

Q.1) Microsatellite DNA' is used in the case of which one of the following?

- a) Studying evolutionary relationships among various species of fauna.
- b) Stimulating stem cells transform into diverse functional tissues.
- c) Promoting clonal propagation of horticultural plant.
- d) Assessing the efficacy of drugs by conducting series of drug trials in a population.

Ans) a

Exp) Option a is the correct answer.

Microsatellite DNA, also known as short tandem repeats (STRs), is a type of genetic marker that consists of repeating sequences of DNA. It is commonly used in genetic studies, including population genetics and phylogenetic analysis, to study relationships among different species of fauna.

Microsatellites are highly polymorphic and vary in length due to differences in the number of repeat units. By analysing the variations in microsatellite DNA sequences among individuals or populations, researchers can assess genetic diversity, population structure, and evolutionary relationships within and between species.

Source: UPSC CSE Pre 2023

Subject:) Science and Technology

Subtopic:) Biotechnology

Q.2) Which one of the following is **incorrect** regarding the difference between ballistic missiles and cruise missiles?

- a) Ballistic Missiles leave the earth's atmosphere and re-enter it while the Cruise Missiles' flight path is within the earth's atmosphere.
- b) While Cruise missiles can be launched from aircraft, ships, and submarines, ballistic missiles can be launched only from aircraft.
- c) Compared to ballistic missiles, the payload capacity is much limited in case of Cruise missiles.
- d) While Brahmos missile is a type of cruise missile, Agni II is a type of ballistic missile.

Ans) b

Exp) Option b is the correct answer.

Ballistic and cruise missiles are advanced weapons designed to deliver warheads over long distances. Ballistic missiles are launched into the upper atmosphere and then re-enter the Earth's atmosphere to strike the target. Cruise missiles, on the other hand, are designed for sustained flight within the Earth's atmosphere.

Statement a is correct: Cruise Missile fly within the earth's atmosphere and use jet engine technology. Ballistic missile's path has three phases:

- 1) **Boost phase: The missile uses thrust to reach its target's velocity.**
- 2) **Midcourse phase: The missile continues to ascend towards its highest point in its trajectory. This is the longest phase of flight, where the missile coasts in a ballistic arc under the influence of gravity.**
- 3) **Terminal phase: The missile re-enters the Earth's atmosphere**

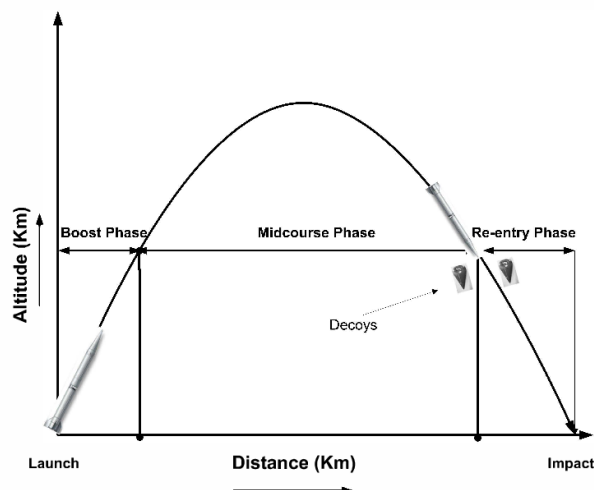


Fig. 1- Ballistic missile trajectory with three phases

Statement b is incorrect: Both cruise missiles and ballistic missiles can be launched from aircraft, ships, and submarines in addition to land-based silos and mobile platforms.

Statement c is correct: Payload capacity is limited in Cruise missiles. Cruise missile usually carries a single payload while Ballistic missiles can carry more than one payload (Multiple Independently targetable Re-entry Vehicle).

Statement d is correct: BrahMos is a universal long range supersonic cruise missile system. It is a collaboration between India (Defense Research and Development Organization (DRDO)) and Russia (NPO Mashinostroyeniya). Agni-II is a medium-range ballistic missile (MRBM) able to reach targets up to 2,000km away, and it has already been inducted into the Indian strategic arsenal.

Source: <https://armscontrolcenter.org/wp-content/uploads/2017/04/Ballistic-vs.-Cruise-Missiles-Fact-Sheet.pdf>

Subject:) Science and Technology

Subtopic:) Defence

Q.3) Consider the following statements regarding 'Quantum dots':

1. They are nanometer sized semiconducting crystals having properties of quantum size effects.
2. They have the same structure and atomic composition as conventional semiconductor materials.
3. They are free from any kind of harmful heavy metals, making them more environmentally sustainable.

How many of the statements given above are correct?

- a) Only one
- b) Only two
- c) All three
- d) None

Ans) b

Exp) Option b is the correct answer.

Recently, the 2023 Nobel Prize in chemistry was awarded to Moungi G. Bawendi, Louis E. Brus and Alexei I. Ekimov for the discovery and synthesis of quantum dots.

Statement 1 is correct: Quantum dots are nanometer-sized semiconductor crystals, the properties of which are determined by quantum size effects (property of showing very different results for small particles compared to bulk metals).

Statement 2 is correct: Quantum dots have the same structure and atomic composition as bulk semiconductor materials, but their properties can be tuned using a single parameter, the particle's size.

Statement 3 is incorrect: Quantum dots contain toxic heavy metals such as Cadmium selenide (CdSe), Zinc oxide (ZnO), silica etc. Additionally, the production and disposal of even non-metal-containing quantum dots can carry environmental risks due to their nano-scale nature.

Source: <https://www.thehindu.com/sci-tech/science/2023-nobel-prize-chemistry/article67377618.ece>

<https://www.nobelprize.org/uploads/2023/10/advanced-chemistryprize2023-3.pdf>

Subject:) Science and Technology

Subtopic:) Nanotechnology

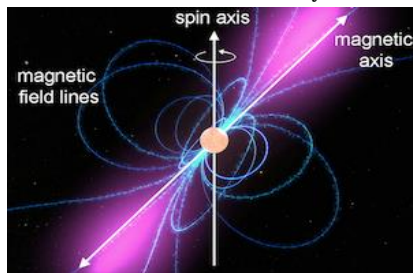
Q.4) Which one of the following is correct regarding the astronomical phenomenon "Pulsars"?

- a) They are rapidly rotating stars that emit beams of electromagnetic radiation.
- b) They are remnants of massive stars that have merged to form black holes.
- c) They are luminous and hot celestial bodies, larger than typical stars.
- d) They are stars with less than five solar masses and have low luminosity.

Ans) a

Exp) Option a is the correct answer.

When a massive star exhausts its fuel and collapses, neutron stars emerge. The star's core undergoes an intense collapse, crushing together every proton and electron into a neutron. The collapse leads to the formation of extremely dense objects known as neutron stars, specifically pulsars.



Option a is correct: Pulsars are spinning neutron stars that exhibit periodic bursts of electromagnetic radiation in the form of beams that sweep through space at regular intervals, like cosmic lighthouses. These stars possess exceptionally potent magnetic fields that channel streams of particles outward along two magnetic poles. These accelerated particles generate immensely intense beams of light. Frequently, the star's magnetic field doesn't align precisely with its spin axis, causing the beams of particles and light to sweep around as the star rotates. As this beam intersects with our viewpoint, we perceive a pulsating effect—essentially witnessing pulsars flicker on and off as their beams traverse across Earth.

Option b is incorrect: Pulsar formation occurs through the explosion of supernovae, not the merging of stars to create black holes. When the collapsing star's core falls within the range of approximately 1 to 3 solar masses, newly formed neutrons can halt the collapse, resulting in the formation of a neutron star. Stars with greater masses will proceed to collapse, forming stellar-mass black holes.

Option c is incorrect: Pulsars are incredibly dense and compact, much smaller than typical stars. They are extremely dense stars composed almost entirely of neutrons and have a diameter of only 20 km (12 miles) or less.

Option d is incorrect: A dwarf star not Pulsars, is a star that is relatively small in size and has low luminosity. Dwarf stars, which includes all stars with masses less than five solar masses.

Source: https://imagine.gsfc.nasa.gov/science/objects/neutron_stars1.html

<https://solarsystem.nasa.gov/genesmission/gm2/mission/pdf/Dwarfstars.pdf>

Subject:) Science and Technology

Subtopic:) Space

Q.5) Consider the following statements regarding the 'Recombinant DNA technology':

1. It involves the artificial manipulation of DNA by combining genetic material from different species.
2. It can be used to treat diseases in humans without causing any adverse immune reactions.
3. It cannot be used to create genetically identical organisms.

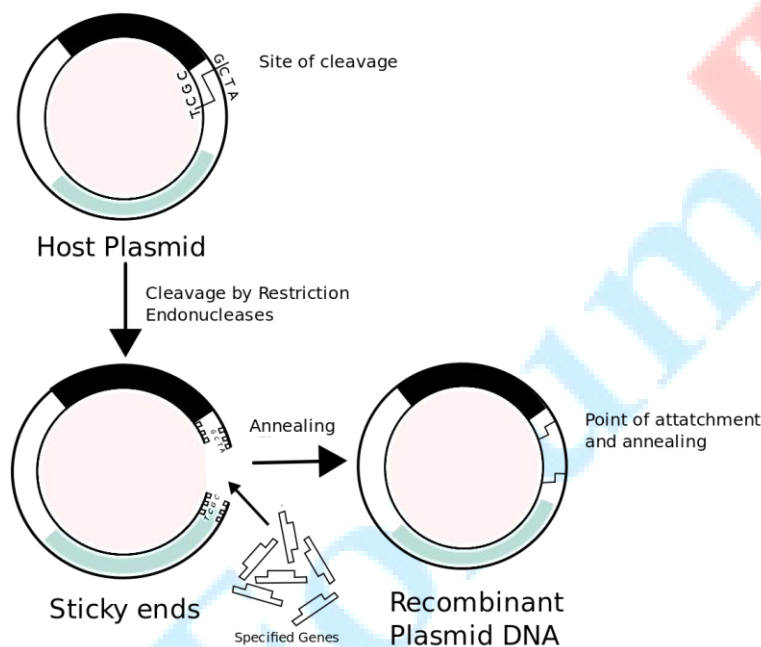
How many of the statements given above are correct?

- a) Only one
- b) Only two
- c) All three
- d) None

Ans) a

Exp) Option a is the correct answer.

Recombinant DNA technology has contributed to health care in two important ways: production of pharmaceutically important proteins (biopharmaceuticals) and gene therapy for replacement of defective genes.



Statement 1 is correct: Recombinant DNA technology involves using enzymes and various laboratory techniques to manipulate and isolate DNA segments of interest. This method can be used to combine (or splice) DNA from different species or to create genes with new functions. The resulting copies are often referred to as recombinant DNA. Examples include engineering crops with pest resistance, creating livestock with increased milk production, or developing microorganisms with enhanced properties for environmental cleanup.

Statement 2 is incorrect: While recombinant DNA technology holds great potential for developing gene therapy treatments for various diseases, the assertion that **it never causes any adverse immune reactions is incorrect**. Introducing foreign DNA into human cells can sometimes trigger an immune response, depending on factors like the specific gene used, delivery method, and individual differences.

Statement 3 is incorrect: Recombinant DNA technology plays a crucial role in producing **genetically identical organisms, like clones**. Gene cloning utilizes DNA sequences from two distinct organisms: the source species providing the DNA to be cloned and the species serving as the living host for replicating the recombinant DNA.

Recombinant DNA technology aids the process of isolating desired genes, inserting them into a genetic carrier (e.g., plasmid), and placing it in host organisms for the replication of these genes.

Source: <https://www.sciencedirect.com/topics/immunology-and-microbiology/recombinant-dna-technology#:~:text=%E2%80%A2-,Allergenicity,-/adverse%20immune%20reactions>

Subject:) Science and Technology

Subtopic:) Biotechnology

Q.6) The concept of Swarm drone operation envisages integrating and flying a large number of Unmanned Aerial Vehicles (UAVs) to achieve a specific goal. In this context, consider the following statements regarding 'Swarm drones':

1. In this system, the failure of individual drones leads to the collapse of the whole system.
2. In this system, drones distribute and coordinate tasks among themselves with little to no human intervention.
3. This system is immune from hacking threats as drones operate collectively.

How many of the statements given above are correct?

- a) Only one
- b) Only two
- c) All three
- d) None

Ans) a

Exp) Option a is the correct answer.

Swarm drones refer to a collective of drones operating together under a decentralized control system. They mimic the behavior of swarms in nature, where numerous entities work collaboratively to achieve a common goal.

Statement 1 is incorrect: Swarm drones' key feature is decentralized control. **Individual drone failures in a swarm do not necessarily collapse the entire system.** The remaining drones can adapt and continue the mission.

Statement 2 is correct: **Swarm drones' decentralized nature enhances their resilience;** they have the potential to distribute tasks and coordinate operation of many UAVs with little to no human intervention. Even if one drone faces issues, the others communicate and adjust behavior to overcome obstacles, ensuring task continuity and efficient completion.

Statement 3 is incorrect: **Swarm drones are susceptible to hacking threats.** While their distributed nature may offer some advantages in terms of resilience, **hackers can redirect a drone swarm for malicious purposes** by exploiting the vulnerabilities in communication protocols or individual drones.

