement processes.
    - **Testing and Certification:** Ensuring the quality, reliability, and safety of indigenously developed defense systems through rigorous testing and certification processes is crucial.
        - Developing **robust testing facilities and establishing effective quality control mechanisms are essential for gaining** the confidence of users and export markets.

Way Forward

- **Create a Defense Innovation Ecosystem:** There is a need to establish a dedicated **defense innovation ecosystem** that brings together defense organizations, research institutions, startups, and technology companies.
    - This ecosystem should promote **collaboration, knowledge sharing, and technology transfer** to drive indigenous defense capabilities.
- **Defense Technology Accelerators:** Establish **defense technology accelerators that provide mentorship, funding, and resources to startups and small and medium-sized enterprises (SMEs)** working on cutting-edge defense technologies.
    - These accelerators should facilitate connections with defense organizations, offer access to test facilities, and help navigate regulatory processes.
- **Defence Skilling and Training Programs:** There is a need to develop skilling and training programs to bridge the gap between **academia and industry in defense-related disciplines.**
    - Collaborating with universities and technical institutes to design specialized courses and **certifications that align with defense technology requirements will be a significant step in this direction.**

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

Q. In the context of the Indian defense, what is 'Dhruv'? (2008)

(a) Aircraft-carrying warship
(b) Missile-carrying submarine
(c) Advanced light helicopter
(d) Intercontinental ballistic missile

Ans: (c)

Mains

Q. What is the significance of Indo-US defence deals over Indo-Russian defence deals? Discuss with reference to stability in the Indo-Pacific region. (2020)

Q. How is S-400 air defence system technically superior to any othersystem presently available in the world? (2021)

Source: PIB
