ANSWERS & EXPLANATIONS
GENERAL STUDIES (P) TEST – 4148 (2024)

Q 1.C

- **Permanent wilting point (PWP) or wilting point (WP) is defined as the minimum amount of water in the soil that the plant requires not to wilt.** If the soil water content decreases to this or any lower point a plant wilts and can no longer recover its turgidity when placed in a saturated atmosphere for 12 hours. Turgidity is the state of being turgid or swollen, especially due to high fluid content. Turgidity is essential in plant cells to make them keep standing upright. Plant cells that lose much water have less turgor pressure and tend to become flaccid.
- The matric potential at this soil moisture condition is commonly estimated at -15 bar. Most agricultural plants will generally show signs of wilting long before this moisture potential or water content is reached (more typically at around -2 to -5 bars) because the rate of water movement to the roots decreases and the stomata tend to lose their turgor pressure and begin to restrict transpiration.
- This water is strongly retained and trapped in the smaller pores and does not readily flow. The volumetric soil moisture content at the wilting point will have dropped to around 5 to 10% for sandy soils, 10 to 15% in loam soils, and 15 to 20% in clay soils.
- **Hence option (c) is the correct answer.**

Q 2.B

- Bases are a class of chemical substances that exhibit certain characteristic properties.
  - **Taste and Feel:**
    - ✓ **Bases often have a bitter taste. Hence statement 1 is correct.**
    - ✓ Many bases have a slippery or soapy feel when touched.
    - ✓ This is especially noticeable with concentrated solutions.
  - pH:
    - ✓ Bases have pH values greater than 7 on the pH scale.
    - ✓ The pH scale is a measure of the acidity or basicity of a solution, with 7 being neutral, values below 7 indicating acidity, and values above 7 indicating alkalinity (basicity).
  - **Turns Litmus Paper Blue:**
    - ✓ **Bases turn red litmus paper blue. Hence statement 2 is correct.**
    - ✓ Litmus paper is a commonly used indicator that changes color depending on whether a substance is acidic or basic.
  - Electrolyte Properties:
    - ✓ Bases typically dissociate or ionize in water to produce hydroxide ions (OH^-).
    - ✓ This makes them electrolytes, as they conduct electricity in solution.
  - Reaction with Acids:
    - ✓ Bases react with acids in a chemical reaction known as neutralization.
    - ✓ In this reaction, a base and an acid combine to form water and a salt.
  - Feeling of Coolness:
    - ✓ Some dilute bases give a cooling sensation when applied to the skin.
    - ✓ This property is commonly observed with substances like antacids.
  - **Solubility**:
    - ✓ **Many bases are soluble in water, forming aqueous solutions. Hence statement 3 is not correct.**
    - ✓ However, some bases, especially those containing heavy metal cations, may be less soluble.
  - Corrosive Properties:
    - ✓ Concentrated bases can be corrosive and may cause damage to living tissues.
    - ✓ Caution is necessary when handling strong bases.

- Reaction with Metals:
  - ✓ Bases can react with certain metals to produce hydrogen gas.
  - ✓ This reaction is similar to the reaction of acids with metals but produces hydroxide ions instead of hydronium ions.
- Amphoteric Nature:
  - ✓ Some substances can act as both acids and bases, depending on the conditions.
  - ✓ These substances are referred to as amphoteric. Water itself is an example of an amphoteric substance.

- Common examples of bases include sodium hydroxide (NaOH), potassium hydroxide (KOH), and ammonia (NH_3).

Q 3.C

- **Electrochemical Machining (ECM) is a non-traditional machining process that involves the controlled removal of metal from a workpiece through the process of electrochemical dissolution. The primary application of ECM in the industry is removing metal from surfaces through controlled dissolution.**
- In ECM, a conductive workpiece (anode) and a tool (cathode) are immersed in an electrolyte solution. When a voltage is applied between the workpiece and the tool, metal ions from the workpiece are selectively dissolved into the electrolyte, leading to the removal of material from the workpiece surface.
- ECM is particularly effective for machining complex shapes, intricate patterns, and areas that are difficult to reach with traditional machining methods.
- It is a precise and efficient process that allows for the machining of high-strength and heat-resistant materials.
- ECM is often used in the aerospace, medical, and automotive industries for applications such as turbine blade machining, the production of complex molds, and the creation of intricate components.
- **Hence option (c) is the correct answer.**

Q 4.A

- The melting point of a metal is the temperature at which it changes from a solid to a liquid state. Here's a brief overview of the melting points of some common metals.