Source: <https://cdnsiencepub.com/doi/10.1139/juvs-2018-0009#:~:text=many%20UAVs%20with-,little,-to%20no%20operator>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6806085/#:~:text=members%20of%20the-,swarm,-.%20In%20particular%2C%20multiple>

Subject:) Science and Technology

Subtopic:) Defence

Q.7) Planet X orbits its Star. Interestingly, one side of the planet perpetually faces the scorching heat of its star, while the other side remains shrouded in eternal darkness. Scientists attribute this unique situation to the gravitational influence of the star on the planet.

Which of the following phenomena is referred to in the above passage?

- a) Gravitational slingshot
- b) Axial tilt
- c) Tidal locking
- d) Orbital Eccentricity

Ans) c

Exp) Option c is the correct answer.

Option a is incorrect: Gravitational slingshot, also known as a gravity assist, involves using the gravitational pull of a celestial body, like a planet or moon, to alter the trajectory and speed of a spacecraft. By flying close to a massive body, the spacecraft gains or loses momentum, allowing it to speed up or slow down without expending extra fuel.

Option b is incorrect: Axial tilt refers to the angle between a planet's rotational axis and its orbital plane around the star. This tilt is responsible for creating seasons on planets. When a planet's axis is tilted, different parts of the planet receive varying amounts of sunlight during different times of the year, leading to seasonal changes in the planet.

Option c is correct: Tidal locking is a phenomenon that occurs when the gravitational forces between two objects cause the smaller body to rotate in sync with its orbit around the larger body. This phenomenon, alternatively termed synchronous rotation, gravitational locking, or spin-orbit locking, naturally takes place when a body's rotational period aligns with its orbital period around another celestial entity.

This phenomenon results in a scenario where one side of the planet experiences perpetual daylight and elevated temperatures, while the other side remains shrouded in perpetual darkness.

Option d is incorrect: Orbital eccentricity refers to the measure of how much an orbit deviates from a perfect circle. An eccentricity of 0 signifies a perfectly circular orbit, while values closer to 1 indicate highly elongated or elliptical orbits. Orbits with higher eccentricities have more variation in distance between celestial bodies, resulting in greater differences in temperature and gravitational forces throughout the orbit.

Source: <https://moon.nasa.gov/moon-in-motion/earth-and-tides/tidal-locking/>

Subject:) Science and Technology

Subtopic:) Space

Q.8) Consider the following about the 'Scramjet engines':

1. They use atmospheric oxygen for fuel combustion.
2. They offer higher specific impulse and fuel efficiency compared to traditional rocket engines.
3. They operate efficiently at hypersonic speed.

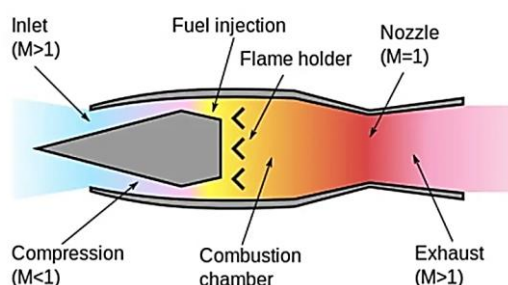
How many of the above statements are correct?

- a) Only one
- b) Only two
- c) All three
- d) None

Ans) c

Exp) Option c is the correct answer.

A Supersonic Combustion Ramjet (**Scramjet**) engine is an advanced air-breathing jet engine designed to operate at extremely high speeds, typically in the hypersonic range, above Mach 5 (five times the speed of sound) and higher. Scramjets do not have rotating compressors, instead they rely on the forward motion of the aircraft to compress incoming air.



Statement 1 is correct: Scramjet engines use oxygen from the atmosphere for combustion of hydrogen fuel, which means they rely on atmospheric oxygen as the oxidizer. This distinguishes them from traditional rocket engines, which do not use oxygen from the atmosphere for combustion of fuels.

Statement 2 is correct: Compared to traditional rocket engines, Scramjets offer higher fuel efficiency due to their higher specific impulse (thrust per unit of propellant) at hypersonic speeds.

Statement 3 is correct: The Scramjet, short for Supersonic Combustion Ramjet, represents an advancement over the ramjet engine, demonstrating **efficient performance at hypersonic speed** and facilitating supersonic combustion.

A ramjet functions as an air-breathing jet engine, utilizing the vehicle's forward movement to compress incoming air for combustion, all without the need for a rotating compressor. **Optimal efficiency for ramjets is achieved at supersonic speeds**, typically around Mach 3 (three times the speed of sound), and they can operate effectively up to speeds of Mach 6.

Source: <https://www.isro.gov.in/ScramjetEngineTechnology.html>

Subject:) Science and Technology

Subtopic:) Space

Q.9) Consider the following:

1. Higher yield
2. Higher nutritional value
3. Lesser vulnerability to pests
4. Exhibiting higher drought resistance
5. Promoting genetic diversity

How many of the above are the likely advantages of Genetically Modified (GM) Crops over traditional crops?

- a) Only two
- b) Only three
- c) Only four
- d) All five

Ans) c

Exp) Option c is the correct answer.

Genetically modified (GM) crops undergo **DNA modification** through **genetic engineering** to introduce **non-naturally occurring traits**. This process involves incorporating foreign genes from plants, animals, or soil bacteria into seeds for specific effects. Globally, widespread GM variants include crops like **maize, canola, and soybean**.

Option 1 is correct: GM crops are engineered to have enhanced growth and development, which can lead to **faster maturity, higher yields and higher levels of essential nutrients, such as vitamins and minerals**.

Option 2 is correct: **Genetically modified (GM) crops** may exhibit superior nutritional content compared to their traditional counterparts. A notable example is "**Golden Rice**," which is enriched with higher levels of **beta-carotene, a precursor to vitamin A**. Additionally, other nutritionally enhanced GM crops encompass **gluten-free wheat varieties** and **vegetables with increased vitamin-E content compared to traditional varieties**.

Option 3 is correct- Certain genetically modified (GM) crops exhibit resistance to specific insects and plant viruses, often referred to as **Bt crops** due to the incorporation of genes from the bacterial species **Bacillus thuringiensis**. Additionally, GM crops can possess tolerance to particular herbicides employed for **weed control**. The cultivation of herbicide-tolerant GM crops has resulted in an uptick in herbicide application, while GM crops producing insecticides have contributed to a reduction in insecticide use. Thus, GM crops have been altered to be **less vulnerable to insects and other pests**.

Option 4 is correct- In comparison to traditional crops, **genetically modified (GM) crops** are plants that display increased tolerance to **abiotic stresses such as cold, drought, salt, and heat**. Thus, they **exhibit higher drought resistance**.

Option 5 is incorrect- The production of GM crops imposes **high risks to the disruption of biodiversity**. Genetic modification can **decrease genetic diversity** within a species, as it involves the selective breeding of a small number of individuals with desired traits. This can lead to a loss of genetic variation and a decrease in the overall resilience of a population.

Source: <https://ncert.nic.in/ncerts/l/lebo112.pdf>

Subject:) Science and Technology

Subtopic:) Biotechnology

Q.10) With reference to the Nuclear Power Reactors and their locations in India, consider the following pairs:

Nuclear Power Location

Reactor

- | | |
|-------------|-------------|
| 1. Kakrapar | Karnataka |
| 2. Kaiga | Rajasthan |
| 3. Narora | Gujarat |
| 4. Tarapur | Maharashtra |

How many of the above pairs are correctly matched?

- a) Only one
- b) Only two
- c) Only three
- d) All four

Ans) a

Exp) Option a is the correct answer.

Constituting the **fifth-largest electricity source for India**, nuclear energy contributes approximately **3% to the country's total power generation**. With more than 22 nuclear reactors distributed among 7 power plants nationwide, the nuclear facilities collectively generate **6780 MW of power**.

Pair 1 is incorrectly matched- **Kakrapar nuclear reactor** is located in **Gujarat**, and **not Karnataka**. Situated in the state of Gujarat, India, the Kakrapar Atomic Power Station is a nuclear facility located in close proximity to **Mandvi, Surat, and the Tapi River**. It has an operational capacity of **1840 MW**.

Pair 2 is incorrectly matched- **Kaiga Nuclear reactor** is located in **Karnataka**, and not Rajasthan. Located near the **Kali River in the Uttara Kannada district of Karnataka, India**, the Kaiga Generating Station is a nuclear power facility. The plant is managed by the **Nuclear Power Corporation of India** with a current operational capacity of **880 MW**.

Pair 3 is incorrectly matched- The **Narora Atomic Power Station (NAPS)** is a nuclear power facility situated in **Narora, Dibal Tehsil, Bulandshahar District, Uttar Pradesh, India**. The plant has a current operational capacity of **440 MW**.

Pair 4 is correctly matched- The **Tarapur Atomic Power Station (T.A.P.S.)** is situated in **Tarapur, Maharashtra, India**, and holds the distinction of being the **first commercial nuclear power station** constructed in the country. The Plant has a current operational capacity of **1400 MW**.

Source: <https://pib.gov.in/PressReleasePage.aspx?PRID=1809285>

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<https://ncert.nic.in/textbook/pdf/jesc114.pdf>

Subject:) Science and Technology

Subtopic:) Nuclear

Q.11) With reference to communication technologies, what is/are the difference/differences between LTE (Long-Term Evolution) and VoLTE (Voice over Long-Term Evolution)?

1. LTE is commonly marketed as 3G, and VoLTE is commonly marketed as advanced 3G.
2. LTE is data-only technology and VoLTE is voice-only technology.

Select the correct answer using the code given below:

- a) 1 only
- b) 2 only
- c) Both 1 and 2
- d) Neither 1 nor 2

Ans) d

Exp) Option d is the correct answer.

LTE stands for Long Term Evolution, and it is a standard for high-speed data communication. VoLTE stands for Voice over Long Term Evolution, and it is a technology that enables voice calls over LTE networks.

Statement 1 is incorrect: LTE (Long-Term Evolution) is marketed as 4G (fourth-generation technology), not 3G. VoLTE is an enhancement of LTE that allows for high-quality voice calls over the LTE network.

Statement 2 is incorrect: LTE is a data-only technology, while VoLTE supports both voice and data simultaneously.

Knowledge Base:

Some of the differences between LTE and VoLTE are:

- 1) LTE is a data-only technology, while VoLTE supports both voice and data simultaneously.
- 2) LTE may turn off the data connection while making voice calls, while VoLTE does not turn off the data connection while making voice calls.
- 3) LTE may require external applications to make video calls, while VoLTE does not require any external applications to make video calls.

Source: UPSC CSE Pre 2019

Subject:) Science and Technology

Subtopic:) IT and Telecom

Q.12) With reference to the Impact of the Coronal Mass Ejection (CME) on earth and its surroundings, consider the following statements:

1. It may impact navigation service providers like Google Maps.
2. It may impact earth-orbiting satellites in geosynchronous orbits.
3. It may cause widespread blackouts due to the surge in electrical currents at power grids.
4. Astronauts can be exposed to lethal doses of radiation emitted during the CME.

How many of the above statements are correct?

- a) Only one
- b) Only two
- c) Only three
- d) All four

Ans) d

Exp) Option d is the correct answer.

Coronal Mass Ejections (CMEs) are huge expulsions of plasma and magnetic fields from the Sun's corona that release billions of Tonnes of material. CMEs, which contain a magnetic field stronger than the solar wind's background intensity, go outward at speeds ranging from less than 250 km/s to approximately 3000 km/s. The quickest Earth-directed CMEs can reach us in 15 to 18 hours, whereas

slower ones may take several days. Larger CMEs grow in size as they migrate away from the Sun, eventually covering about a fifth of the distance between Earth and the Sun.

Statement 1 is correct- GPS systems are **susceptible to disruptions in the ionosphere**, leading to potential deviations in GPS coordinates by **several feet during a CME event**. This disturbance arises because **GPS relies on radio signals for communication** between **satellites and ground receivers**. During a CME event, **severe disruptions in the ionosphere can occur**, overwhelming GPS models, causing receivers to lose track of these changes and rendering them unable to calculate an accurate position.

Statement 2 is correct- Earth-orbiting satellites are vulnerable to CMEs, particularly those in high geosynchronous orbits – which is where most communications satellites are found. When a CME triggers a geomagnetic storm, satellites can be struck by a high current discharged into the satellite or damaged when high-energy particles penetrate the satellite.

Statement 3 is correct- Strong CMEs can induce **strong currents in long power lines, overloading transformers and causing widespread blackouts**. This risk is higher for longer grids and older infrastructure.

Statement 4 is correct- In **low-Earth orbit**, astronauts **receive higher radiation doses than on Earth**, yet they are **mostly shielded by the magnetosphere**. However, the real danger arises when astronauts venture beyond the safety of the magnetosphere, such as **exploring the moon or Mars**. In these scenarios, they become vulnerable to space weather events like **CMEs**. In scenario of an event like CME, astronauts are exposed to **lethal doses of radiation** which can prove **fatal** to them.

