SFG – FRC for CSE 2024 | S&T #3 – Solutions | ForumIAS

Q.2)

Exp) Option a is the correct answer.

Cyber Physical Systems (CPS) combine digital/ cyber elements with physical objects (e.g. machines, autonomous vehicles) and data with capabilities of communication, data collection & processing, computing, decision making and action. CPS is an integrated system involving Sensors, Communication, Actuators, Control, interconnected computing networks and data analytics. Therefore, there is a need to create an integrated and overarching National platform to bring convergence among all stakeholders with regards to development of CPS in India.

Statement 1 is correct: The National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS) was announced in the Budget 2020 and declared to be under the **Department of Science & Technology (DST).** It is to last for a period of 5 years. Hence this statement is correct.

Statement 2 is incorrect: It is the **National Mission on Quantum Technologies & its applications (not NM-ICPS) which aims to build industrial capacities as well as promote R&D** in various Quantum Computing Technologies so that they may be applied commercially. Hence this statement is incorrect. The National Mission on Quantum Computing was announced in 2020 for a period of 5 years under DST. The technologies that will receive a push under this mission include quantum computers and computing, quantum communication, quantum key distribution, encryption, crypt analysis, quantum devices, quantum sensing, quantum materials, quantum clock, etc.

Statement 3 is incorrect: It is the National Mission on Supercomputing (not NM-ICPS) that aims to establish a vast network of Supercomputers in India. Hence this statement is incorrect. The National Mission on Supercomputers aims to establish a grid of supercomputers known as National Knowledge Network (NKN) to provide a boost in computing capabilities of India as a nation. This will help in various fields, such as

• R&D capabilities in STEM universities
• Climate Modelling
• Atomic energy simulations
• Astrophysics
• Big Data analytics
• Usage of CPS
• Government Information Systems, etc.

This program is being steered jointly by the Department of Science and Technology (DST) and Department of Electronics and Information Technology (DeitY) over a period of 7 years

Knowledge Base:

The Mission will have four major activities i.e.,

1) Technology Development,
2) Human Resource & Skill Development,
3) Innovation, Entrepreneurship & Start-Up Ecosystem and
4) International Collaborations.

Q.5)

Exp) Option d is the correct answer.

Edge computing enables data to be analysed, processed and transferred at the edge of a network. The idea is to analyse the data locally closer to where it is stored, in real-time without latency rather than send it far away to a centralised data centre.

Application of Edge Computing can be realised in the following areas:

Autonomous vehicles: With edge computing, it will be possible to remove the need for drivers in all trucks except the front one, because the trucks will be able to communicate with each other with ultra-low latency.

Virtualised radio networks and 5G (vRAN): Operators are increasingly looking to virtualise parts of their mobile networks (vRAN). This has both cost and flexibility benefits. The new virtualised RAN hardware needs to do complex processing with a low latency. Operators will therefore need edge servers to support virtualising their RAN close to the cell tower.

Traffic management: Edge computing can enable more effective city traffic management. Examples of this include optimising bus frequency given fluctuations in demand, managing the opening and closing of extra lanes, and, in future, managing autonomous car flows.

In-hospital patient monitoring: An edge on the hospital site could process data locally to maintain data privacy. Edge also enables right-time notifications to practitioners of unusual patient trends or behaviors (through analytics/AI), and creation of 360-degree view patient dashboards for full Visibility.

Smart grid: Sensors and IoT devices connected to an edge platform in factories, plants and offices are being used to monitor energy use and analyse their consumption in real-time. With real-time visibility, enterprises and energy companies can strike new deals, for example where high-powered machinery is run during off-peak times for electricity demand. This can increase the amount of green energy (like wind power) an enterprise consumes.

Q.12)

Exp) Option b is the correct answer.

A team of scientists from the Defense Research and Development Organization (DRDO) and Indian Institute of Technology (IIT) Delhi has successfully demonstrated the Quantum Key Distribution (QKD) link between Prayagraj and Vindhyachal in Uttar Pradesh, a distance of more than 100 kilometers.