Metal	Melting Point (°C)
Tungsten	3400
Chromium	1860
Molybdenum	2620
Titanium	1670
Platinum	1770
Nickel	1453
Stainless Steel*	1375-1530
Carbon Steel*	1425-1540
Inconel*	1390-1425
Cast Iron	1204
Brass	930
Aluminum Bronze*	1027-1038
Aluminum	660
Silver	961
Gold	1063
Copper	1084
Zinc	420
Lead	328

- **Hence option (a) is the correct answer.**

Q 5.B

- **A catalyst is a substance that speeds up the rate of a chemical reaction by providing an alternative pathway with a lower activation energy, without itself undergoing any permanent change or being consumed in the reaction.**
  - In other words, a catalyst increases the reaction rate by lowering the energy barrier (activation energy) for the reaction to occur, facilitating the conversion of reactants into products.
- Key points about catalysts:
  - Speeding up Reactions: Catalysts accelerate the rate of chemical reactions by providing an alternative reaction pathway that requires less energy for the formation of products.
  - **Remains Unchanged: A catalyst is not consumed in the reaction, and at the end of the reaction, it is regenerated and can be used again in subsequent reactions. Hence statement 1 is not correct.**
  - Specific to Reactions: Catalysts are specific to particular reactions or types of reactions. They do not alter the equilibrium position of a reaction but influence the kinetics, making the reaction proceed faster.
  - Not a Reactant or Product: A catalyst is not a reactant, and it does not appear in the stoichiometry of the balanced chemical equation for the reaction. It is not a part of the final products formed.
  - Can be Homogeneous or Heterogeneous: Catalysts can be in the same phase as the reactants (homogeneous catalysis) or in a different phase (heterogeneous catalysis).
- Examples: Common catalysts include transition metals (such as platinum, palladium, and nickel), enzymes in biological systems, acid or base catalysts, and various solid materials with catalytic properties.
- **Platinum is indeed a commonly used catalyst in various chemical reactions, particularly in heterogeneous catalysis where the catalyst is in a different phase from the reactants. Platinum's catalytic properties are utilized in reactions such as hydrogenation and dehydrogenation reactions in the chemical industry. Hence statement 2 is correct.**

Q 6.B

- **Gravitational lensing is a phenomenon in which the gravitational field of a massive object, such as a galaxy or a black hole, bends the light coming from a more distant object behind it. This bending of light is a consequence of Einstein's theory of General Relativity.**
- When a massive object, like a galaxy or a black hole, is situated between a distant light source (e.g., another galaxy or a quasar) and an observer, its gravitational field acts as a lens.
- **The massive object's gravitational field warps the spacetime around it. As light travels through this curved spacetime, it bends, following the curvature caused by the massive object's gravity.**
- Depending on the alignment of the observer, the massive object, and the distant light source, gravitational lensing can result in multiple images of the background object. These images may appear as distorted arcs, rings, or even multiple copies of the same object.
- **Gravitational lensing has been observed and confirmed through various astronomical observations.** One famous example is the gravitational lensing effect around massive galaxy clusters, where the lensing can magnify and distort background galaxies.
- In some cases, individual stars within a galaxy can act as gravitational lenses. This phenomenon, known as microlensing, can be used to detect objects like exoplanets, which might otherwise be challenging to observe directly.
- Gravitational lensing provides a powerful tool for astronomers to study the distribution of mass in the universe, including dark matter, and to investigate distant objects that might otherwise be too faint or distant to observe directly.
- **Hence option (b) is the correct answer.**

Q 7.B

- **Viruses are non-living and made up of DNA or RNA surrounded by a protein coat.** They can replicate. However, they cannot reproduce on their own. They reproduce when inside a living cell. Therefore viruses pose a special classification problem. Viruses are extremely small and can be seen only under the electron microscope. They are smaller than the smallest bacteria. They can pass through fiters which retain bacteria.
- Virus has a simple structure consisting of a core and a cover. **The core particle is the genetic material, either DNA or RNA.** The cover is a protein coat called capsid. **Hence statement 2 is not correct.**
- **A virus cannot reproduce by itself. For its reproduction it needs to enter the cell of some organism.** From the host cell, it uses the raw material and enzymes and energy generating machinery of

the host cell to produce its own DNA. A number of virus particles are thus formed inside the host cell. The host cell bursts to release the new virus particles. **Hence statement 1 is correct.**

- Viruses are known to attack bacteria, plants or animals. **Viruses which invade bacteria are called bacteriophages.** Viruses are highly specific in their relationship with the host and tissue.
    - **Viroids are circular RNA molecules, consisting of several hundred nucleotides.** They infect plants and even kill them. In plants, they use enzymes of the plant cells to replicate like the viruses do. **Hence statement 3 is not correct.**
- Viruses are responsible for causing many diseases, including:
    - AIDS, Common cold, Ebola, **Herpes, Influenza, Measles**, Chickenpox and shingles, Coronavirus disease 2019 (COVID-19), **Hepatits, Small Pox, Dengue e**tc. **Antibiotics designed for bacteria have no effect on viruses. Hence statement 4 is correct.**