Source: <https://www.livescience.com/what-are-coronal-mass-ejections>

<https://www.space.com/coronal-mass-ejections-cme>

Subject:) Science and Technology

Subtopic:) Space

Q.13) With reference to the Chimeric Antigen Receptor (CAR) T-cell therapy, consider the following statements:

1. A patient's own cells cannot be used in the CAR T-cell therapy.
2. This therapy can be used to treat patients suffering from leukemia or lymphomas.

Which of the statements given above is/are correct?

- a) 1 only
- b) 2 only
- c) Both 1 and 2
- d) Neither 1 nor 2

Ans) b

Exp) Option b is the correct answer.

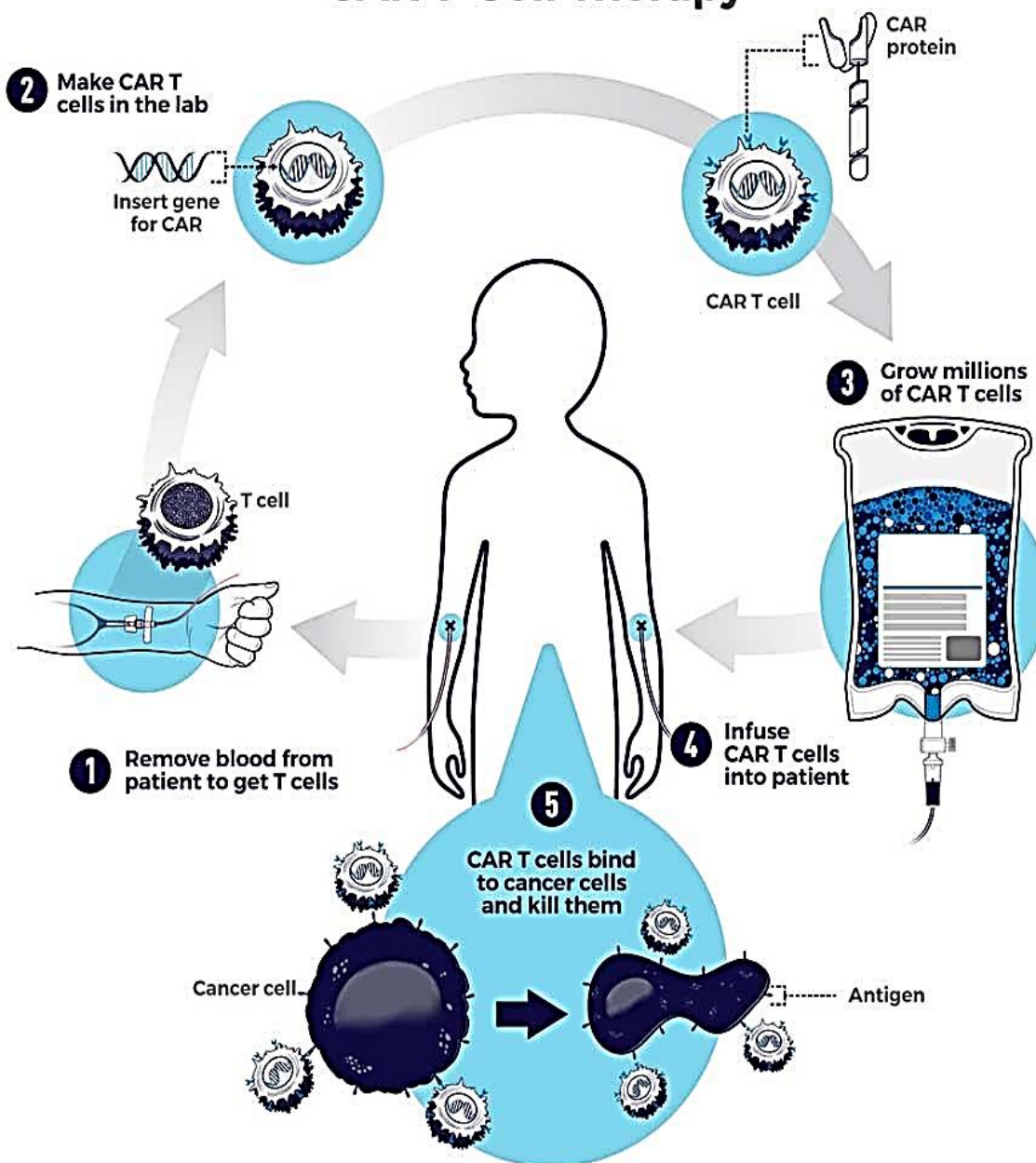
Chimeric antigen receptor (CAR) T-cell therapy is an approach which involves employing genetically **modified cells to attach to and eliminate cancer cells**. CAR-T cells can persist in the body for **months post-infusion**, potentially aiding in **preventing cancer recurrence**. This therapeutic technique has resulted in prolonged remissions for certain blood cancers.

Statement 1 is incorrect- Unlike chemotherapy or immunotherapy which involves the use of drugs, **CAR T-cell therapies use a patient's own cells**. They are modified in the laboratory to activate T-cells and target tumor cells.

In **CAR T-cell therapy**, the **T-cells** are **extracted** from the **patient's blood**, **genetically engineered** to express **chimeric antigen receptors (CARs)** that **target specific cancer cells**, and then **infused back** into the patient's body to **attack the cancer**. **T cells, or T lymphocytes**, are crucial **white blood cells** integral to the **immune response**. They participate in cell-mediated immunity, aiding the body in recognizing and responding to foreign substances like viruses, bacteria, and abnormal cells such as cancer cells.

Statement 2 is correct- CAR T-cell therapy has received approval for the treatment of **leukemias** (cancers originating from cells that produce white blood cells) and **lymphomas** (cancers arising from the lymphatic system).

CAR T-Cell Therapy



CAR T-cell therapy is a type of treatment in which a patient's T cells are genetically engineered in the laboratory so they will bind to specific proteins (antigens) on cancer cells and kill them. (1) A patient's T cells are removed from their blood. Then, (2) the gene for a special receptor called a chimeric antigen receptor (CAR) is inserted into the T cells in the laboratory. The gene encodes the engineered CAR protein that is expressed on the surface of the patient's T cells, creating a CAR T cell. (3) Millions of CAR T cells are grown in the laboratory. (4) They are then given to the patient by intravenous infusion. (5) The CAR T cells bind to antigens on the cancer cells and kill them.

cancer.gov

Source: <https://www.cancer.gov/about-cancer/treatment/research/car-t-cells>

Subject: Science and Technology

Subtopic: Biotechnology

Q.14) In the context of cyber security threats, which of the following best denotes the term 'Smishing'?

- a) Installing the malware in the host's mobile to steal confidential information through email.
- b) Installing the malware in the host's mobile to steal confidential information through the local Wi-Fi network.
- c) Installing the malware in the host's mobile devices to steal confidential information through Bluetooth.
- d) Installing the malware in the host's mobile device to steal confidential information through SMS.

Ans) d

Exp) Option d is the correct answer.

Smishing, a blend of "SMS" and "phishing," is a cyber-attack targeting **mobile devices** through **text messages**. It can be a seemingly harmless text from a **bank, a delivery service, or even a friend**, but with a hidden hook – a **malicious link or embedded malware**. Clicking on the link or downloading the attachment can compromise the host's phone and potentially steal their **personal information, and financial data, or even control their device**.

Knowledge Base:

- 1) **Vishing** gains access to your personal information, but this method uses a phone call or voicemail to prompt users to expose private information.
- 2) **Phishing** is one of the most common forms of fraud, where scammers use a seemingly real email address with a link that urges you to input information like your full name, social security number, and credit card number.

Source: <https://timesofindia.indiatimes.com/education/upskill/most-common-cyber-security-threats-in-2023/articleshow/101578195.cms>

Subject:) Science and Technology

Subtopic:) IT and Telecom

Q.15) With reference to polyethylene terephthalate, the use of which is so widespread in our daily lives, consider the following statements:

- 1. Its fibers can be blended with wool and cotton fibers to reinforce their properties.
- 2. Containers made of it can be used to store any alcoholic beverage.
- 3. Bottles made of it can be recycled into other products.
- 4. Articles made of it can be easily disposed of by incineration without causing greenhouse gas emissions.

Which of the statements given above are correct?

- a) 1 and 3 only
- b) 2 and 4 only
- c) 1 and 4 only
- d) 2 and 3 only

Ans) a

Exp) Option a is the correct answer.

Polyethylene terephthalate (or PET) is the most common thermoplastic polymer resin of the polyester family and is used in fibers for clothing, containers for liquids and foods, and thermoforming for manufacturing. PET is commonly recycled and has the digit 1 as its resin identification code (RIC).

Statement 1 is correct: PET fibers can be blended with wool and cotton fibers to reinforce their properties. For example, Terylene is a trademark name for a polyester fiber that is made from PET and blended with cotton or wool.

Statement 2 is incorrect: Containers made of PET cannot be used to store any alcoholic beverage, as PET is not resistant to ethanol and can degrade over time. PET bottles are mainly used for water, soft drinks, juices, and edible oils.

Statement 3 is correct: Bottles made of PET can be recycled into other products, such as fibres, carpets, clothing, furniture, and engineering plastics. PET recycling is a well-established industry that reduces waste and saves energy and resources.

Statement 4 is incorrect: Articles made of PET cannot be easily disposed of by incineration without causing greenhouse gas emissions, as PET combustion produces carbon dioxide and water vapour. Incineration of PET also poses a risk of releasing toxic substances such as dioxins and furans.

Source: UPSC CSE Pre 2022

Subject: Science and Technology

Subtopic: Plastics

Q.16) 'Bletchley Declaration' is, sometimes, talked about with reference to which one of the following?

- a) A declaration aimed at fostering collaboration among nations in formulating laws on Intellectual property.
- b) A declaration seeking to align and facilitate worldwide collaboration on the safety of artificial intelligence (AI).
- c) A declaration fostering collaboration among nations to reduce illegal uses of cryptocurrency.
- d) A declaration fostering cooperation and collaboration among nations to address the issues of space debris.

Ans) b

Exp) Option b is the correct answer.

The **Bletchley Declaration**, released in **November 2023**, stands as a **significant international accord** endorsed by **28 countries and the European Union**. It is centered on formulating principles and frameworks to ensure the responsible and **secure development and utilization of artificial intelligence (AI)**. Key components include a **shared recognition of the risks and opportunities associated with AI**, with a commitment to international collaboration in addressing potential drawbacks. The declaration also highlights the importance of **joint efforts in AI safety research**, underscoring the necessity for global cooperation to develop safeguards against issues such as bias, misuse, and unintended consequences in AI systems.

Source: <https://indianexpress.com/article/explained/explained-sci-tech/delhi-declaration-gpai-regulation-ai-explained-9067865/>

Subject: Science and Technology

Subtopic: fibers

Q.17) With reference to the RNA interference (RNAi) technology, consider the following statements:

- 1. The technology silences genes by triggering the destruction of targeted mRNA via double-stranded RNA-guided machinery.
- 2. The technology can protect the roots of tobacco plants from the attack of nematode *Meloidogyne incognita*.

Which of the above statements is/are correct?

- a) 1 only
- b) 2 only
- c) Both 1 and 2
- d) Neither 1 nor 2

Ans) c

Exp) Option c is the correct answer.

RNA interference (RNAi) is a natural mechanism in almost all cells discovered by **Andrew Fire and Craig Mello in 2006**. It works at the **RNA level**, **silencing genes** by targeting the **organism's mRNA** and **disrupting protein synthesis**. RNAi serves as a form of **gene regulation and defense against external RNA**. Additionally, it is used in genetic engineering to **artificially suppress** specific genes, playing a crucial role in various applications like **studying gene function, cancer therapy, controlling viral infections, and advancements in agricultural biotechnology**.

Statement 1 is correct- By introducing **double-stranded RNA molecules** complementary to a specific mRNA sequence, a cellular complex called **RISC** is activated. This complex guides the **destruction of the targeted mRNA**, effectively **silencing the corresponding gene**.

Statement 2 is correct- Researchers have successfully used RNAi to target genes essential for the **nematode *Meloidogyne incognita*'s development and survival**, protecting **tobacco plants** from their parasitic effects. This demonstrates the potential of RNAi for pest and disease control in agriculture.

Source: <https://ncert.nic.in/ncerts/l/lebo112.pdf>

Subject:) Science and Technology

Subtopic:) Biotechnology

Q.18) With reference to the Aditya-L1, a space mission of India, which of the following statements is **incorrect**?

- a) This mission is aimed at studying the Solar upper atmospheric (chromosphere and corona) dynamics.
- b) This mission involved the use of GSLV-Mark III rocket to travel directly towards sun.
- c) The satellite is positioned in a halo orbit around the L1 Lagrange point to provide an unobstructed view of the Sun without any eclipses.
- d) This mission represents ISRO's second astronomy observatory-class mission, following AstroSat in 2015.

Ans) b

Exp) Option b is the correct answer.