Statement 1 is correct: Quantum Key Distribution (QKD) is primarily a mechanism to undertake **secure communication which utilizes a cryptographic protocol** involving various components of quantum mechanics. It generates keying material for an encryption algorithm that provides confidentiality.

Statement 2 is incorrect: The Quantum Key Distribution technology **enables two**

communicating sides to come up with random secret keys shared by both of them and known exclusively to them, so only they can use it to encrypt and decrypt messages, thus achieving a very highly-secure communication.

Statement 3 is correct: Quantum Key Distribution is based on physical properties, and its security derives from unique physical layer communications. This **requires users to lease dedicated fibre connections or physically manage free-space transmitters.** It cannot be implemented in software or as a service on a network, and cannot be easily integrated into existing network equipment.

Q.14)

Exp) Option b is the correct answer.

PARAM PORUL is a state-of-the-art supercomputer inaugurated on May 25, 2022, at NIT Tiruchirappalli under the National Supercomputing Mission. The facility has an 838 TeraFlops computing capacity and is equipped with a mix of CPU nodes, GPU nodes, High Memory nodes, High throughput storage, and high-performance Infiniband interconnect.

Statement 1 is correct: PARAM PORUL is a supercomputer dedicated to the nation under the National Supercomputing Mission (NSM), which is a joint initiative of Ministry of Electronics and Information Technology (MeitY) and Department of Science and Technology (DST).

Statement 2 is correct: PARAM PORUL is equipped with Direct Contact Liquid Cooling technology to obtain a high-power usage effectiveness and thereby reducing the operational cost.

Statement 3 is incorrect: PARAM PORUL was not inaugurated at IISc Bangalore. It was inaugurated at NIT Tiruchirappalli.

Q.22)

Exp) Option c is the correct answer.

Blockchain is a decentralized and distributed digital ledger technology that securely records and verifies transactions across a network of computers, ensuring transparency, immutability, and trust without a central authority. Blockchain in agriculture ensures transparent, secure transactions, enhances traceability, reduces fraud, and streamlines processes, fostering efficiency and trust.

Statement 1 is correct. Blockchain accelerates the acquisition and sale of agricultural products on e-commerce sites by providing a transparent and efficient platform. It ensures secure, real-time transactions, traceability, and trust, streamlining the process for both buyers and sellers. KHETHINEXT, a digital transformation platform, empowers 4.5 lakh Indian farmers. Through its dApp, it establishes a direct marketplace, connecting farmers to retailers and produce organizations, enhancing their living conditions.

Statement 2 is correct. Blockchain can be used for transparent and automated crop insurance processes, ensuring that claims are processed efficiently, and farmers are compensated for losses.

Statement 3 is correct. Blockchain modernizes land records by providing an immutable, transparent, and secure ledger. It ensures real-time updates, reduces fraud, and streamlines transactions. Smart contracts automate processes, enhancing efficiency, reducing administrative burdens, and fostering trust in land-related transactions for improved governance.

Statement 4 is incorrect. Blockchain diminishes transaction costs in agriculture by enabling direct, transparent, and efficient transactions. For instance, **in agricultural supply chains, it eliminates intermediaries in supply chain, reduces fees.** Smart contracts automate and enforce agreements, streamlining processes and enhancing trust, ultimately lowering the overall transaction costs for farmers and stakeholders.

Q.26)

Exp) Option a is the correct answer.

Recently, Union Cabinet has approved a public Wi-Fi access network called PM-WANI (Wi-Fi Access Network Interface).

Statement 1 is incorrect: Ministry of communication (and not Ministry of electronics and information technology) launched the Prime Minister Wi-Fi Access Network Interface, which is also called the 'PM-WANI' in December 2020. The scheme envisages **setting up of public Wi-Fi networks** and access points **by local Kirana and neighborhood shops** through **public data offices**.