Q 8.B

- **SDN or sequence specific nuclease (SSN) refers to the practice of cleaving DNA strands to affect the subsequent genome editing.** SDN technology takes advantage of targeted DNA break and host's natural repair mechanisms to introduce specific small changes at the site of the DNA break.
- The basis of current targeted genome editing applications is the capacity to induce a DNA double strand break (DSB) at a selected location in the genome where the modification is intended. Directed repair of the DSB allows for targeted genome editing. Such applications can be applied to generate mutations (targeted mutations or precise native gene editing) as well as precise insertion of genes (cisgenes, intragenes, or transgenes).
- Different approaches can be used to achieve targeted DNA breaks, including **Meganucleases (MN), Zinc Finger Nucleases (ZFNs),** Transcription Activator-Like Effector Nucleases **(TALENs) and** the Clustered Regularly Interspaced Short Palindromic Repeats **(CRISPR)-associated proteins (CRISPR/Cas) etc**. Collectively, these are often discussed under the acronym **site directed nucleases (SDNs), pointing out to the general principle of the technology to use a DNA cutting enzyme (nuclease) for the generation of the targeted (or site directed) DNA break. Hence option (b) is the correct answer.**
- Variants of SDN applications are often categorized as **SDN-1, SDN-2 and SDN-3** depending on the outcome of the DNA double strand break repair.
    - **SDN-1:** When the SDN is used in the absence of a DNA repair template (see SDN-2/-3), the outcome is a targeted, non-specific genetic deletion mutation. In this case, the position of the DNA DSB is precisely selected, but the DNA repair by the host cell is random and results in small nucleotide deletions, additions or substitutions.
    - **SDN-2:** Is used to generate gene editing mutations. In this case, a SDN is used to generate a targeted DSB and a DNA repair template (a short DNA sequence identical to the targeted DSB DNA sequence except for one or a few nucleotide changes) is used to repair the DSB. The outcome is a targeted and predetermined point mutation in the desired gene of interest.
    - **SDN-3:** When the SDN is used along with a DNA repair template that contains new DNA sequence (e.g.gene), the outcome of the technology would be the integration of that DNA sequence into the plant genome. The most likely application illustrating the use of SDN-3 would be the insertion of cisgenic, intragenic, or transgenic expression cassettes at a selected genome location.

Q 9.A

- An actively photosynthesizing plant has an insatiable need for water. Photosynthesis is limited by available water which can be swiftly depleted by transpiration. The humidity of rainforests is largely due to this vast cycling of water from root to leaf to the atmosphere and back to the soil. The evolution of the C4 photosynthetic system is probably one of the strategies for maximizing the availability of CO2 while minimizing water loss. **C4 plants are twice as efficient as C3 plants in terms of fixing carbon (making sugar). However, a C4 plant loses only half as much water as a C3 plant for the same amount of CO2 fixed. Hence statement 1 is not correct.**
- Food, primarily sucrose, is transported by the vascular tissue phloem from a source to a sink. Sugar stored in roots may be mobilized to become a source of food in the early spring when the buds of trees, act as a sink; they need energy for growth and development of the photosynthetic apparatus. Since the source-sink relationship is variable, **the direction of movement in the phloem can be upwards or downwards, i.e., bi-directional.** This contrasts with that of the **xylem where the movement is always unidirectional, i.e., upwards.** Hence, unlike the one-way flow of water in transpiration, food in phloem sap can be transported in any required direction so long as there is a source of sugar and a sink able to use, store, or remove the sugar. **Hence statement 2 is correct.**

- **Mycorrhizae are a symbiotic association between plant roots and fungi.** The fungal filaments form a network around the young root or they penetrate the root cells. The hyphae have a very large surface area that absorbs mineral ions and water from the soil a much larger volume of soil that perhaps a root cannot do. **The fungus provides minerals and water to the roots, in turn, the roots provide sugars and N-containing compounds to the mycorrhizae.** Some plants have an obligate association with the mycorrhizae. For example, Pinus seeds cannot germinate and establish without the presence of mycorrhizae. **Hence statement 3 is not correct.**