The **Aditya-L1 mission** was launched using the **PSLV-C57 rocket**, and notably, the **PSLV's fourth stage was fired twice—a historic first for ISRO—to accurately position the spacecraft into its elliptical orbit**. India utilizes both the **Polar Satellite Launch Vehicle (PSLV)** and the **Geosynchronous Satellite Launch Vehicle (GSLV)** for deploying satellites into space. The PSLV is employed to launch satellites for **remote sensing and earth observation into low Earth orbits**. In contrast, the **GSLV** is utilized for deploying **substantial communication satellites into Geosynchronous Transfer Orbit (GTO)**.

Knowledge Base:

The major science objectives of Aditya-L1 mission are:

- 1) Study of Solar upper atmospheric (chromosphere and corona) dynamics.
- 2) Study of chromospheric and coronal heating, physics of the partially ionized plasma, initiation of the coronal mass ejections, and flares
- 3) Observe the in-situ particle and plasma environment providing data for the study of particle dynamics from the Sun.
- 4) Physics of solar corona and its heating mechanism.
- 5) Diagnostics of the coronal and coronal loops plasma: Temperature, velocity and density.
- 6) Development, dynamics and origin of CMEs.
- 7) Identify the sequence of processes that occur at multiple layers (chromosphere, base and extended corona) which eventually leads to solar eruptive events.
- 8) Magnetic field topology and magnetic field measurements in the solar corona.
- 9) Drivers for space weather (origin, composition and dynamics of solar wind).

- a. The Aditya-L1 spacecraft launched by the PSLV from Sriharikota was placed into an elliptical orbit of 235x19500 km around the earth. Subsequently, ISTRC in Bengaluru carried out **four earth-bound manoeuvres** between September 3 and September 15.
- b. **AstroSat, India's first astronomy mission**, explores **celestial sources** across **X-ray, optical, and UV spectral bands** simultaneously. Its payloads span **Ultraviolet (Near and Far), limited optical, and X-ray ranges (0.3 keV to 100 keV)**. Launched on September 28, 2015, aboard **PSLV-C30**, AstroSat's **1515 kg satellite** conducts **multi-wavelength observations**.

Source: https://www.isro.gov.in/Aditya_L1.html

Subject:) Science and Technology

Subtopic:) Space

Q.19) Mr. A, B, C, and D are collaborating on a project that requires real-time document sharing, simultaneous editing, and secure data storage. Now, Mr. A, B, C, and D propose how they can strategically utilize Web 3.0 technologies to enhance their collaboration. Thus, whose recommendation would be the best and would align with the principles of Web 3.0?

- a) Mr. A can recommend creating a document that remains centrally stored on a traditional server.
- b) Mr. B can propose the use of decentralized storage solutions to avoid the need for encryption.
- c) Mr. C can suggest implementing smart contracts enabling automated execution of predefined activities.
- d) Mr. D can recommend making all payments online using Unified Payment Interface (UPI) portals.

Ans) c

Exp) Option c is the correct answer.

Web 3.0 is the third generation of the world wide web. It is characterized by **decentralization, trustlessness, permission-lessness, ubiquity, connectivity, machine learning and artificial intelligence**. It has no central controlling node or single failure point. Web 3.0 **facilitates complete user-to-user interaction** with no interference of the platform. Also, permission-lessness means neither party in a transaction nor interaction has to seek permission of from a third party.

Option a is incorrect: Storing documents centrally contradicts the principles of Web 3.0, which emphasizes decentralization. Storing documents on a traditional, centralized server may **expose the project to security vulnerabilities and a single point of failure**. In a Web 3.0 context, it's more advisable to explore decentralized platforms or blockchain-based solutions for document storage to enhance security and transparency.

Option b is incorrect: While decentralized storage solutions are a characteristic of Web 3.0, they **do not eliminate the need for encryption**. In fact, **encryption remains crucial** for ensuring the security and privacy of data, even in decentralized environments. Mr. B should consider combining decentralized storage with robust encryption methods for a more comprehensive approach to data security.

Option c is correct: The suggestion of Mr. C is aligned with the principles of Web 3.0. **Smart contracts, powered by blockchain technology, can automate the execution of predefined project activities or milestones**. This enhances transparency, reduces the need for intermediaries, and ensures that agreed-upon conditions are met automatically, contributing to a more efficient and trustful collaboration.

Option d is incorrect: Using UPI portals does not specifically relate to the characteristics of Web 3.0. Mr. D's recommendation is **more related to conventional online payment methods** rather than specific Web 3.0 principles. Further, due to involvement of bank, online platform (UPI), this **not a direct user-to-user transaction**. However, sending a bitcoin directly to another person is an example of Web 3.0. Hence, the statement given is incorrect.

Source: <https://www.forbes.com/advisor/investing/cryptocurrency/what-is-web-3-0/>

Subject:) Science and Technology

Subtopic:) IT and Telecom

Q.20) Consider the following statements regarding ‘monoclonal antibodies’:

1. These are produced by an organism’s immune system in response to an attack by a pathogen.
2. These are designed for a specific antigen.
3. These can help in curing both infectious as well as non-infectious diseases.

How many of the above statements are correct?

- a) Only one
- b) Only two
- c) All three
- d) None

Ans) b

Exp) Option b is the correct answer.

Statement 1 is incorrect: Monoclonal antibodies are not produced by an organism's immune system. Instead, they are **artificially created in a laboratory by cloning a unique immune cell**, called a hybridoma, that produces a specific antibody. This process ensures a consistent and controlled production of antibodies.

Statement 2 is correct: An **antigen** is a molecule or molecular structure that is recognized by the immune system as foreign or non-self. Antigens can trigger an immune response, leading to the production of antibodies or the activation of immune cells. **Monoclonal antibodies are designed to target a specific antigen.** The specificity of monoclonal antibodies allows them to bind to and neutralize a particular target, such as a protein on the surface of a cancer cell or a virus.

Statement 3 is correct: Monoclonal antibodies have demonstrated efficacy in treating a broad range of diseases, **including both infectious and non-infectious conditions.** In infectious diseases, monoclonal antibodies can be designed to **target pathogens like viruses, preventing them from infecting host cells.** In non-infectious diseases, they may target abnormal cells, such as **cancer cells or cells involved in autoimmune disorders, cardiovascular disorders, asthma, migraine, etc.** contributing to disease management or remission.

Source: <https://www.icgeb.org/scientific-team-discovers-new-monoclonal-antibody-for-heart-therapy/>

<https://www.ncbi.nlm.nih.gov/books/NBK572118/>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7093874/>

Subject:) Science and Technology

Subtopic:) Biotechnology

Q.21) With reference to “Software as a Service (SaaS)”, consider the following statements:

1. SaaS buyers can customise the user interface and can change data fields.
2. SaaS users can access their data through their mobile devices.
3. Outlook, Hotmail and Yahoo! Mail are forms of SaaS.

Which of the statements given above are correct?

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

Ans) d

Exp) Option d is the correct answer.

Software-as-a-Service (SaaS) is a software licensing model. It allows access to software on a subscription basis using external servers.

Statement 1 is correct: Today's web-based software is flexible enough to be modified for specific business uses but also individual users. **Buyers can customize the user interface (UI)** to change the look and feel of the program, **as well as modify specific areas, such as data fields, to alter what data appears.** Several business process features can also be turned off and on at will.

Statement 2 is correct: SaaS allows each user to access programs via the Internet. The user need not install the software on his/her computer. Thus, **users can access data through their mobile devices.** SaaS allows users to access the software through a web browser from multiple locations. He or she can have remote desktop software and can work from home

Statement 3 is correct: Outlook, Hotmail or Yahoo! Mail are forms of SaaS. With these services, a user log into their account over the Internet, often from a web browser. The email software is located on the service provider's network and your messages are stored there as well. You can access your email and stored messages from a web browser on any computer or Internet-connected device.

Source: UPSC CSE Pre 2022

Subject:) Science and Technology

Subtopic:) IT and Telecom

Q.22) Ailments in the human body can be categorized as hereditary or acquired. In this context, consider the following diseases/ailments:

1. Sickle-cell disease
2. Leukemia
3. Hemophilia
4. Cystic fibrosis

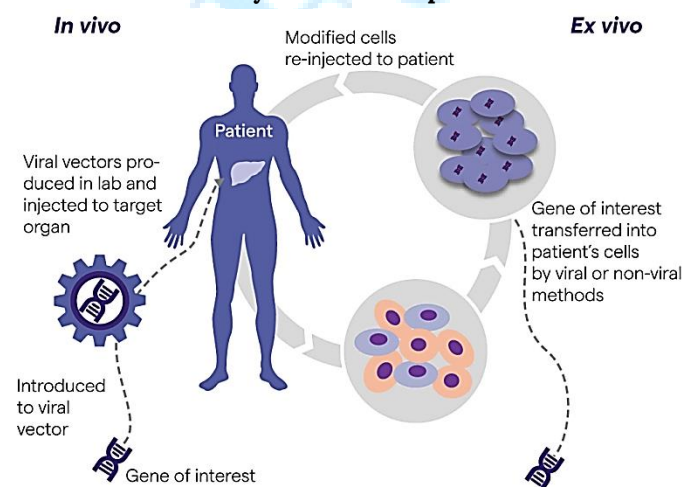
Gene therapy has shown feasibility in curing how many of the above listed ailments?

- a) Only one
- b) Only two
- c) Only three
- d) All four

Ans) d

Exp) Option d is the correct answer.

Gene therapy is a therapeutic strategy that involves manipulating the genetic material within an individual's cells to address the root causes of various disorders. Gene therapy holds potential to **treat both hereditary as well as acquired ailments.**



Option 1 is correct: Gene therapy has demonstrated **feasibility in curing sickle-cell disease**, a hereditary blood disorder characterized by abnormal red blood cells (sickle-shaped, instead of disc-shaped).

Option 2 is correct: Leukemia is a type of blood cancer. Gene therapy has shown remarkable potential in treating this ailment. Techniques such as **CAR-T cell therapy** involve modifying a patient's immune cells to target and destroy leukemia cells, representing a groundbreaking advancement in cancer treatment.

Option 3 is correct: Hemophilia is a disorder affecting blood clotting (that is, blood does not clot properly). Gene therapy offers the potential to introduce functional genes responsible for producing clotting factors.

Option 4 is correct: Cystic fibrosis, a hereditary respiratory condition, has seen promising strides in gene therapy research. Introducing functional copies of the defective gene associated with the disease holds potential for addressing the underlying causes and improving the respiratory function of affected individuals.

Source: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6027861/>

<https://www.lls.org/treatment/types-treatment/immunotherapy/chimeric-antigen-receptor-car-t-cell-therapy>

Subject:) Science and Technology

Subtopic:) Biotechnology

Q.23) Which of the following statements is **incorrect** regarding the indigenously developed 'Nirbhay Missile'?

- a) It has been designed and developed by the Defense Research and Development Organization (DRDO).
- b) It is capable of hitting targets at a distance of more than 5000 kms.
- c) It is a subsonic cruise missile that helps in providing stealth capability.
- d) It can be launched from multiple platforms, including land, air and sea.

Ans) b

Exp) Option b is the correct answer.

The Nirbhay Missile, an **indigenously developed precision-guided munition**, represents a significant advancement in the country's missile technology. Notably, its versatile design allows deployment from various platforms, showcasing its adaptability and strategic value in modern warfare.

Statement a is correct: The Nirbhay Missile is a product of the **Defense Research and Development Organization (DRDO)**, an Indian governmental agency responsible for military research and development. The **Aeronautical Development Establishment (ADE)** as the system designer and integrator led a consortium of DRDO laboratories for the indigenous design and development of Nirbhay. **ADE** is the key Aeronautical Systems Design House involved in the **design and development of Unmanned Aerial Vehicles (UAVs), aeronautical systems**, etc. to meet the requirements of the Indian Armed Forces. It comes under **DRDO, Ministry of Defence**.

Statement b is incorrect: Nirbhay Missile is designed for a range of around 1000 km, not exceeding 2000 km. This **medium-range capability** allows it to effectively engage targets at a considerable distance, providing India with a strategic advantage in regional defense.

Statement c is correct: The Nirbhay Missile is a **subsonic cruise missile**, meaning it travels at speeds slower than the speed of sound. This design allows for enhanced stealth capabilities and improved target penetration. A cruise missile is a smart, self-guided missile that flies at a constant speed toward a target.

Statement d is correct: One of Nirbhay's notable features is its **multi-platform launch capability**. It can be deployed from **land-based mobile launchers**, making it a valuable asset for ground forces. Additionally, its adaptability extends to **air platforms**, such as aircraft, and potentially **sea-based platforms (like submarine)**, offering versatility in strategic deployment across different military scenarios.

Source: <https://www.drdo.gov.in/nirbhay>

<https://www.sps-aviation.com/experts-speak/?id=786&h=Military-Inducting-Nirbhay-Pralay-Missiles#:~:text=Nirbhay%20is%20a%20long%20range,carrying%20conventional%20and%20nuclear%20warheads>.

