

GS PAPER 3

Technology-Nov'18

Kilogram Redefined

Syllabus: Science and Technology- developments and their applications and effects in everyday life

In News

- In a historic judgment, at the 26th CGPM, General Conference on Weights and Measures, in Versailles, Paris more than **60 nations came together to vote unanimously** for a new system that redefines the kilogram.
- Along with the kilogram three other units, the **ampere** (electrical current), the **kelvin** (thermodynamic temperature) and the **mole** (amount of a substance) were redefined at the conference.
- It is arguably the most significant redefinition of an SI unit **since the 'second' was recalculated in 1967**, a decision that helped ease communication across the world via technologies like GPS and the internet.

Need For Change

- The kilogram has been defined **since 1889 by a shiny piece of platinum-iridium** kept in a special glass case, the **International Prototype of the Kilogram (IPK)**, also known as Le Grand K (The Big K). It is housed at the headquarters of the International Bureau of Weights and Measures (BIPM), just outside Paris.
- The issue is that the IPK doesn't always weigh the same. Even inside its three glass bell jars, **it picks up micro particles of dirt and is affected by the atmosphere**. Sometimes it needs cleaning, which can affect its mass which can have profound implications. If the prototype were to lose mass, atoms would, in theory, weigh more **since the base kilogram must by definition always weigh a kilogram**.
- **Hence**, the scientists wanted to create a measurement system that is based entirely on unchanging fundamental properties of nature.
- Now the kilogram will be defined by a tiny but immutable fundamental value called the **Planck Constant**.
- The Planck constant denoted as h , is a physical constant that is the quantum of action, which relates the energy carried by a photon with the frequency of its electromagnetic wave. It is named after the physicist Max Planck and is an important quantity in quantum physics.
- The new definition involves an exquisitely accurate weighing machine called the **Kibble balance, which makes use of the constant to measure the mass of an object using a precisely measured electromagnetic force**.
- Unlike a physical object, the formula cannot pick up particles of dust, decay with time or be dropped and damaged. It is also expected to be more accurate when measuring very, very small or very, very large masses
- While **there will be no change for the average consumer**, it is expected to be more accurate when measuring very, very small or very, very large masses and help usher in new innovations in science, industry, climate study and other fields.

SpiNNaker (Spiking Neural Network Architecture) Supercomputer

Syllabus: Awareness in the fields of IT and Computers

In News

- The world's largest **neuromorphic supercomputer**, designed and built to work in the same way a human brain does, has been fitted with its landmark one-millionth processor core and has been switched on for the first time.
- The project was initially funded by the Engineering and Physical Sciences Research Council and is now supported by the **European Human Brain Project**.
- It has taken £15million in funding, 20 years in conception and over 10 years in construction, with the initial build starting way back in 2006.
- The SpiNNaker is capable of completing **more than 200 million actions per second**, with each of its chips having 100 million transistors.
- The SpiNNaker machine, designed and built in The University of Manchester in the UK, can model more biological neurons in real time than any other machine on the planet.
- Biological neurons are basic brain cells present in the nervous system that communicate primarily by emitting spikes of pure electro-chemical energy.
- Neuromorphic computing uses large scale computer systems containing electronic circuits to mimic these spikes in a machine.
- SpiNNaker is unique because, unlike traditional computers, it does not communicate by sending large amounts of information from point A to B via a standard network.
- Instead, it **mimics the massively parallel communication architecture of the brain**, sending billions of small amounts of information simultaneously to thousands of different destinations.
- Researchers eventually aim to model up to a billion biological neurons in real time and are now a step closer.
- One billion neurons is one per cent of the scale of the human brain, which consists of just under 100 billion brain cells, or neurons, which are all highly interconnected via approximately one quadrillion synapses.

European Human Brain Project

The HBP Flagship was launched by the European Commission's Future and Emerging Technologies (FET) scheme in October 2013, and is scheduled to run for ten years.

Applications

- One of the fundamental uses for the supercomputer is to **help neuroscientists better understand how our own brain works**.
- It has also simulated a region of the brain called the Basal Ganglia - an area affected in Parkinson's disease, meaning it has **massive potential for neurological breakthroughs in science such as pharmaceutical testing**.

- It has also been **used to control a robot**, the SpOmnibot. The robot uses the SpiNNaker system to interpret real-time visual information and navigate towards certain objects while ignoring others.