Statement 2 is incorrect: PM WANI scheme aims to bring **large scale deployment of Wi-Fi hotspots** through the country to **drive up connectivity options** and **improve digital access. Whereas, ASEEM scheme** which aims to **provide real-time data analytics** about the demand and supply patterns including - industry requirements, skill gap analysis, demand per district/ state/cluster , key workforce suppliers a **potential career prospects for candidates.**

Statement 3 is correct: PM-WANI will be operated by different players as described herein under:

• Public Data Office (PDO): It will establish, maintain, and operate only WANI compliant Wi-Fi Access Points and deliver broadband services to subscribers.

• Public Data Office Aggregator (PDOA): It will be an aggregator of PDOs and perform the functions relating to Authorization and Accounting.

• **Central Registry: It will maintain the details of App Providers, PDOAs and PDOs**. To begin with, the Central Registry will be maintained by the Centre for Development of Telematic (C-DOT).

Knowledge Base:

Benefits of the PM WANI Scheme: There are several benefits that the PM WANI scheme has brought about in the country. Some of them are listed below:

• It will bring a new wave of internet users to the country. The PM WANI scheme will increase the penetration of the internet even in rural India, and it will open up a whole new world of commercial and entertainment options for everyone

• **With the PM WANI scheme, connectivity will no longer be a problem.**

• **The PM WANI scheme will act as an enabler of digital India, where Wi-Fi services will be available for even a small shopkeeper**

• The TRAI report estimates that the internet penetration will increase by about 10%, which in turn will lead to a 1.4% increase in the GDP

• Also, with the PM WANI scheme, the digital divide between the rural and urban India would be erased, and it will bring both these worlds closer

• The internet service provided by the Government under the PM WANI scheme will be cheaper compared to the once people avail of the private 5G service providers.

Challenges surrounding the scheme: There are some concerns, mainly with respect to **security and privacy**

• A large-scale study conducted at public Wi-Fi spots in 15 airports across the United States, Germany, Australia, and India discovered that 2/3rd of users leaks private information whilst accessing the Internet.

• Data protection: Further, the TRAI report recommends that 'community interest' data be stored locally, raising questions about data protection in a scenario where the country currently does not have a data protection law in place.

Q.32)

Exp) Option b is the correct answer

Statement 1 is correct. New Space India Limited (NSIL), incorporated on 6 March 2019 (under the Companies Act, 2013) is a wholly owned Government of India company, under the administrative control of Department of Space (DOS).

Statement 2 is correct. NSIL is the commercial arm of Indian Space Research Organisation (ISRO) with the primary responsibility of enabling Indian industries to take up high technology space related activities. It is also responsible for promotion and commercial exploitation of the products and services emanating from the Indian space programme.

Statement 3 is incorrect. Building of Satellites (both Communication and Earth Observation) as per user requirements is also a mandate of NSIL.

Q.34)

Exp) Option a is the correct answer.

The splinternet is the opposite of the Internet. **The splinternet is the idea that the open, globally connected Internet we all use splinters into a collection of isolated networks controlled by governments or corporations.** These separate networks might use the same names and protocols as the global Internet, but the information one gets from each intranet is what the government or company wants one to see.

Statement 1 is incorrect: The network solution called GigaMesh wirelessly provides fibre-like backhaul capacity and paves the road for 5G. (Splinternet is altogether a different concept explained briefly in the begining). GigaMesh, developed by Astrome, supported by ARTPARK, is world's first multi-beam E-band Radio that is able to communicate from one tower to multiple towers simultaneously while delivering multi GBPS throughput to each of these towers. A single GigaMesh device can provide up to forty links with 2+ Gbps capacity, communicating up to a range of ten kilometres. This flexibility in range makes it suitable for both decongesting the dense urban networks and extending rural coverage. With India's huge population in the rural segment, Astrome can help improve domestic internet connectivity.