Q 10.B

- **Recent Context:** A Namibian cheetah gave birth increasing the population amid deaths of Cheetahs at Kuno National Park.
- Project Cheetah, India's ambitious attempt to introduce African cheetahs in the wild in the country was launched in September 2022.
  - The cheetah was declared extinct in India by 1952, the only large carnivore species that went extinct in Independent India. So, its objective was to establish viable cheetah metapopulation in India that allows cheetahs to perform its functional role as top predator.
- Under Project Cheetah, a total of 20 animals were relocated from Namibia and South Africa to Kuno National Park (KNP) in two batches under the government's Project Cheetah. The first batch came in September 2022 and the second in February 2023. As of now, 13 of the original 20 are alive. 20 Cheetah were translocated from Namibia and South Africa. Whereas, Sahel region is defined as the North-Central African semi-arid region between the Sahara Desert and savanna regions. It includes the countries of Burkina Faso, Cameroon, Chad, The Gambia, Guinea Mauritania, Mali, Niger, Nigeria and Senegal. **Hence statement 1 is not correct.**
- Out of 6 criteria for assessing short-term success, the project has already met four criteria namely:50% survival of introduced cheetahs, Establishment of home ranges, Birth of cubs in Kuno, and Revenue to local communities.
- Implementing Agency of Project Cheetah is National Tiger Conservation Authority (NTCA). **Hence statement 2 is correct.**
- Funding of project Cheetah is from **Project Tiger as well as Compensatory Afforestation Fund Management & Planning Authority (CAMPA)**.
- Cheetah is protected under Appendix 1 of CITES. **The IUCN status of African cheetah is Vulnerable and Asiatic cheetah is Critically endangered.** Till now, there were 15 cheetahs at KNP and the tally now stands at 18.

Q 11.C

- **Growth regulators are chemical substances, other than naturally produced hormones,** which promote, inhibit or modify growth and development in plants. The naturally produced growth hormones are broadly grouped under five major classes. **They are Auxin, Ethylene, Cytokinins, Gibberellins and Abscissic acid.**
- **Auxin:** Auxin is a growth promoter, generally produced by the growing apex of stem and root of the plants. It helps in the elongation of shoot and root tips behind apical meristem. The naturally produced auxins is Indole-3-Acetic Acid (IAA).
  - **Functions of Auxin:**
    - ✓ It **promotes cell elongation. Hence pair 1 is correctly matched.**
    - ✓ It suppresses the growth of lateral bud. If the tip of a plant is removed, the lateral branches begin to grow; In most of the plants apical bud suppresses the development of lateral buds. This is called apical dominance.
    - ✓ It delays fall of leaves. (leaf abscission)
- **Gibberellin:** Gibberellin or Gibberellic Acid (GA) was initially isolated from a fungus Gibberella fujikuroi. In plants, it is produced in embryos, roots, and young leaves and it enhances growth.
  - **Functions of Gibberellins**
    - ✓ It helps in elongation of stems in genetically dwarf plants. By using gibberellin the height of the dwarf plants can be increased.
    - ✓ It **breaks dormancy of seeds and buds. Hence pair 2 is not correctly matched.**
    - ✓ It induces parthenocarpy. (Formation of seedless fruits without fertilization) or provides stimulus received by pollination.
- **Cytokinins:** They were extracted from coconut milk. Cytokinins are synthesized in root apex, endosperm of seeds, and young fruits where cell division takes place continuously.
  - **Functions of Cytokinins**

        - ✓ They stimulate cell division, cell enlargement and cell differentiation.
        - ✓ **They prevent aging of plant parts. Hence pair 3 is correctly matched.**
        - ✓ They inhibit apical dominance and help in growth of lateral buds into branches.
- **Ethylene:** Ethylene is a gaseous hormone. It is found in ripening fruits, young flowers and young leaves.
    - **Functions of Ethylene**
        - ✓ It induces ripening of fruits.
        - ✓ **It promotes senescence and abscission of leaf, and flowers. Hence pair 4 is correctly matched.**
        - ✓ In cells it only increases the width not the length.
- **Abscissic acid:** Abscissic acid also known as Dormin is a naturally occurring growth inhibitor found in wide variety of plants. It is synthesised in leaves.
    - **Functions of Abscissic acid:**
        - ✓ It induces dormancy of buds and seeds as opposed to Gibberellin, which breaks dormancy.
        - ✓ It promotes the senescence of leaf, i.e., fall of leaves happen due to abscissic acid.
        - ✓ It inhibits seed germination and development.
        - ✓ It causes closing of Stomata.