HysIS

Syllabus: Awareness in the fields of Space

In News

- ISRO has successfully launched the PSLV-C43 mission that carried **HysIS (Hyper Spectral Imaging Satellite)** as part of its payload. This was the 45th launch flight of the polar satellite launch vehicle (PSLV) rocket.
- The satellite was accompanied by 30 other satellites developed by various nations, including 23 from the US and had a combined payload of 641.5kg
- The heart of the system required for the satellite is an **optical imaging detector chip** which was indigenously designed and developed by Isro's space application centre and fabricated at a semiconductor lab in Chandigarh.
- The objective of the probe is to monitor the Earth's surface within a bandwidth of 400nm-2500nm wavelength. This includes visible, near infrared and far infrared bands of the electromagnetic spectrum.
- It can be used for an array of activities from monitoring the crops, environmental monitoring, water management, atmospheric activity monitoring, coastal patterns, looking for minerals and oil, military surveillance, while also assisting studies of Earth's magnetic field all of which need visuals that show a high level of differentiation of the scene or object.
- It has been projected into **a polar synchronous orbit**, which sets it in motion along the axis that runs along the Earth's geographic North and South Pole. With its orbit, it will remain at the same position relative to the sun throughout its five-year mission, which ends in 2023.

China Unveils Heavenly Palace Space Station

Syllabus: Awareness in the fields of Space

In News

- China recently unveiled a replica of its first permanently crewed space station, which would replace the international community's orbiting laboratory and symbolises the country's major ambitions beyond Earth.
- The model represented the living and working space of the Tiangong — or "Heavenly Palace" — which will also have two other modules for scientific experiments and will be equipped with solar panels.
- Three astronauts will be permanently stationed in the 60-tonne orbiting lab, which will enable the crew to conduct biological and microgravity research assembly. It is expected to be completed around 2022 and the station would have a lifespan of around 10 years.
- The International Space Station — a collaboration between the US, Russia, Canada, Europe and Japan — has been in operation since 1998 but is due to be retired in 2024.

- China will then have the only space station in orbit, though it will be much smaller than the ISS which weighs 400 tonnes and is as large as a football pitch.
- The country has also announced that the lab would be open to "all countries" to conduct science experiments.

GSAT 29 Launch

Syllabus: Awareness in the fields of Space

In News

- ISRO's GSAT-29 communication satellite was recently launched successfully by the second developmental flight of Geosynchronous Satellite Launch Vehicle Mark III (GSLV Mk III-D2) from the Satish Dhawan Space Centre, Sriharikota.
- It was launched into an elliptical Geo Transfer Orbit (GTO) with a 190 km perigee, the point in the orbit of the moon or a satellite at which it is nearest to the earth, and 35,975 km apogee, the farthest or highest point.

GSAT 29

- It is a communication satellite with two separate payloads (Ku-band and Ka-band) designed to improve telecommunication and internet services under the Digital India program in remote areas in the country, especially Jammu and Kashmir and the North-East.
- It is a **multiband, multi-beam communication satellite**, intended to serve as a test bed for new and critical technologies.
- Weighing 3,423 kg at lift-off, GSAT-29 is the **heaviest satellite to be launched from India**. With a mission life of 10 years, it is the 33rd communication satellite built by ISRO.
- In addition, the Q/V-Band communication payload onboard is intended to demonstrate the future high throughput satellite system technologies.
- It also carries a **Geo High-Resolution Camera** which will carry out high resolution imaging and the **Optical Communication Payload** will demonstrate data transmission at a very high rate through optical communication link.

GSLV Mark III

- GSLV Mk III is a **three-stage heavy lift launch vehicle** developed by ISRO. The vehicle has two solid strap-ons, a core liquid booster and a cryogenic upper stage.
- It is designed to carry 4 ton class of satellites into Geosynchronous Transfer Orbit (GTO) or about 10 tons to Low Earth Orbit (LEO), which is about twice the capability of GSLV Mk II.
- With the success of this launch, the developmental phase of the GSLV Mk III vehicle programme will be complete and the vehicle's operational phase will begin.
- The success of GSLV Mk III-D2 marks an important milestone in Indian space programme towards **achieving self-reliance in launching heavier satellites**, as it is currently dependent on European launchers to put heavy satellites in space.
- The first operational mission of this vehicle will be the **Chandrayaan-II mission in January** next year.

- It will also be used for the **Gaganyaan mission** wherein ISRO has set a target of achieving the country's manned mission to space by 2021, with the first unmanned programme planned for December 2020.