Statement 2 is correct: The most famous example of splinternet is China's "Great Firewall." The Golden Shield Project, often called the "great firewall of China", is an initiative managed by the Ministry of Public Security division of the Chinese government. As the nickname implies, the focus of this project is to monitor and censor what can and cannot be seen through an online network in China. This project started in 1998 and is still continually improving in restriction techniques through multiple methods.

Statement 3 is incorrect:

- **The "splinternet**," where cyberspace is controlled and regulated by different countries is no longer just a concept, **but considered as a dangerous reality by the advocates of free and open internet for all.**
- The Universal Declaration of Human Rights states that "people have the right to seek, receive, and impart information and ideas through any media and regardless of frontiers."
- Drafted in 1948, this declaration reflects the sentiment felt following World War II, when people worked to prevent authoritarian propaganda and censorship from ever taking hold the way it once did.
- **This declaration challenges the very concept of the splinternet and the undemocratic digital boundaries we see developing today.**

Q.38)
Exp) Option c is the correct answer.

Lidar is short for light detection and ranging. The technology uses near-infrared light to scan objects and create a 3D map of the environment. A lidar sensor transmits laser beams that bounce off objects and return to the sensor.

Radar stands for radio detection and ranging. Technology uses radio waves to measure the distance to objects as well as their velocity and angle. It constantly sends signals that bounce off obstacles. It compares the transmitted signal to the received signal to understand the environment.

Statement 1 is correct: The RADAR system works in much the same way as the LiDAR, with the only difference being that it uses radio waves instead of laser. However, **radio waves have less absorption compared to the light waves when contacting objects.** Thus, they can work over a relatively long distance. Unlike RADAR technology, **LiDAR pulses are adversely affected by atmospheric weather conditions** such as dense fog, smoke, and even rain. The light pulses will be distorted during flight and this will affect the accuracy of the data collected.

Statement 2 is correct: Unlike RADAR, **LiDAR data has a higher accuracy** of measurement because of its speed and short wavelength. Also, LiDAR targets specific objects which contribute to the accuracy of the data relayed. High-end LiDAR sensors can identify the details of a few centimeters at more than 100 meters.

LiDAR	RADAR
It uses laser light rays (NIR, visible) for transmission and reception medium.	It uses radio waves (microwave signals in the range of 1 cm wavelength) for transmission and reception medium
It can provide accurate surface measurements with 3D mapping	Size and the position of the object can be identified fairly using RADAR
It uses charge coupled device (CCD) optics and lasers for transmission and reception	It uses antennae for transmission and reception of the signals
Lower wavelengths allow detection of very small objects e.g., cloud particles	Target size is limited by longer wavelength
Performance degraded with bad atmospheric condition	It can operate in bad weather conditions

Knowledge Base:

The most well-known use of RADAR technology is for military purposes. Airplanes and battleships are often equipped with RADAR to measure altitude and detect other transport devices and objects in the vicinity.

The LiDAR system can readily detect objects located in the range of 30 meters to 200 meters. But, when it comes to identifying objects in the vicinity, the system is a big letdown. That's why self-driving car manufacturers such as Google often use LIDAR along with secondary sensors such as cameras and ultrasonic sensors.

The RADAR system is relatively less expensive. Cost is one of the reasons why Tesla has chosen this technology over LiDAR. However, it is less angularly accurate than LiDAR as it loses sight of the target vehicle on curves. It may get confusing if multiple objects are placed very close to each other. Unlike the LiDAR system, RADAR can determine relative traffic speed or the velocity of a moving object accurately using the Doppler frequency shift.

Q.39)

Exp) Option a is the correct answer.

Statement 1 is incorrect: The Vikram-S rocket is developed by Hyderabad-based private space-tech start-up Skyroot Aerospace. Sykroot Aerospace have become the first ever private space company in India to launch a rocket into space and will open a new avenue for India's space sector. It was Launched from Indian Space Research Organisation's (ISRO) launchpad in Sriharikota.