Q 12.B

- **All the options are correct.**
- **Doppler Effect:** The Doppler effect is a phenomenon observed whenever the source of waves is moving with respect to an observer. The **Doppler effect** can be described as the effect produced by a moving source of waves in which there is an apparent upward shift in frequency for the observer and the source are approaching and an apparent downward shift in frequency when the observer and the source are receding. The Doppler effect can be observed to occur with all types of waves - most notably water waves, sound waves, and light waves.
- **Examples:** A police car or emergency vehicle was traveling towards you on the highway. As the car approached with its siren blasting, the pitch of the siren sound (a measure of the siren's frequency) was high; and then suddenly after the car passed by, the pitch of the siren sound was low. That was the Doppler effect - a shift in the apparent frequency for a sound wave produced by a moving source**.**
- **Applications of Doppler Effect:**
    - Police radar to check the speed of vehicles on a highway.
    - To read weather events. In this case, the stationary transmitter is located in a weather station and the moving object being studied is a storm system.
    - Echocardiogram.
    - **Sonic boom produced by the supersonic aircraft.**
- Echolocation by bats: To help them find their prey in the dark, most bat species have developed a remarkable navigation system called **echolocation**

Q 13.B

- Conductors, semiconductors, and insulators are classified on the basis of conductivity/resistivity.
- Conductors possess very low resistivity (or high conductivity).
- Semiconductors have resistivity or conductivity intermediate to conductors and insulators.
- Insulators have high resistivity (or low conductivity).
    - Thus resistivity of semiconductors is more than conductors but less than insulators. **Hence statement 1 is not correct.**
- Semiconductors can be :
    - Elemental semiconductors: Silicon(Si) and Germanium(Ge)
    - Compound semiconductors: Examples are:
        - ✓ Inorganic: CdS, GaAs, CdSe, InP, etc.
        - ✓ Organic: anthracene, doped pthalocyanines, etc.
        - ✓ Organic polymers: polypyrrole, polyaniline, polythiophene, etc.
- Most of the currently available semiconductor devices are based on elemental semiconductors Si or Ge and compound inorganic semiconductors. **Hence statement 2 is correct.**

Q 14.B

- IRNSS is an independent regional navigation satellite system being developed by India. **It is designed to provide accurate position information service to users in India as well as the region extending up to 1500 km from its boundary**, which is its primary service area. An Extended Service Area lies between

primary service area and area enclosed by the rectangle from Latitude 30 deg South to 50 deg North, Longitude 30 deg East to 130 deg East. **Hence statement 2 is correct.**

- **The IRNSS System provides navigation solutions all the time with position accuracy better than 20m during all weather conditions, anywhere within India** and a region extending about 1500 km around India. IRNSS provides Standard Positioning Service (SPS) and Restricted Service (RS) to the users on dual frequencies in L5 and S band. **Hence statement 3 is correct.**
- **The IRNSS space segment consists of 7 satellites (3 Geostationary Orbit and 4 Geosynchronous Orbit). Hence statement 1 is not correct.**

Q 15.C

- **TB is caused by bacteria (Mycobacterium tuberculosis)** and it most often affects the lungs. TB is **spread through the air** when people with lung TB cough, sneeze or spit. A person needs to inhale only a few germs to become infected. Every year, 10 million people fall ill with tuberculosis (TB). Despite being a preventable and curable disease, 1.5 million people die from TB each year – making it the world's top infectious killer. Hence statement 1 is correct. **Hence statement 1 is correct.**
- **XDR-TB, an abbreviation for extensively drug-resistant tuberculosis (TB),** is a form of TB which is **resistant to at least four of the core anti-TB drugs**. XDR-TB involves resistance to the two most powerful anti-TB drugs, **isoniazid and rifampicin, also known as multidrug-resistance (MDR-TB)**, in **addition to resistance to any of the fluoroquinolones (such as levofloxacin or moxifloxacin)** and to at least one of the three injectable second-line drugs (amikacin, capreomycin or kanamycin). **Hence statement 2 is not correct.**
- MDR-TB and XDR-TB both take substantially longer to treat than ordinary (drug-susceptible) TB, and require the use of second-line anti-TB drugs, which are more expensive and have more side-effects than the first-line drugs used for drug-susceptible TB.
- Under Universal Immunization Programme, immunization of children starts as soon as child is born. **Vaccination against childhood tuberculosis (BCG), polio (OPV) and maternally transmitted Hepatitis B (Hep B vaccine) are given to a child immediately after birth.** After this, specific vaccines are given at recommended ages and routes as outlined in National Immunization Schedule. **Hence statement 3 is correct.**