Bionic Mushrooms

Syllabus: Awareness in the fields of bio-tech

In News

- Scientists, including those of Indian origin, have created a bionic device that generates green power by 3D-printing clusters of cyanobacteria on an ordinary white button mushroom.
- The research by the Stevens Institute of Technology in the U.S. is part of a broader effort to better improve our understanding of cells biological machinery and how to use them to fabricate new technologies.
- Cyanobacteria, a bacteria with a blue-green colour, was used in the experiment as it creates its energy through photosynthesis, like plants.
- Cyanobacteria's ability to produce electricity is well known. However, researchers have been limited in using these microbes in bioengineered systems because cyanobacteria do not survive long on artificial bio-compatible surfaces.
- To create the bionic mushroom, researchers used a 3D printer to create two types of electronic ink patterns, one containing the bacteria, and a second containing graphene nano ribbons to collect the current. Those patterns were placed on the mushroom's cap.
- The mushrooms essentially serve as a suitable environmental substrate with advanced functionality of nourishing the energy-producing cyanobacteria.
- Integrating cyanobacteria with nanoscale materials capable of collecting the current, it was possible to better access the unique properties of both, augment them and create an entirely new functional bionic system.
- The study can pave the way for larger opportunities involving bio-electricity. It can also help to potentially realise many other designer bio-hybrids for the environment, defence, healthcare and many other fields.

Earth BioGenome Project

Syllabus: Awareness in the fields of bio-tech

In News

- A new scientific mission with an ambitious objective was recently announced to **map the entire genome of every known animal, plant, fungus and protozoan on earth.**
- The **Earth BioGenome Project (EBP)**, being described as the next "moonshot for biology", is a decade-long experiment to map the genomes of roughly 1.5 million species — all the complex life forms known to man.
- The last project of a similar scale and importance was the 13-year endeavour to map the human genetic code, the Human Genome Project, which was completed in 2003.

- Till date, roughly 3,500 complex lifeforms, an estimated 0.2 percent of the total, have had their genomes sequenced. Of those, fewer than a hundred are of a quality worthy of being used as "reference" quality by researchers.
- The volume of data generated by the EBP is expected to be at a massive, 'exascale' — more than the volumes accumulated by Twitter, YouTube or astronomy.

Applications

- The study would create a massive resource for scientists, offering many potential insights, including how environmental change is affecting living systems at the genetic level.
- Having the roadmap, will be a tremendous resource for new discoveries, understanding the rules of life, how evolution works, new approaches for the conservation of rare and endangered species, and new resources for researchers in agricultural and medical fields.
- The project is also a means to open up new avenues for treating infections, drugs for anti-ageing, or even develop new approaches to addressing food shortage and for the development of innovative biomaterials.
- If successful in its goal, the EBP would revolutionize how biology and evolution are studied. Its completion would also give efforts towards the conservation of wildlife and biodiversity a massive boost.

Transgenic Rice With Reduced Arsenic Accumulation

Syllabus: Awareness in the fields of bio-tech

In News

- Arsenic accumulation in rice grains is one of the serious agricultural issues in India. To address this, researchers at **Lucknow- based CSIR-National Botanical Research Institute** have developed transgenic rice by inserting a novel fungal gene, which results in reduced arsenic accumulation in rice grain.
- In their latest study, researchers have cloned Arsenic methyltransferase (WaarsM) gene from a soil fungus, *Westerdykella aurantiaca*, and inserted the same into the rice genome with the help of *Agrobacterium tumefaciens*, a soil bacterium which has natural ability to alter the plant's genetic makeup.
- The newly developed transgenic rice along with normal rice was then treated with arsenic. Comparison of transgenic and **non-transgenic rice showed that transgenic plants accumulated less arsenic in root as well as shoot as compared to non-transgenic lines.**
- In addition, researchers are also looking for gaps in arsenic metabolism in rice which will ultimately lead to understand arsenic uptake and metabolism in rice.
- The knowledge can be applied to develop practices to decrease accumulation of arsenic in rice grain by molecular breeding, gene editing or transgenic approaches which can have tremendous public health consequences

Shakti Microprocessor

Syllabus: Indigenization of technology and developing new technology.

In News

- Researchers at Indian Institute of Technology Madras (IIT-M) have designed and booted up **India's first indigenous microprocessor**, Shakti, which could be used in mobile computing and other devices.
- The microchip is fabricated in the Semi-Conductor Laboratory (SCL) of Indian Space Research Organisation (ISRO) at Chandigarh.
- SCL, which has played a significant part, is an autonomous body engaged in research and development in microelectronics to meet the strategic needs of the country,
- **Bluespec**, an open-source high level synthesis language, went into making the chips and the design originated from an open source instruction set architecture called **RISC V**, which makes it customisable to any device.
- It can be used in low-power wireless systems and networking systems besides reducing reliance on imported microprocessors in communication and defence sectors.
- It will also help in reducing the risk of deploying systems that may be infected with back-doors and hardware Trojans.
- The impact of this completely indigenous fabrication is that India has now attained independence in designing, developing and fabricating end-to-end systems within the country, leading to self-sufficiency.