Statement 2 is incorrect: This rocket is part of Mission Prarambh of Sykroot Aerospace, which is aimed at carrying three payloads into space. The payloads include Andhra Pradesh-based N Space Tech India, Chennai-based start-up Space Kidz and Armenian BazoomQ Space Research Lab.

Statement 3 is correct: Vikram-S rocket is a single stage suborbital space launch vehicle. It is powered by the solid-fuelled propulsion, cutting edge avionics and all carbon fibre core structure.

On the launch pad
Hyderabad-based Skyroot's satellite launch vehicle is called Vikram and Chennai-based Agnikul's is called Agnibaan. A look at their payloads

Vikram 1	Vikram 2	Vikram 3	Agnibaan
225-315kg	410-520kg	580-720kg	100kg

Source: Skyroot Aerospace, Agnikul Cosmos

Q.46)

Exp) Option b is the correct answer.

ARTEMIS means **Acceleration, Reconnection, Turbulence and Electrodynamics of Moon's Interaction with the Sun. Mission Artemis** I is an **un-crewed mission of NASA.** It will explore lunar surface and will lay groundwork for sending astronaut to Mars. The Artemis program began in 2017. Its primary goal is to take humans to the Moon, specifically the lunar south pole, by 2025.

Statement 1 is correct: Artemis I mission will demonstrate Orion Spacecraft system in a spaceflight environment and ensure a safe re-entry, descent, splashdown, and recovery prior to the first flight with crew on Artemis II.

Statement 2 is correct: NASA's Space Launch System (SLS), is a **super heavy-lift launch vehicle** that provides the foundation for human exploration beyond Earth's orbit. Artemis I mission will test this new Space Launch System(SLS). It is the most powerful rocket ever built, generating 8.8 million pounds of thrust on lift off, making it 1.3 million pounds more powerful than the Saturn V rocket used in the Apollo missions.

Statement 3 is incorrect: Under Artemis III mission, NASA aims to land the first woman and first person of color on the Moon and establish sustainable lunar exploration.
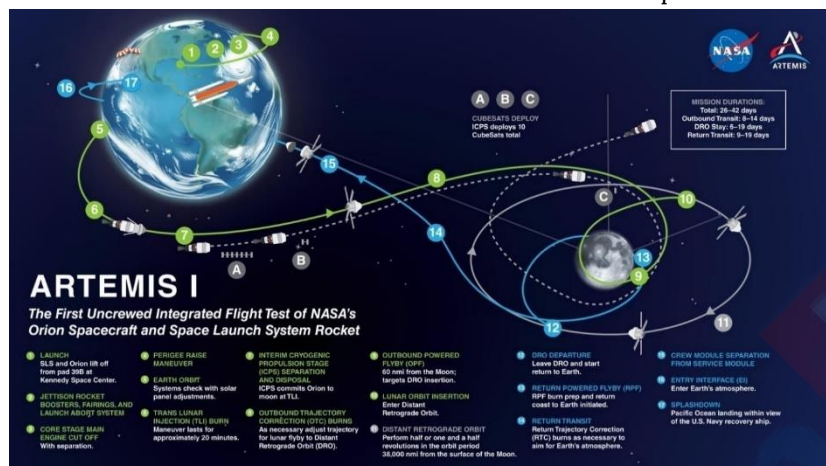
Q.47)

Exp) Option b is correct

Presently, satellites are launched into orbit by multi-staged satellite launch vehicles that can be used only once (expendable). These launch vehicles carry oxidiser along with the fuel for combustion to produce thrust.

Types of air-breathing systems:

Ramjet Engine: A ramjet is a form of air-breathing jet engine that uses the vehicle's forward motion to compress incoming air for combustion without a rotating compressor. Fuel is injected in the combustion chamber where it mixes with the hot compressed air and ignites.