Q 16.C

- **Free Space Optical (FSO) is a communication system where free space acts as a medium between transceivers and data is transmitted by the propagation of light in free space allowing optical connectivity. The medium can be air, outer space, or vacuum. Hence statement 1 is correct.**
- Working of FSO is similar to OFC (optical fiber cable) networks but the only difference is that the optical beams are sent through free air instead of OFC cores that are glass fiber.
- **FSO is a LOS (line of sight) technology,** where data, voice, and video communication is achieved with maximum 10Gbps of data rate by full-duplex (bidirectional) connectivity
- **<u>Applications:</u>**
  - It can be used by wireless service providers for communication and it requires no license to use the FSO as it is required in case of microwave bands.
  - FSO links can be used to form a Storage Area Network (SAN). It is a network that is known to provide access to consolidated, block-level data storage.
  - To lay cables of users in the last mile is very costly for service providers as the cost of digging to lay fiber is so high and it would make no sense to lay as much fiber as possible. FSO can be used to solve such a problem by implementing it in the last mile along with other networks.
  - FSO systems are easily installable. This feature makes it applicable for interconnecting LAN segments to connect two buildings or other property.
  - Providing a backup link in case of failure of transmission through a fiber link
  - Extending the fiber rings of an existing metropolitan area.
  - To provide instant service to customers when their fiber infrastructure is being deployed in the meantime.
  - **To communicate between point-to-point links, for example, two buildings, two ships, and point-to-multipoint links, for example, from aircraft to ground or satellite to ground, for short and long reach communication. Hence statement 2 is correct.**
  - As it is a secure and undetectable system it can connect large areas safely with minimal planning and deployment time and is hence suitable for military applications.

Q 17.B

- **Branching descent and natural selection are the two key concepts of the Darwinian Theory of Biological Evolution**.
- In his 'The Origin of Species', Darwin used the idea of branching descent to describe the process of descent with modification and how it results in the origin of new species (different species share common ancestral species).
- The essence of Darwinian theory about evolution is natural selection. The rate of appearance of new forms is linked to the life cycle or the life span. Microbes that divide fast have the ability to multiply and become millions of individuals within hours. A colony of bacteria (say A) growing on a given medium has built-in variation in terms of the ability to utilize a feed component. A change in the medium composition would bring out only that part of the population (say B) that can survive under the new conditions. In due course of time, this variant population outgrows the others and appears as a new species. This would happen within days. For the same thing to happen in a fish or fowl would take millions of years as life spans of these animals are in years. Here we say that the fitness of B is better than that of A under the new conditions. Nature selects for fitness.
- One must remember that the so-called fitness is based on characteristics which are inherited. Hence, there must be a genetic basis for getting selected and to evolve. Another way of saying the same thing is that some organisms are better adapted to survive in an otherwise hostile environment. Adaptive ability is inherited. It has a genetic basis. Fitness is the end result of the ability to adapt and get selected by nature.

Q 18.D

- **Recent Context:** In a bid to reduce cases of cervical cancer, the government is likely to roll out an immunisation campaign against Human Papillomavirus (HPV) in the second quarter of the year. Girls between the ages of 9 and 14 years across India will be vaccinated for free in three phases under the government's programme over the next three years.
- Globally, cervical cancer is the 4th most common cancer in women. India contributes to the largest proportion of global cervical cancer burden. **Hence Statement-II is correct.**
- In India, cervical cancer is the second most common cancer in women and breast cancer is most common cancer. **Hence Statement-I is not correct.**
- The National Technical Advisory Group for Immunization (NTAGI) has recommended the introduction of HPV Vaccine in the Universal Immunization Programme (UIP) for 9-14 year-old adolescent girls but it has not been introduced in the Universal Immunization Programme (UIP).

Q 19.C

- **Cryogenic engines are highly efficient propulsion systems used in the upper stages of rockets.** They offer a higher specific impulse, which measures the efficiency or thrust of an engine, resulting in an increased payload capacity. A Cryogenic rocket stage is more efficient and provides more thrust for every kilogram of propellant it burns compared to solid and earth-storable liquid propellant rocket stages. **Hence statement 1 is correct.**
- The main components of a cryogenic rocket engine include an igniter, combustion chamber (thrust chamber), fuel cryo pumps, fuel injector, oxidiser cryo pumps, gas turbine, cryo valves, regulators, fuel tanks, and a rocket engine nozzle.
- **Cryogenic engine makes use of Liquid Oxygen (LOX) and Liquid Hydrogen (LH2) as propellants** which liquefy at -183 deg C and -253 deg C respectively. LOX and LH2 are stored in their respective tanks. Typically, these engines use a combination of liquid oxygen (LOX) as the oxidizer and liquid hydrogen (LH2) as the fuel. The use of cryogenic fuels allows for high performance and efficiency in rocket engines. **Hence statement 2 is correct.**
- For the Chandrayaan-3 mission, the CE-20 cryogenic engine was used. The CE-20 was India's first cryogenic engine with a gas-generator cycle and the largest cryogenic engine to be made by ISRO. It took its first flight in June 2017.