<https://www.indiatoday.in/india-today-insight/story/how-cruise-missile-nirbhay-adds-muscle-to-indias-rocket-force-plan-2463295-2023-11-15>

Subject:) Science and Technology

Subtopic:) Defence

Q.24) In the context of celestial bodies in solar system, consider the following statements regarding the asteroids and a comets:

1. Asteroids are rocky objects found mainly between Mars and Jupiter, while comets are icy bodies that originate from the outer regions of the solar system.
2. Asteroids essentially revolve around the Sun, while a comet does not necessarily revolve around the Sun.
3. Unlike comets, asteroids pose a threat of collision to the Earth.

How many of the above statements are correct?

- a) Only one
- b) Only two
- c) All three
- d) None

Ans) a

Exp) Option a is the correct answer.

The solar system hosts a diverse array of celestial bodies, each offering unique insights into the intricate dynamics of space. Among these, **asteroids and comets**, with their distinct compositions, play a crucial role in expanding our understanding of cosmic phenomena.

Statement 1 is correct: Asteroids are referred to as **rocky or metallic bodies** and are primarily found in the **asteroid belt, a region between Mars and Jupiter**. On the other hand, comets are composed of **ice, frozen gases, dust, and organic compounds**, and they typically originate from the outer reaches of the solar system, such as the **Kuiper Belt and the Oort Cloud**.

Statement 2 is incorrect: **Both asteroids and comets revolve around the Sun**. The motion of celestial bodies in our solar system is governed by gravitational forces, causing them to orbit the Sun. Therefore, asteroids and comets share this fundamental characteristic of orbiting the Sun.

Statement 3 is incorrect: Occasionally, **gravitational tugs, orbital collisions, and interactions in outer space can perturb the path of an asteroid or comet, bringing it close to Earth**. This altered trajectory, if intersecting with Earth's path, poses a risk of impact, potentially leading to a collision. However, most of them are too small to cause any damage. Instead, they burn up in the atmosphere and appear to us as shooting stars. Thus, both asteroid as well as comets pose a threat of collision to the Earth.

Source: <https://www.nationalgeographic.com/science/article/asteroids-comets>

https://lasp.colorado.edu/outerplanets/spacejunk_asteroids.php#:~:text=All%20asteroids%20orbit%20the%20Sun,located%20in%20the%20asteroid%20belt.

Subject:) Science and Technology

Subtopic:) Space

Q.25) Satellite internet is a wireless internet service that uses satellites to transmit data. In this context, consider the following statements regarding the 'satellite internet':

1. At present it can offer high download speed at par with 5G.
2. It can provide better online gaming experiences to users than the cable and fiber internet.

3. Starlink is a satellite internet constellation that uses low Earth orbit to provide broadband internet.

How many of the above statements are correct?

- a) Only one
- b) Only two
- c) All three
- d) None

Ans) a

Exp) Option a is the correct answer.

Satellite internet provides an online connection powered by satellites in space. Satellite internet is a common technology in remote areas where homes don't have access to other broadband internet options such as cable, fiber optics, etc.

Statement 1 is incorrect: Existing satellite internet technology does not typically offer download speeds at par with 5G. 5G (Fifth-generation mobile network) can deliver speeds between 10 and 20 gigabits per second (Gbps), while **satellite internet services offer speeds up to 100 Mbps**, which is similar to what most cable service providers offer.

Statement 2 is incorrect: Satellite internet faces the problem of higher latency as compared to the cable and fiber networks. Cable and fiber internet offers latency in the range of 20 to 50 milliseconds (ms), whereas satellite internet can be as high as 600 ms. This is because data in satellite internet travels through a longer distance. **Online gaming suffers the adverse effects of higher latency as it requires ultra-quick responses.** Hence, the given statement is incorrect.

Statement 3 is correct: Starlink is a satellite internet constellation that uses low Earth orbit to provide broadband internet. It's the world's first and largest satellite constellation, with thousands of satellites that orbit the planet at about 550 kilometers. Starlink is operated by SpaceX, a private aerospace company.

Source: <https://timesofindia.indiatimes.com/gadgets-news/explained-know-all-about-satellite-internet-and-how-it-operates/articleshow/89755420.cms>

<https://www.forbes.com/home-improvement/internet/what-is-satellite-internet/>

<https://www.starlink.com/technology>

Subject:) Science and Technology

Subtopic:) IT and Telecom

Q.26) Consider the following statements regarding the 'Polymerase Chain Reaction (PCR)' technology:

- 1. It can detect diseases even when the concentrations of pathogens in an individual are very low.
- 2. In PCR, replication is an in-vivo process that copies the entire genome at once.
- 3. It can also be used in the detection of genetic disorders.

How many of the above statements are correct?

- a) Only one
- b) Only two
- c) All three
- d) None

Ans) b

Exp) Option b is the correct answer.

Molecular diagnosis, an integral aspect of modern healthcare, harnesses advanced technologies to detect and analyze diseases at the molecular level. **Polymerase Chain Reaction (PCR) provides capabilities in amplifying and analyzing specific DNA segments.**

Statement 1 is correct: PCR helps in **early detection** of a disease. In this technique, **very low concentration of a bacteria or virus can be detected by amplification of their nucleic acid**. This helps in diagnosing a disease even when its symptoms are not yet visible.

Statement 2 is incorrect: Polymerase Chain Reaction (PCR) is a **quick and efficient lab (in-vitro not in-vivo) method to make millions or billions of copies (amplify) a particular part of DNA**. This amplified DNA can be studied more closely. PCR uses small pieces of synthetic DNA, called primers, to choose the part of the genome to amplify. After that, it goes through several rounds of DNA synthesis to make many copies of that chosen part.

Statement 3 is correct: PCR technology is **widely employed in the molecular diagnosis of genetic disorders**. By targeting specific genes associated with genetic conditions, PCR allows for the amplification and detection of genetic mutations or variations. **The technique is being used for rapid prenatal diagnosis and carrier testing of several inherited disorders.**

Knowledge Base: **In vitro studies** are conducted in a controlled environment, such as a test tube or petri dish. **In vivo studies** are conducted on a living organism, such as a person, laboratory animal, or plant.

Source:

[https://pubmed.ncbi.nlm.nih.gov/2570652/#:~:text=The%20polymerase%20chain%20reaction%20\(PCR,testing%20of%20several%20inherited%20disorders.](https://pubmed.ncbi.nlm.nih.gov/2570652/#:~:text=The%20polymerase%20chain%20reaction%20(PCR,testing%20of%20several%20inherited%20disorders.)

<https://www.genome.gov/genetics-glossary/Polymerase-Chain-Reaction#:~:text=Definition,be%20studied%20in%20greater%20detail.>

<https://ncert.nic.in/ncerts/l/lebo112.pdf>

Subject:) Science and Technology

Subtopic:) Biotechnology

Q.27) While solid fuels are used in the first stage of the rocket, liquid fuel is used in higher stages. In that context, which of the following statements is **incorrect** about the solid and liquid fuels used in the rockets?

- a) Liquid fuel used in rockets allows more precise control of thrust than solid fuel.
- b) Liquid fuel used in the rocket has a lower specific impulse than solid fuel.
- c) Liquid fuel is cleaner than solid fuel used in rocket engines, producing lesser residue or carbon emissions.
- d) Liquid fuel used in rocket engines requires separate storage for the fuel and oxidizer, while solid fuel does not.

Ans) b

Exp) Option b is the correct answer.

Liquid fuels and solid fuels are two primary types of propellants used in rocket engines. Each type has its own characteristics and is suitable for different applications.

Statement a is correct: Liquid fuel rocket engines can vary the **amount of fuel and oxidizer that are injected into the combustion chamber**, which changes the rate of the chemical reaction and the amount of thrust produced. This **allows the rocket to adjust the thrust control precisely and direction as needed**. Solid fuel rocket engines, on the other hand, have a fixed amount of propellant that burns at a constant rate, which means the thrust cannot be controlled once ignited.

Statement b is incorrect: Specific impulse is a measure of how efficiently a rocket engine uses its propellant to produce thrust. It is calculated by dividing the thrust by the mass flow rate of the propellant. **Liquid fuel rocket engines have a higher specific impulse than solid fuel rocket engines**, meaning they produce more thrust per unit mass of propellant. This is because liquid fuel and oxidizer can be mixed in optimal ratios and conditions to achieve higher combustion temperatures and pressures.

Statement c is correct: Liquid fuel rocket engines use **liquid hydrogen and liquid oxygen as the most common propellant** combination, which results in water vapor as the only exhaust product (no carbon emissions). This is environmentally friendly and leaves less residue. Solid fuel rocket engines use a mixture of solid chemicals, such as ammonium perchlorate and aluminum, which produce hot gases and solid particles as the exhaust products. These can cause pollution and damage to the rocket engine.

Statement d is correct: Liquid fuel rocket engines need a **complex system of pumps, valves, pipes, and tanks to store and deliver the liquid propellants to the combustion chamber**. Hence liquid fuels requires separate storage for the fuel and oxidizer, while solid fuel does not as the propellants are mixed together and packed into a single solid cylinder.

Source: https://www.esa.int/Education/Solid_and_liquid_fuel_rockets4

<https://www.thehindu.com/sci-tech/science/explained-what-is-a-reusable-launch-vehicle-who-is-using-it-now-how-far-along-is-india/article66835126.ece>

Subject:) Science and Technology

Subtopic:) Space

Q.28) Which one of the following statements is correct regarding the process of Nuclear Fusion and Nuclear Fission?

- a) Nuclear fission releases energy by combining light nuclei, while nuclear fusion releases energy by breaking apart heavy nuclei.
- b) Nuclear fission produces long-lived radioactive nuclear waste, while nuclear fusion does not create any long-lived radioactive nuclear waste.
- c) Unlike Nuclear fusion, it is difficult to sustain Nuclear fission for longer period of time as it requires extreme conditions.
- d) Nuclear fission reaction powers the sun while Nuclear fusion reaction powers the traditional nuclear power reactors.

Ans) b

Exp) Option b is the correct answer.

Both fission and fusion are nuclear reactions that produce energy, but the processes are very different. Fission is the splitting of a heavy, unstable nucleus into two lighter nuclei, and fusion is the process where two light nuclei combine together releasing vast amounts of energy.

Option b is correct: Nuclear fission power plants have the disadvantage of generating unstable nuclei; some of these are radioactive for millions of years. **Fusion on the other hand does not create any long-lived radioactive nuclear waste.** A fusion reactor produces helium, which is an inert gas. It also produces and consumes tritium within the plant in a closed circuit. Tritium is radioactive (a beta emitter) but its half life is short. It is only used in low amounts so, unlike long-lived radioactive nuclei, it cannot produce any serious danger.

Option a is incorrect: Nuclear fission **releases energy by splitting heavy nuclei, while nuclear fusion releases energy by combining light nuclei.** In nuclear fission, a neutron bombards a large atom (such as uranium or plutonium) and causes it to split into two or more smaller atoms, called fission products. This process also releases more neutrons, which can trigger a chain reaction. In nuclear fusion, two light atoms (such as hydrogen isotopes) collide at high speed and fuse together to form a larger atom (such as helium), releasing a huge amount of energy. This process requires extremely high temperature and pressure to overcome the repulsive force between the nuclei.

Option c is incorrect: **Nuclear fusion releases more energy than nuclear fission, but it is harder to achieve and sustain.** The amount of energy released by a fusion reaction is proportional to the mass difference between the reactants and the products. Since the mass difference is larger for fusion than for fission, the energy output is also larger. **Hence, the nuclear fusion is difficult to sustain**

because it requires extreme conditions to maintain the high temperatures and pressures needed for nuclear fusion to occur.

Option d is incorrect: Nuclear Fusion reactions power the Sun and other stars. In a fusion reaction, two light nuclei merge to form a single heavier nucleus. The process releases energy because the total mass of the resulting single nucleus is less than the mass of the two original nuclei. The leftover mass becomes energy.

In traditional nuclear power plants, the nuclear fission reaction is used. In nuclear fission atoms are split apart, which releases energy. This principle is employed to generate electricity.

Source: <https://www.energy.gov/ne/articles/fission-and-fusion-what-difference>

<https://www.thehindubusinessline.com/specials/clean-tech/clean-facts-on-nuclear-fusion-energy/article66337536.ece>

<https://www.energy.gov/science/doe-explainsnuclear-fusion-reactions#:~:text=Nuclear%20Fusion%20reactions%20power%20the,The%20leftover%20mass%20becomes%20energy.>

Subject:) Science and Technology

Subtopic:) Nuclear

Q.29) Which one of the following statements correctly describes the term 'eDNA' or 'Environmental DNA'?

- a) It is a cloud server, which is used to store data about the level of pollution in various cities across the world.
- b) It is a genetic material extracted from human cells in a laboratory setting.
- c) It is a virtually simulated ecosystem to access the loss and damage to biodiversity.
- d) It is a DNA sequence of organisms extracted from environmental samples like water, soil, or air.

Ans) d

Exp) Option d is the correct answer.

Environmental DNA, or eDNA, is DNA that is **collected from various environmental samples, such as soil, water, snow, or air, rather than from an individual organism**. eDNA can provide information about the species living in an ecosystem, their population size, distribution, and health, as well as the presence of pathogens or invasive species. It is nuclear or mitochondrial DNA that is released from an organism into the environment. Sources of eDNA include secreted feces, mucous, and gametes; shed skin and hair; and carcasses. eDNA can be detected in cellular or extracellular (dissolved DNA) form. eDNA is a powerful tool for biodiversity monitoring and conservation, as it can detect rare, elusive, or endangered species without harming them or disturbing their habitat.