A ramjet-powered vehicle requires an assisted take-off like a rocket assist to accelerate it to a speed where it begins to produce thrust.

Statement 1 is *incorrect* In a ramjet, the combustion chamber – where the air is mixed with fuel and ignited – **only works at subsonic speeds**. So the intake slows the air down, releasing some of its energy as a shock wave, but this reduces fuel efficiency.

Ramjets work most efficiently at supersonic speeds around Mach 3 (three times the speed of sound) and can operate up to speeds of Mach 6.

However, the ramjet efficiency starts to drop when the vehicle reaches hypersonic speeds.

Statement 2 is correct Scramjet Engine: A scramjet engine is an improvement over the ramjet engine as it efficiently **operates at hypersonic speeds and allows supersonic combustion**. Thus it is known as Supersonic Combustion Ramjet, or Scramjet. Supersonic airflow in a scramjet creates more reaction giving the **capability for scramjets to operate efficiently at Hypersonic speeds**

Statement 3 is correct The advantage of scramjet over rockets is that **scramjets have higher specific impulse levels** . Also ramjets have greater efficiency, but cannot operate at higher free stream Mach numbers like scramjets. **Specific impulse** is the thrust produced per unit rate of consumption of the propellant that is usually expressed in pounds of thrust per pound of propellant used per second and that is a measure of the efficiency of a rocket engine.

Knowledge Base: A propulsion system which can utilise the atmospheric oxygen during their flight will considerably reduce the total propellant required to place a satellite in orbit.

If those vehicles are made reusable, the cost of launching satellites will further come down significantly.

The basic difference between air-breathing systems and others is the material that plays the role of oxidiser. Generally, launch vehicles use combustion of propellants consisting of oxidiser and fuel for deriving the energy. Air breathing propulsion systems use atmospheric oxygen, which is available up to about 50 km of earth's surface to burn the fuel stored on-board thereby making the system much lighter, more efficient and cost effective.

Dual mode ramjet (DMRJ): It is a type of jet engine where a ramjet transforms into scramjet over Mach 4-8 range, which means it can efficiently operate both in subsonic and supersonic combustor modes.

Q.58)

Exp) Option b is the correct answer.

Near field communication (NFC), Radio-frequency identification (RFID) and Bluetooth Low Energy (BLE) are modern communication technologies that allow one to automatically identify objects or people and due to their different operating characteristics, complete each other.

Statement 1 is correct. RFID stands for 'Radio-frequency identification' where digital data is encoded in RFID tags or smart labels which is captured by a reader. It is similar to barcoding where data from a tag is captured by a device. The disadvantage with methods like a bar-code is that it needs to be in the line of sight to be read whereas RFID tags need not be in line of sight.
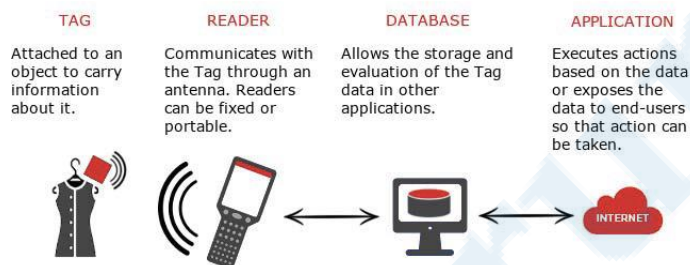

Creative Commons Graphic by SkyRFID

Statement 2 is incorrect. Near field communication (NFC) is the set of protocols that enables electronic devices to establish radio communication with each other by touching the devices together or bringing them into proximity to a distance of typically 10cm or less. It works by the principle of induction.