Q 20.C

- **RNA interference (RNAi)** is a precise mechanism operative in eukaryotic cells which helps a cell to check the invasion of foreign genes (from viruses and transposons and also to check the expression of their own genes). **RNAi takes place in all eukaryotic organisms as a method of cellular defense.** RNA Interference was discovered by **Andrew Fire and Craig Mello in 2006 who were awarded the Nobel Prize. Hence statement 2 is correct.**

- This method **involves silencing of a specific mRNA due to a complementary dsRNA molecule that binds to and prevents translation of the mRNA (silencing).** Double stranded RNA molecules may arise in several ways:
  - by the transcription of inverted repeats into an RNA molecules that then base pairs with itself to form double- stranded RNA,
  - by simultaneous transcription of two different RNA molecules that are complementary to one another that pair, forming double- stranded RNA,
  - by infection of viruses that make double stranded RNA. **Hence statement 1 is correct.**
- Geneticists speculate that RNA interference evolved as a defense against RNA viruses and transposable elements that move through RNA intermediate. However, RNA interference is also responsible for number of **key genetic and developmental processes including changes in chromatin structure, translation, cell fate and proliferation, and cell death.** Geneticists also use RNAi machinery as an effective tool for **blocking the expression of specific genes and hence in gene silencing.**
  - **Several nematodes parasitise a wide variety of plants and animals including human beings.** A nematode Meloidegyne incognitia infects the roots of tobacco plants and causes a great reduction in yield. A **novel strategy was adopted to prevent this infestation which was based on the process of RNA interference (RNAi).** The source of this complementary RNA could be from an infection by viruses having RNA genomes or mobile genetic elements (transposons) that replicate via an RNA intermediate.
  - **Using Agrobacterium vectors, nematode-specific genes were introduced into the host plant.** The introduction of DNA was such that it produced both sense and anti-sense RNA in the host cells. These two RNA's being complementary to each other formed **a double stranded (dsRNA) that initiated RNAi and thus, silenced the specific mRNA of the nematode.** The consequence was that the parasite could not survive in a transgenic host expressing specific interfering RNA. The transgenic plant therefore got itself protected from the parasite. **Hence statement 3 is correct.**

Q 21.B

- Small Satellite Launch Vehicle (SSLV) is the new small satellite launch vehicle developed by ISRO to cater the launch of small satellites up to 500 kg
- **It is a 3 stage Launch Vehicle configured with three Solid Propulsion Stages** and liquid propulsion-based Velocity Trimming Module (VTM) as a terminal stage. SSLV is 2m in diameter and 34m in length with lift-off weight of ~120 tonnes. **Hence statement 1 is not correct.**
- SSLV is capable of launching 500kg satellite in 500km planar orbit from SDSC/SHAR. **Hence statement 2 is correct.**
- The key features of SSLV are Low cost, with low turn-around time, flexibility in accommodating multiple satellites, Launch on demand feasibility, minimal launch infrastructure requirements, etc.

Q 22.C

- **The Milky Way is a spiral galaxy around 13.6 billion years old with large pivoting arms stretching out across the cosmos.**
  - Spiral galaxies are characterized by a central bulge surrounded by spiral arms that extend outward. The arms contain a concentration of stars, gas, and dust, giving the galaxy its distinctive spiral appearance when observed from certain angles.
  - Our solar system is located in one of the Milky Way's spiral arms, known as the Orion Arm or Local Spur.
- **At the center of the Milky Way, in the region known as Sagittarius A*, there is a supermassive black hole. This supermassive black hole has a mass equivalent to about 4 million times that of our Sun.**
  - It was discovered through observations of the motions of stars orbiting around an invisible and extremely compact object, indicating the presence of a massive gravitational source, characteristic of a black hole.
- **Hence both statements 1 and 2 are correct.**

Q 23.C

- **Satellites in geostationary orbit (GEO) circle Earth above the equator from west to east following Earth's rotation** – taking 23 hours 56 minutes and 4 seconds – by travelling at exactly the same rate as Earth. **This makes satellites in GEO appear to be 'stationary' over a fixed position. Hence statement I is correct and statement II is not correct.**

- In order to perfectly match Earth's rotation, the speed of GEO satellites should be about 3 km per second at an altitude of 35 786 km. This is much farther from Earth's surface compared to many satellites.
- GEO is used by satellites that need to stay constantly above one particular place over Earth, such as telecommunication satellites. This way, an antenna on Earth can be fixed to always stay pointed towards that satellite without moving. It can also be used by weather monitoring satellites, because they can continually observe specific areas to see how weather trends emerge there.