Source: [https://www.usgs.gov/special-topics/water-science-school/science/environmental-dna-edna#:~:text=Environmental%20DNA%20\(eDNA\)%20is%20organismal,monitored%20using%20new%20molecular%20methods.](https://www.usgs.gov/special-topics/water-science-school/science/environmental-dna-edna#:~:text=Environmental%20DNA%20(eDNA)%20is%20organismal,monitored%20using%20new%20molecular%20methods.)

<https://www.thehindubusinessline.com/news/science/environmental-dna-a-novel-method-to-detect-all-life-forms-in-an-ecosystem/article67489199.ece>

Subject:) Science and Technology

Subtopic:) Biotechnology

Q.30) Consider the following:

- 1. Higher energy density.
- 2. Lower self-discharge rate.
- 3. Lower manufacturing cost
- 4. Longer lifespan.

How many of the above given are the advantages of Lithium-ion batteries over conventional batteries?

- a) Only one
- b) Only two
- c) Only three
- d) All four

Ans) c

Exp) Option c is the correct answer.

Lithium-ion batteries are a type of rechargeable battery that use lithium ions to store and release energy. Compared to conventional batteries, such as lead-acid or nickel-cadmium, the lithium-ion batteries have several advantages, such as:

Option 1 is correct: Lithium-Ion batteries have a **high energy density, which means they can store more energy per unit volume and weight than other batteries**. This makes them suitable for power-hungry devices and applications. Traditional batteries, such as lead-acid, nickel-cadmium, and nickel-metal hydride, have lower energy densities and require more space and weight to provide the same amount of energy.

Option 2 is correct: Lithium-Ion batteries **exhibit a lower self-discharge rate, which means they lose less charge when not in use than other batteries**. For example, a nickel-cadmium battery has a 20% self-discharge rate per month, while a lithium-ion battery has only 1.5%. Traditional batteries have higher self-discharge rates and need to be recharged more often, even when not in use.

Option 3 is incorrect: Lithium-Ion batteries are expensive to manufacture - about 40 percent higher in cost than nickel-cadmium batteries.

Option 4 is correct: **Lithium-Ion batteries generally have a longer lifespan** compared to traditional batteries, because they have low or zero memory effect. Memory effect is the phenomenon where a battery loses its maximum charge capacity when repeatedly recharged after being partially discharged. Lithium-Ion batteries do not suffer from this problem, or only to a negligible degree. Traditional batteries, especially nickel-cadmium and nickel-metal hydride, have significant memory effects and lose their charge capacity over time.

Source: https://www.electronics-notes.com/articles/electronic_components/battery-technology/li-ion-lithium-ion-advantages-disadvantages.php

[https://blog.storemasta.com.au/lithium-ion-batteries-and-thermal-](https://blog.storemasta.com.au/lithium-ion-batteries-and-thermal-runaway#:~:text=Put%20in%20the%20simplest%20of,the%20heat%20that%20is%20dispersed.)

[runaway#:~:text=Put%20in%20the%20simplest%20of,the%20heat%20that%20is%20dispersed.](https://blog.storemasta.com.au/lithium-ion-batteries-and-thermal-runaway#:~:text=Put%20in%20the%20simplest%20of,the%20heat%20that%20is%20dispersed.)

https://wecanfigurethisout.org/ENERGY/Web_notes/Electrochemical/Batteries_and_Fuel_Cells_Supporting_Files/Is%20Lithium-ion%20the%20Ideal%20Battery%20-%20Battery%20University.pdf

Subject:) Science and Technology

Subtopic:) IT and Telecom

Q.31) Consider the following actions:

1. Detection of car crash/collision which results in the deployment of airbags almost instantaneously.
2. Detection of accidental free fall of a laptop towards the ground which results in the immediate turning off of the hard drive.
3. Detection of the tilt of the smart- phone which results in the rotation of display between portrait and landscape mode.

In how many of the above actions is the function of accelerometer required?

- a) Only one
- b) Only two
- c) All three
- d) None

Ans) c

Exp) Option c is the correct answer.

Accelerometers are devices that measure the vibration, or acceleration of motion of a structure. They have a transducer that converts mechanical force caused by vibration or a change in motion, into an electrical current using the piezoelectric effect.

Statement 1 is correct: Any reliable **car crash detection system requires an accelerometer** that can measure up to several hundred g-force accelerations. In the event of a crash, the crash sensor (an accelerometer) sends a signal to the airbag control unit. This control unit triggers the inflation device, which generates nitrogen gas by igniting a mixture of sodium azide (NaN_3) and potassium nitrate (KNO_3).

Statement 2 is correct: Accelerometers in laptops protect hard drives from damage. If **the laptop were to suddenly drop while in use, the accelerometer would detect the sudden free fall and immediately turn off the hard drive** to avoid hitting the reading heads into the hard drive platter.

Statement 3 is correct: An **accelerometer detects** acceleration, vibration, and **tilt** to determine movement and exact orientation along the three axes. Apps use this smartphone sensor to determine whether your phone is in portrait or landscape orientation. It can also tell if your phone screen is facing upward or downward.

Source: UPSC CSE Pre 2023

Subject:) Science and Technology

Subtopic:) IT and Telecom

Q.32) With reference to Genetic Engineering Appraisal Committee (GEAC) of India, consider the following statements:

1. It is an autonomous body under the Ministry of Consumer Affairs, Food and Public Distribution.
 2. Clearance of GEAC is mandatory for the environmental release of Genetically Modified (GM) crops.
- Which of the statements given above is/are correct?

- a) 1 only
- b) 2 only
- c) Both 1 and 2
- d) Neither 1 nor 2

Ans) b

Exp) Option b is the correct answer.

The Genetic Engineering Appraisal Committee (GEAC) is the statutory committee constituted under the “Rules for the Manufacture, Use/Import/Export and Storage of Hazardous Micro Organisms/Genetically Engineered Organisms or Cells (Rules, 1989)” under Environment (Protection) Act, 1986.

Statement 1 is incorrect: Genetic Engineering Appraisal Committee functions under the **Ministry of Environment, Forest and Climate Change**, not the Ministry of Consumer Affairs, Food and Public Distribution.

Statement 2 is correct: Clearance of Genetic Engineering Appraisal Committee (GEAC) is **mandatory for the environmental release of Genetically Modified (GM) crops**. Applications are considered by GEAC as per the provisions of the Rules, 1989 and amendments thereafter. Every set of application has specific form and pre-requisite documents along with recommendations, wherever needed. For the consideration of any application related to confined field trials of Genetically Modified (GM) crops by GEAC, NOC from the State/UT Government is required.

Source: <http://geacindia.gov.in/about-geac-india.aspx>

<http://geacindia.gov.in/composition.aspx>

<https://ncert.nic.in/ncerts/l/lebo112.pdf>

Subject:) Science and Technology

Subtopic:) Biotechnology

Q.33) In the context of internet domain, the term 'cookies' refers to:

- a) advanced encryption algorithms used for securing databases from malware.
- b) small pieces of software used by businesses that track one's browsing activity for targeted advertising.
- c) text files containing website preferences and login information stored on one's device.
- d) secret codes used by hackers to access one's personal information.

Ans) c

Exp) Option c is the correct answer.

Cookies (often known as internet cookies) are text files with small pieces of data – like a username and password – that are used to identify one's computer as they use a network. Specific cookies are used to identify specific users and improve their web browsing experience. Data stored in a cookie is created by the server upon users connection. This data is labeled with an ID unique to users' computer. When the cookie is exchanged between users' computer and the network server, the server reads the ID and knows what information to specifically serve the user.

Cookies are used for many purposes, including:

- 1) Managing user sessions
- 2) Personalization
- 3) Ad tracking
- 4) Identifying users
- 5) Improving web browsing experience
- 6) Tracking a user's journey
- 7) Telling the server that users have returned to a particular website
- 8) Allowing ad tech providers to track how often a user is being shown a particular advertisement

Source: <https://www.techtarget.com/searchsoftwarequality/definition/cookie>

<https://www.kaspersky.com/resource-center/definitions/cookies>

Subject:) Science and Technology

Subtopic:) IT and Telecom

Q.34) Consider the following statements :

Statement I: DNA vaccines have a lower immunogenicity (immune response) and efficacy than RNA vaccines.

Statement II: DNA vaccines are more stable compared to RNA vaccines and can be stored at room temperature.

Which one of the following is correct in respect of the above statements?

- a) Both Statement-I and Statement-II are correct and Statement-II is the correct explanation for Statement-I.
- b) Both Statement-I and Statement-II are correct and Statement-II is not the correct explanation for Statement-I.
- c) Statement-I is correct but Statement-II is incorrect.
- d) Statement-I is incorrect but Statement-II is correct.

Ans) b

Exp) Option b is the correct answer.

DNA and RNA vaccines are both types of genetic vaccines that use part of the virus' genetic code to stimulate an immune response. However, they have some differences in how they work.

- 1) DNA Vaccines use a specific DNA sequence that codes for an antigen. They are delivered into the **cell's nucleus by a plasmid vector.**

2) RNA vaccines use a copy of mRNA that encodes an antigen. They are delivered into the **cell's cytoplasm by lipid nanoparticles**.

Statement I is correct: DNA vaccines have a lower immunogenicity (immune response) and efficacy than RNA vaccines. This is because DNA vaccines need to be transcribed into mRNA before they can produce antigens, while RNA vaccines consist of an mRNA strand that codes for a disease-specific antigen. Once the mRNA strand in the vaccine is inside the body's cells, the cells use the genetic information to produce the antigen. This antigen is then displayed on the cell surface, where it is recognised by the immune system. RNA vaccines also have the advantage of being more versatile and adaptable to different strains of viruses.

Statement II is correct: DNA vaccines are more stable and can be stored at room temperature. RNA, being more susceptible to degradation, may require special storage conditions, including ultra-cold storage for some RNA vaccines. DNA vaccines, due to their stability, may have less stringent storage requirements. **Hence the stability of the vaccine has no relation with the immune response in this case. Therefore, statement I and II are correct, but Statement II is not the correct explanation of statement I.**

Source: <https://www.verywellhealth.com/rna-vs-dna-vaccine-5082285#:~:text=DNA%20and%20RNA%20vaccines%20both,potential%20risk%20with%20DNA%20vaccines.>

Subject:) Science and Technology

Subtopic:) Biotechnology

Q.35) With reference to 'Open-source software', consider the following statements:

1. It is a software publicly available for anyone to view, modify, and enhance.
2. It is comparatively less vulnerable to malicious attacks than proprietary software.
3. Android, Linux and Selenium are some of the examples of Open-source software.

How many of the above statements are correct?

- a) Only one
- b) Only two
- c) All three
- d) None

Ans) c

Exp) Option c is the correct answer.

Open-source software refers to software whose source code is made available to the public. Users can view, modify, and distribute the code, fostering collaboration and community-driven development. Open-source software is often free to use and encourages transparency and innovation through a collaborative approach.

Statement 1 is correct: Open source software (OSS) is software that has its **source code publicly available for anyone to view, modify, and enhance**. "Source code" is the part of software that most computer users don't ever see; it's the code computer programmers can manipulate to change how a piece of software—a "program" or "application"—works.

Statement 2 is correct: OSS is transparent and open to scrutiny, which makes it less vulnerable to **malicious attacks than proprietary software(owned by an individual or company)**. Because anyone can view and modify open source software. Community can spot and correct errors or omissions that a program's original authors might have missed

Statement 3 is correct: Android, Linux, and Selenium are some of the examples of OSS. Android is an open source operating system for mobile devices, Linux is an open source operating system for computers, and Selenium is an open source software for testing web applications.

Source: <https://opensource.com/resources/what-open-source>

Subject:) Science and Technology

Subtopic:) IT and Telecom

Q.36) Consider the following statements regarding Pressurized Heavy Water Reactors (PHWRs):

1. All operational nuclear reactors in India are PHWRs.
2. Only fissile material can be used as fuel in PHWRs.
3. It generates no nuclear waste as it uses heavy water as coolant.

How many of the statements given above are correct?

- a) Only one
- b) Only two
- c) All three
- d) None

Ans) d

Exp) Option d is the correct answer.

A pressurized heavy water reactor utilizes heavy water as both its coolant and moderator. Heavy water contains deuterium, an isotope of hydrogen that absorbs fewer neutrons than regular hydrogen. This characteristic is crucial for nuclear fission reactions, which rely on neutrons for their chain reactions. The heavy water is pressurized, elevating its boiling point and enabling operation at high temperatures without boiling.

Statement 1 is incorrect: Presently, India has 22 operating reactors, with an installed capacity of 6780 MWe. Among these **eighteen reactors** are Pressurized Heavy Water Reactors (PHWRs) and **four are Light Water Reactors (LWRs)**.