NFC is also based on the RFID protocols. The main difference to RFID is that an NFC device can act not only as a reader, but also as a tag (not the other way round). In peer-to-peer mode, it is also possible to transfer information between two NFC devices.
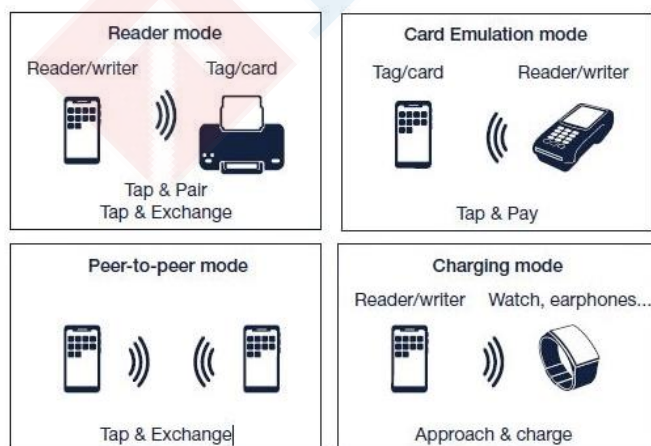
Statement 3 is correct. Bluetooth Low Energy is for specific use cases with limited data transfer and requires significantly less energy than classic Bluetooth—hence the name Low Energy. The hidden difference is that Bluetooth Low Energy remains in sleep mode unless a connection initiates. The actual connection times only last a few milliseconds, unlike Bluetooth, which connects for a few seconds or a few hours at a time. These short connections are necessary because data rates are significantly higher (1 Mb per second). It is radio technology that allows devices to be networked within a distance of about 10 meters. BLE is not voice compatible.
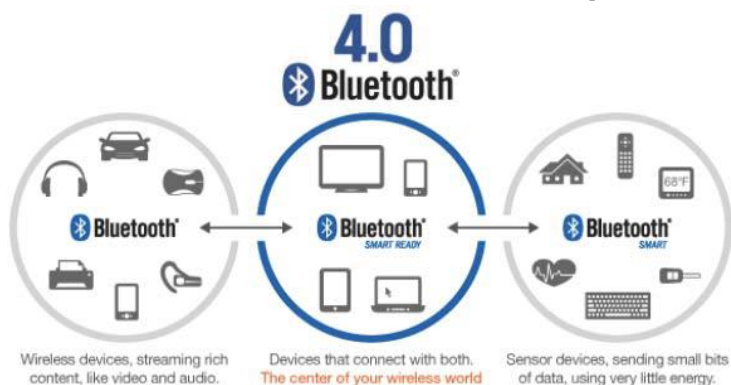
Q.60)

Exp) Option a is correct.

This question is based on the article **"Mapping of 6 lakh villages under the SVAMITVA scheme and pan-India 3D Maps for 100 cities undertaken, which will be a game changer for India"** published in **PIB** on **15th Feb 2022.** On the 1st Anniversary of the Release of Geospatial Data, the union minister has said that the SVAMITVA scheme with the help of drones will survey all the over 6 lakh Indian villages. At the same time, Pan India 3D Maps Program will prepare 3D Maps for 100 Indian cities.

Statement 1 is incorrect: **Pan India 3D Maps Program** was launched by **private technology firm Genesys International.** Whereas it is **SWAMITVA is a Central Sector** Scheme is implemented with the collaborative efforts of the Ministry of Panchayati Raj, State Revenue Department, State Panchayati Raj Department and Survey of India.

Statement 2 is correct: **Pan India 3D Maps Program** will create **pan-India 3D maps** for 100 Indian cities. These 3D maps would depict reality as it is. The maps will be available in a **freemium model** which will be partly free and partly paid.

Statement 3 is incorrect: **Pan India 3D Maps Program** would benefit a huge number of start-ups, private enterprises as the 3D maps will unlock the potential of augmented reality and new areas of growth.

SWAMITVA scheme aims to provide clear **ownership of property in rural inhabited** (Abadi) areas by mapping of land parcels using drone technology and providing 'Record of Rights' to village household owners with issuance of legal ownership cards (Property cards/Title deeds) to the property owners.