Statement 2 is incorrect: The Pressurized Heavy Water Reactors (PHWRs) **uses natural Uranium as its primary fuel**. Uranium-238 is non-fissile, meaning it cannot sustain a chain reaction in a thermal-neutron reactor. PHWR doesn't require the uranium fuel to be enriched like in some other nuclear reactors. Deuterium absorbs fewer neutrons than hydrogen, which is extremely important as nuclear fission reactions require neutrons to carry out their chain reactions.

Statement 3 is incorrect: **PHWRs, like all nuclear reactors, produce nuclear waste such as** Fission products when uranium dioxide pellets undergo fission and spent fuel from PHWR reactors. PHWR are not exempt from generating such byproducts.

Source: <https://www.aerb.gov.in/english/regulatory-facilities/nuclear-power-plants#:~:text=Presently%2C%20India%20has-,22,-operating%20reactors%2C%20with>

<https://www.world-nuclear.org/nuclear-essentials/are-there-different-types-of-reactor.aspx>

Subject:) Science and Technology

Subtopic:) Nuclear

Q.37) “Kessler syndrome”, often seen in news, is a-

- a) computer security protocol for preventing data breaches.
- b) theory in environmental science explaining the impact of climate change on migratory patterns of birds.
- c) certain critical mass of space debris around the earth after which the total amount of space debris keeps on increasing.
- d) geophysical phenomenon in which the Earth's magnetic field reverses its polarity.

Ans) c

Exp) Option c is the correct answer.

Kessler syndrome, also called the Kessler effect, collisional cascading, or ablation cascade, was proposed by **NASA scientist Donald J. Kessler in 1978. He observed that, once past a certain critical mass, the total amount of space debris will keep on increasing: collisions give rise to more debris**

and lead to more collisions, in a chain reaction. . This could render some orbital ranges unusable for many generations and pose a threat to the functioning of satellites and spacecraft.

Kessler Syndrome is characterized by the presence of millions of debris pieces of various sizes. When these pieces collide, they create additional debris and additional collisions. This creates a cascading effect that increases the likelihood of further collisions.

Source: <https://www.space.com/kessler-syndrome-space-debris>

https://www.esa.int/Enabling_Support/Space_Engineering_Technology/The_Kessler_Effect_and_how_to_stop_it

Subject:) Science and Technology

Subtopic:) Space

Q.38) With reference to potential application of transgenic animals, consider the following statements:

1. They help in understanding how genes contribute to the development of disease.
2. They can be used to create biological products to cure diseases.
3. They can be used for testing the safety of vaccines before they are used on humans.

How many statements given above are correct?

- a) Only one
- b) Only two
- c) All three
- d) None

Ans) c

Exp) Option c is the correct answer.

Animals that have had their DNA manipulated to possess and express an **extra (foreign) gene** are known as transgenic animals. Transgenic rats, rabbits, pigs, sheep, cows and fish have been produced, although over 95 per cent of all existing transgenic animals are mice.

Statement 1 is correct. Many transgenic animals are designed to increase our **understanding of how genes contribute to the development of disease**. These are specially made to serve as models for human diseases so that investigation of new treatments for diseases is made possible. Today transgenic models exist for many human diseases such as cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's.

Statement 2 is correct. Transgenic animals can produce useful **biological products** by the introduction of the portion of DNA (or genes) which codes for a particular product. Medicines required to treat certain human diseases can contain biological products, but such products are **often expensive to make**.

Statement 3 is correct. Transgenic mice are being developed for use in testing the **safety of vaccines** before they are used on humans. Transgenic mice are also used to test the safety of the **polio vaccine**. If successful and found to be reliable, they could replace the use of monkeys to test the safety of batches of the vaccine.

Source: <https://ncert.nic.in/textbook.php?lebo1=12-16>

Subject:) Science and Technology

Subtopic:) Biotechnology

Q.39) In the context of using satellite for navigation services, consider the following statements regarding 'Navigation with Indian Constellation (NavIC)', developed by Indian Space Research Organization (ISRO):

1. It is a constellation of seven satellites in which three are placed in geostationary orbit.
2. It provides Standard Position Service (SPS) for civilian users and Restricted Service (RS) for strategic users.

3. Its coverage area extends to regions lying outside the Indian borders.

How many of the above statements are correct?

- a) Only one
- b) Only two
- c) All three
- d) None

Ans) c

Exp) Option c is the correct answer.

The **Navigation with Indian Constellation (NavIC)** developed by the **Indian Space Research Organization (ISRO)**. The system's interoperability with other global navigation satellite systems, such as GPS, Glonass, Galileo, and BeiDou, highlights its integration into the global navigation framework.

Statement 1 is correct: NavIC is designed with a **constellation of 7 satellites** and a network of ground stations. **Three satellites of the constellation are placed in geostationary orbit**, and **four satellites are placed in inclined geosynchronous orbit** with equatorial crossing of 55°E and 111.75°E respectively, with inclination of 29° (two satellites in each plane). The ground network consists of a control center, precise timing facility, range and integrity monitoring stations, two-way ranging stations, etc.

Statement 2 is correct: It offers two services: **Standard Positioning Service (SPS)** which is provided to all the users and **Restricted Service (RS)**, which is an **encrypted service** provided only to the authorised users. NavIC signals are designed to provide user position accuracy better than 20m and timing accuracy better than 50ns.

Statement 3 is correct: When the NavIC satellite navigation system was first introduced, it was created to meet the needs of important national uses, such as defense and business. Therefore, its **coverage area was planned to include not only Indian Territory but also an additional 1500 km around the Indian borders**. Hence, the given statement is correct.

Source: <https://www.isro.gov.in/SatelliteNavigationServices.html>

<https://pib.gov.in/PressReleasePage.aspx?PRID=1848313>

Subject:) Science and Technology

Subtopic:) Space

Q.40) With reference to the White Hydrogen, consider the following statements:

- 1. It is produced through the electrolysis of water.
 - 2. It causes no CO₂ emissions when used as a fuel.
- Which of the statements given above is/are correct?

- a) 1 only
- b) 2 only
- c) Both 1 and 2
- d) Neither 1 nor 2

Ans) b

Exp) Option b is the correct answer.

Hydrogen (Atomic Number-1) is the **lightest element, a non-metal and invisible gas**. When it comes to the uses of Hydrogen as a source of energy, various industries classify it into 8 types- **Green Hydrogen, Blue Hydrogen, Grey Hydrogen, Black-Brown Hydrogen, Pink Hydrogen, Turquoise Hydrogen, Yellow Hydrogen, and White Hydrogen**. **White Hydrogen is naturally occurring hydrogen producing no greenhouse emissions**.

Statement 1 is incorrect- **Green Hydrogen**, and **not White Hydrogen** is produced by the **electrolysis of water** using **renewable energy**. On the other hand, White hydrogen, also referred to as **“natural,”**

“gold,” or “geologic” hydrogen, is a **naturally existing variant** found **within the Earth's crust**. It is extracted through **fracking** and is **present in subsurface deposits**.

Statement 2 is correct- White Hydrogen causes no CO₂ emissions when used as a fuel.

Source: <https://timesofindia.indiatimes.com/home/science/what-is-white-hydrogen-and-how-it-could-help-save-the-world/articleshow/104811949.cms?from=mdr>

Subject:) Science and Technology

Subtopic:) Energy

Q.41) With reference to street-lighting, how do sodium lamps differ from led lamps?

1. Sodium lamps produce light in 360 degrees, but it is not so in the case of LED lamps.
2. As street-lights, sodium lamps have longer life span than LED lamps.
3. The spectrum of visible light from sodium lamps is almost monochromatic while LED lamps offer significant colour advantages in street-lighting.

Select the correct answer using the code given below:

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

Ans) c

Exp) Option c is the correct answer.

Statement 1 is correct. Sodium lamps produce light in 360 degrees but it is not so in the case of LED lamps. LED lamps have 180-degree bulb angle to preserve light efficiency and allow for target lighting over areas.

Statement 2 is incorrect. As street lights, sodium lamps have on an average shorter lifespan than LED lamps. High Pressure Sodium lamps tend to have a lifespan averaging 24,000 hours. Whereas, LED lamps lifespan ranges from 25,000 to 200,000 hours.

Statement 3 is correct. The spectrum of visible light from sodium lamps is almost monochromatic as they are known for their warm yellow glow. On the other hand, LED lamps offer significant colour advantages in street-lighting. LEDs offer variety of colour options providing better lighting solutions than High Pressure Sodium counterpart.

Source: UPSC CSE Pre 2021

Subject:) Science and Technology

Subtopic:) Energy

Q.42) Project Kusha, which has been in the news recently, is related to:

- a) usage of Artificial Intelligence to detect scams in the Banking sector in India.
- b) enhancing nutritional values of the staple crops of India.
- c) National Waterways of India.
- d) Air Missile defence system of India.

Ans) d

Exp) Option d is the correct answer.

Project Kusha is an **Indian initiative** aimed at developing a **Long-Range Surface to Air Missile (LR-SAM)**. It will be an **air missile defence system of India**. It will be provided to the Indian Air Force by the end of 2028-2029. The **Defence Research and Development Organization (DRDO)** will undertake its development, with an estimated budget of **Rs 21,700 crore**. The project is designed to **identify and neutralize a range of hostile targets**, encompassing **cruise missiles, stealth fighter jets, and drones**, even at extended distances.

Source: <https://theprint.in/defence/desi-s-400-all-about-project-kusha-indias-very-own-long-range-air-defence-system/1826664/>

Subject:) Science and Technology

Subtopic:) Defence

Q.43) Consider the following options:

1. Intra Uterine Devices (IUDs).
 2. In Vitro Fertilisation.
 3. Artificial Insemination (AI)
 4. Gamete Intra Fallopian Transfer (GIFT)
 5. Zygote Intra Fallopian Transfer (ZIFT)
- How many of the above are types of Assisted Reproductive Technology (ART)?

- a) Only two
- b) Only three
- c) Only four
- d) All five

Ans) c

Exp) Option c is the correct answer.

Assisted Reproductive Technology (ART) refers to a variety of procedures used to treat infertility. The technology aids in obtaining a pregnancy through multiple methodologies such as In Vitro Fertilisation Artificial Insemination etc.

Option 1 is incorrect: Intra Uterine Devices (IUDs) is one of the most widely accepted **methods of contraception and is not a type of assisted reproductive technology**. IUDs increase phagocytosis of sperms within the uterus and release copper ions which **suppress sperm motility** and the fertilising capacity of sperms. The hormones released by IUDs make the uterus unsuitable for implantation and the cervix hostile to the sperms. Hence **IUDs are ideal contraceptives for the females**.

Option 2 is correct: In vitro fertilisation is a type of fertility treatment where fertilisation occurs in a laboratory, instead of within the body. It involves extracting one or more eggs from an ovary and placing them in a petri dish with donated sperm. **In vitro fertilisation is a type of ART.**

Option 3 is correct: Artificial insemination is one of the types of Assisted Reproductive Technology (ART). Artificial insemination involves inserting sperm directly into a woman's uterus to increase the chance of fertilisation. It is **used to correct Infertility cases either due to inability of the male partner to inseminate the female or due to very low sperm counts**.

Option 4 is correct: Gamete intra fallopian transfer (GIFT) is one of the types of Assisted Reproductive Technology (ART). GIFT involves three persons i.e, transfer of an **ovum collected from a donor** into the **fallopian tube of another female** who cannot produce one but can provide a suitable environment for fertilisation and further development.

GIFT is a three-step procedure that involves removing the **eggs**, combining them with **sperm**, and immediately placing them in the **fallopian tubes**, where the egg is fertilised.

Option 5 is correct: Zygote intrafallopian transfer (ZIFT) is an Assisted Reproductive Technology which involves procedure similar to 'In vitro fertilisation', the difference being that the fertilised embryo is transferred into the fallopian tube instead of the uterus.

Source: <https://ncert.nic.in/ncerts/l/lebo104.pdf>

Subject:) Science and Technology

Subtopic:) Biotechnology

Q.44) Consider the following statements in the context of satellites and different Earth orbits:

1. Low Earth Orbit satellite always orbits along the Earth's equator.
2. Polar orbiting satellite senses only the polar regions of Earth.

3. All Geostationary orbits are Geosynchronous, while the vice versa is not true.
4. Satellites in the Lower Earth Orbit have a lower orbital velocity than the ones in higher orbits.
How many of the statements given above are correct?

- a) Only one
- b) Only two
- c) Only three
- d) All four

Ans) a

Exp) Option a is the correct answer.

Statement 1 is incorrect. Low Earth Orbit (LEO) satellites do not have to always orbit along Earth's equator. Satellites in Geostationary orbit have to always orbit along Earth's equator. Low Earth Orbiting satellites do not always have to follow a particular path around Earth in the same way – their plane can be tilted. This means there are more available routes for satellites in LEO, which is one of the reasons why LEO is a very commonly used orbit. It is the orbit most commonly used for satellite imaging, as being near the surface allows it to take images of higher resolution.

Statement 2 is incorrect. Polar orbiting satellites are in an orbital plane that is inclined at nearly 90 degrees to the equatorial plane. This inclination allows the satellite to sense the entire globe, including the Polar Regions, providing observations of locations that are difficult to reach via the ground. Many polar-orbiting satellites are considered sun synchronous, meaning that the satellite passes over the same location at the same solar time each cycle. Almost all satellites used for remote sensing and Geographic Information System (GIS) work are polar orbiters.

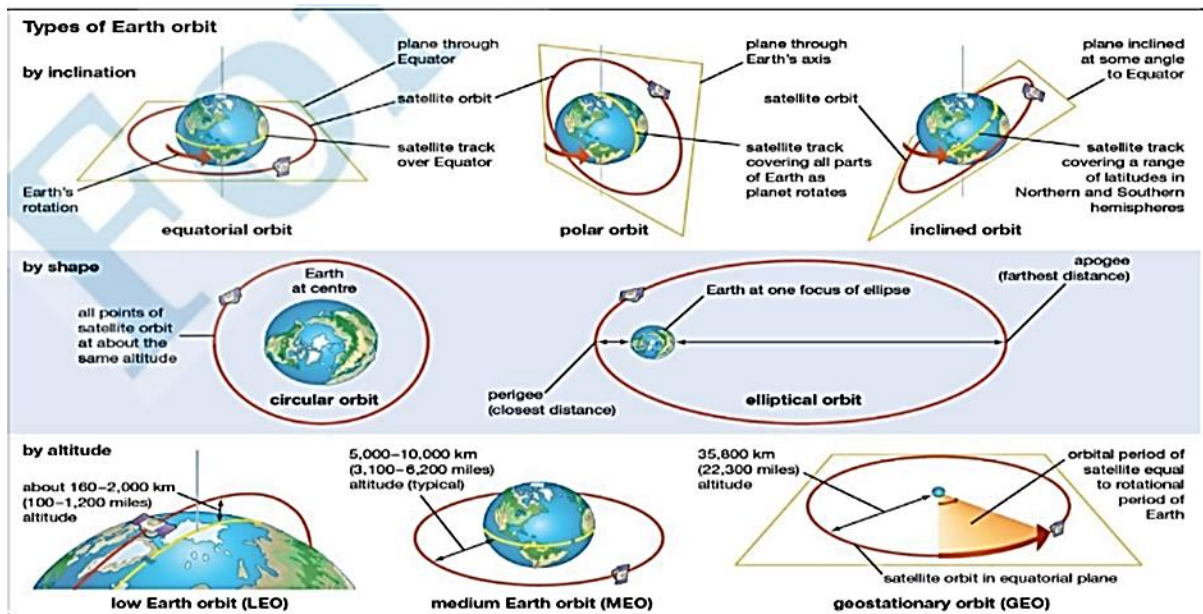
Statement 3 is correct. The Geosynchronous Orbit and Geostationary Orbit are defined on the basis of following conditions:

Condition 1: If the satellite is placed at an altitude of 35786 km above the Earth, where its velocity is such that it takes exactly 23 hrs 56 minutes 4 sec to revolve around the Earth.

Condition 2: If the Orbital plane and the Equatorial plane lies in the same plane throughout. If both the above conditions are satisfied, the satellite is said to be placed in Geostationary orbit. If only condition 1 is satisfied, the orbit is called a Geosynchronous orbit.

Thus, all Geostationary orbits are Geosynchronous as well, while the vice versa is not true. The Geostationary satellites remain permanently fixed with respect to a point on earth while the Geosynchronous satellites have a varying position with respect to a point on earth and wider coverage. Geosynchronous Transfer Orbit refers to an elliptical Geosynchronous orbit from where the satellite is transferred to a higher orbit or to Geostationary orbit through orbit maneuvering.

Statement 4 is incorrect. The satellites in the LEO travel much faster (i.e., they have a higher orbital velocity) than the ones in higher orbits because the gravitational pull of Earth is highest in the LEO, satellites in the LEO are more strongly pulled by the planet than those in the MEO or geostationary orbit.



Source:

<https://earthobservatory.nasa.gov/features/OrbitsCatalog#:~:text=There%20are%20essentially%20three%20types,farthest%20away%20from%20the%20surface>

Subject:) Science and Technology

Subtopic:) Space

Q.45) In the context of digital technologies for entertainment, consider the following statements:

1. In Augmented Reality (AR), a simulated environment is created, and the physical world is completely shut out.
2. In Virtual Reality (VR), images generated from a computer are projected onto real-life objects or surroundings.
3. AR allows individuals to be present in the world and improves the experience using the camera of smart-phone or PC.
4. VR closes the world, and transposes an individual, providing complete immersion experience.

Which of the statements given above is/are correct?

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

Ans) b

Exp) Option b is the correct answer.

Statement 1 is incorrect: Augmented Reality (AR) does not create a simulated environment, but rather adds virtual elements to the real world. For example, an AR app can show you how a piece of furniture would look in your room, or how a tattoo would look on your skin. The physical world is not shut out, but rather enhanced by AR.

Statement 2 is incorrect: Virtual Reality (VR) does not project images onto real-life objects, but rather blocks out the real world and immerses the user in a digital environment. For example, a VR headset can make you feel like you are in a different place, such as a game world, a movie scene, or a historical site. The real-life objects or surroundings are not visible, but rather replaced by VR.

Statement 3 is correct: AR allows users to interact with the real world and enhance their experience with virtual information or objects, using devices such as smartphones or PCs. For

example, an AR app can show you directions on the street, or information about a landmark, using the camera of your smartphone or PC.

Statement 4 is correct: VR transports users to a different reality and provides a complete immersion experience, using devices such as headsets or goggles. For example, a VR headset can make you feel like you are flying in the sky, or diving in the ocean, providing a sense of presence and realism.

Source: UPSC CSE Pre 2019

Subject:) Science and Technology

Subtopic:) IT and Telecom

Q.46) Scientists and legal professionals across the world increasingly utilize DNA fingerprinting technology for diverse purposes. In this context, consider the following

1. To identify the parent of a child
2. To successfully transplant human organs.
3. To transfer genes from animals to plants.
4. To diagnose genetic diseases.

The DNA fingerprinting technology can be effectively utilized in how many of the above cases?

- a) Only one
- b) Only two
- c) Only three
- d) All four

Ans) c

Exp) Option c is the correct answer.

DNA fingerprinting looks at particular areas in a DNA sequence called **repetitive DNA**. These areas have small bits of DNA repeated multiple times. Variations in this repeated DNA sequence are what make each person unique in how they look.

Option 1 is correct: DNA fingerprinting can determine biological parentage with high accuracy by comparing the specific regions of the child's DNA with that of potential parents. By analyzing shared genetic markers, **such as short tandem repeats (repeated DNA sequences), it identifies matches between the child and parents' DNA**. This plays a crucial role in resolving paternity disputes, immigration issues, and adoption cases. DNA fingerprinting works because a child receives half of their DNA from each parent.

Option 2 is correct: DNA fingerprinting helps in **tissue matching for organ transplantation**. By comparing the DNA of the donor and recipient, transplant specialists can **increase the chances of successful organ acceptance and reduce the risk of rejection**.

Option 3 is incorrect: The **recombinant DNA technology (not DNA fingerprinting)** that allows **genes to be transferred** from animals to plants. DNA fingerprinting technology cannot be used to transfer genes between organisms.

Option 4 is correct: **DNA fingerprinting enables medical researchers and physicians to identify hereditary diseases and genetic disorders** by analyzing specific genetic markers in an individual's DNA. By comparing these markers with known patterns associated with certain conditions across generations, it allows for the detection and understanding of inherited diseases, aiding in early diagnosis, and personalized treatment strategies.

Source: <https://ncert.nic.in/ncerts/l/lebo106.pdf>

Subject:) Science and Technology

Subtopic:) Biotechnology

Q.47) Consider the following activities:

1. Tracking the location of goods

2. Analyzing the distribution of mineral resources
3. Used by insurance companies for risk-based assessments.
4. Utilized in agriculture to analyze soil data.
5. Used for tracking geographical spread of diseases.

At the present level of technology available, how many of the above activities can be successfully carried out by using Geo-Spatial technology?

- a) Only two
- b) Only three
- c) Only four
- d) All five

Ans) d

Exp) Option d is the correct answer.

Geo-spatial technology refers to the **use of technology to collect, analyze, and visualize data that is related to a specific location**. This can include data such as maps, satellite imagery, and geographic information systems (GIS) data.

Option 1 is correct: Geo-spatial technology can be **used to track the location and movement of goods**, as well as to monitor and analyze data related to the quality of the goods, such as temperature or humidity data. GPS devices can be **attached to vehicles or cargo to track their location in real time**.

Option 2 is correct: Geo-spatial technology, specifically GIS and remote sensing, can be used to **map and analyze the distribution of mineral resources**. Remote sensing technologies such as satellite imagery and aerial photography can be used to detect and map the surface expression of mineral deposits and to identify areas of mineralization.

Option 3 is correct: **Geospatial technology is used by insurance companies as a predictive model for risk-based assessments**. If a certain location has a track record of things like frequent traffic accidents, high crime rates, etc., insurance companies can determine that may be a maximum risk area and define insurance policies specifically designed for that location.

Option 4 is correct: **Geospatial technology is currently being utilized to analyze soil data in order to determine which crops may grow in specific locations**. It also helps farmers create more efficient harvesting procedures.

Option 5 is correct: **Geospatial technologies are also incredibly important for tracking geographical spread of a disease** like in case of an epidemic use of geospatial information technology can help realize personnel tracking, confirmed cases distribution, grid management and spatial big data analysis to help authorities in making smart decisions in epidemic prevention and control.

Source: <https://www.indiascienceandtechnology.gov.in/geospatial-technology/applications>

Subject:) Science and Technology

Subtopic:) IT and Telecom

Q.48) In which of the following signature a physical mark is made by the person on the object which is to be signed?

- a) Click wrap signature
- b) Electronic signature
- c) Digital signature
- d) Wet mark signature

Ans) d

Exp) Option d is the correct answer.

The wet signature is any physical mark on documents created by a person. In most cases its writing your name in cursive on a piece of paper, document or contract, often with initials on each page indicating the extent of what is being signed.

Knowledge Base:

- 1) **Click Wrap Signatures** is used for **mostly online purchases**, where a simple tick in a box is an acceptance of the terms and conditions contained; referred to somewhere on the website. A **user is required to click the box** before the services can be consumed.
- 2) **Electronic Signature (E-Signature)** is a **digital version of a wet signature**, where many countries have defined the **legality and description of uses for e-signatures**. These are the most common form of signatures used by organizations globally.
- 3) **Digital Signature** is an **authentication mechanism** that enables a **code to be attached as a signature**. It is required for certain specific agreements, and issued through a certification agency.

Source: <https://signaturely.com/types-of-signatures/>

Subject:) Science and Technology

Subtopic:) IT and Telecom

Q.49) With reference to ‘Natural language Processing (NLP)’, consider the following statements:

1. It deals with the interaction between computers and humans using the natural language.
2. It uses algorithms to identify and extract the natural language rules and convert into a form that computers can understand.
3. It can be used to analyze the sentiments and moods of the customer.

How many of the above statements are **incorrect**?

- a) Only one
- b) Only two
- c) All three
- d) None

Ans) d

Exp) Option d is the correct answer.

Statement 1 is correct. Natural language processing (NLP) is a branch of artificial intelligence that deals with the interaction between computers and humans using the natural language. The ultimate objective of NLP is to read, decipher, understand, and make sense of the human languages in a manner that is valuable. Most NLP techniques rely on machine learning to derive meaning from human languages.

Statement 2 is correct. NLP entails applying algorithms to identify and extract the natural language rules such that the unstructured language data is converted into a form that computers can understand.

Statement 3 is correct. NLP can be used in sentiment analysis (understand mood of the customer), topic modelling (discovering abstract topics that occur in a collection of documents), text categorisation (categorising text into organised groups).

Source: <https://ncert.nic.in/textbook/pdf/kecs103.pdf>

<https://www.ibm.com/topics/natural-language-processing>

Subject:) Science and Technology

Subtopic:) IT and Telecom

Q.50) Consider the following statements with reference to the term “Micro-LED”:

1. Only organic materials are used for the manufacturing of Micro-LEDs.
2. They have brighter and better color reproduction than OLED display technology.

Which of the statements given above is/are correct?

- a) 1 only

- b) 2 only
- c) Both 1 and 2
- d) Neither 1 nor 2

Ans) b

Exp) Option b is the correct answer.

Statement 1 is incorrect: Micro LED differs from OLED in the makeup of the LED materials. The O in OLED stands for organic and refers to the organic materials used in light producing part of the pixel stack. **MicroLED technology changes this to an inorganic Gallium Nitride (GaN) material**, which is typically found in regular LED lighting.

Statements 2 is correct: Micro-LEDs are self-illuminating diodes that have brighter and better color reproduction than Organic Light Emitting Diode (OLED) display technology. Micro LED TVs can be made up of a number of smaller panels that attach together to form a bigger screen.

Source: <https://www.thehindu.com/sci-tech/technology/what-are-microled-displays-and-why-is-apple-shifting-to-it/article66500256.ece>

<https://www.microled-info.com/introduction>

Subject:) Science and Technology

Subtopic:) IT and Telecom