Q 24.D

- **Aircraft tires are filled with nitrogen because nitrogen gas is mostly inert, meaning that it requires more energy to react with other substances.** This is important because, at elevated temperatures, oxygen can react with rubber. Oxidized rubber is weaker than non-oxidized rubber, and weaker tires are not preferred.
- **Air has certain moisture content and it is generally very hard to remove this moisture**. If an airplane tires were filled with air, at the flight altitude ice would form inside the tires since the temperature up there is about -30 degrees F. Landing with a chunk of ice in the tire would make it out of balance and change the tire pressure. Tires would probably burst.
- **On the other hand, nitrogen doesn't form a liquid till -173C and pure nitrogen has almost no moisture.**
- **Nitrogen being lighter than air does not play a part in it being used in the airplane tyres.**
- **Hence option (d) is the correct answer.**

Q 25.B

- **Statement 1 is not correct:** The transfer of heat by radiation does not require any medium. It can take place whether a medium is present or not. When we come out in the sun, we feel warm. How does the heat from the sun reach us? It cannot reach us by conduction or convection as there is no medium such as air in most parts of the space between the earth and the sun. From the sun the heat comes to us by another process known as radiation.
- **Statement 2 is correct:** Since the primary source of infrared radiation is heat or thermal radiation, any object which has a temperature radiates in the infrared. Even objects that we think of as being very cold, such as an ice cube, emit infrared. When an object is not quite hot enough to radiate visible light, it will emit most of its energy in the infrared. For example, hot charcoal may not give off light but it does emit infrared radiation which we feel as heat. The warmer the object, the more infrared radiation it emits.

Q 26.D

- Glass manufacturing is a complex process that involves transforming raw materials into a wide range of glass products, from everyday items like bottles and windows to specialized materials used in electronics. The key steps in the glass manufacturing process include:
- **Raw Materials: The primary raw materials for glass production include silica (sand), soda ash, and limestone. Additional materials may be added to achieve specific properties or colors.**
- Melting: The raw materials are mixed and melted in a furnace at high temperatures (typically around 1700°C or 3092°F) to form molten glass. This molten glass is a viscous liquid that can be shaped and molded.
- Forming: The molten glass is shaped into the desired form through various processes: Blown Glass: The glassblower gathers molten glass on the end of a blowpipe and shapes it by blowing air into the pipe.
- Float Process: Molten glass is poured onto a pool of molten tin, creating a smooth, flat surface. Pressed Glass: Molten glass is pressed into molds to achieve specific shapes.
- **Annealing: The formed glass is slowly cooled in an annealing oven. This controlled cooling process helps relieve internal stresses, ensuring the glass's strength and durability.**
- Cutting and Finishing: Once the glass has cooled and solidified, it is cut, polished, and finished to achieve the desired dimensions and surface qualities. Tempering (Optional): In some cases, glass may undergo a tempering process to increase its strength.
- Tempered glass is heated and then rapidly cooled, creating a strong outer layer. Coating and Decoration (Optional): Glass products may be coated or decorated for specific purposes, such as UV protection, insulation, or aesthetics.
- Quality Control: Rigorous quality control measures are applied throughout the manufacturing process to ensure that the glass meets specified standards for strength, clarity, and other properties.
- Recycling: Glass is highly recyclable. Used glass products can be collected, crushed, and melted to create new glass, reducing the demand for raw materials.
- **Hence option (d) is the correct answer.**

Q 27.A

- **A hypersonic missile is a weapon system which flies at least at the speed of Mach 5** i.e. five times the speed of sound and is manoeuvrable. **Hence statement 1 is not correct.**
- The manoeuvrability of the hypersonic missile is what sets it apart from a ballistic missile as the latter follows a set course or a ballistic trajectory. H**ypersonic missiles mostly are cruise missiles that do not follow a ballistic trajectory and can be manoeuvred to the intended target. Hence statement 2 is not correct.**
- The two types of hypersonic weapons systems are Hypersonic Glide Vehicles (HGV) and Hypersonic Cruise Missiles. The HGV is launched from a rocket before gliding to the intended target while the hypersonic cruise missile is powered by air-breathing high-speed engines or 'scramjets' after acquiring their target.
- **Conventional hypersonic weapons use only kinetic energy i.e. energy derived from motion, to destroy unhardened targets** or even underground facilities. **Hence statement 3 is correct.**
- India is also developing an indigenous, dual-capable (conventional as well as nuclear) hypersonic cruise missile as part of its Hypersonic Technology Demonstrator Vehicle programme and has successfully tested a Mach 6 scramjet

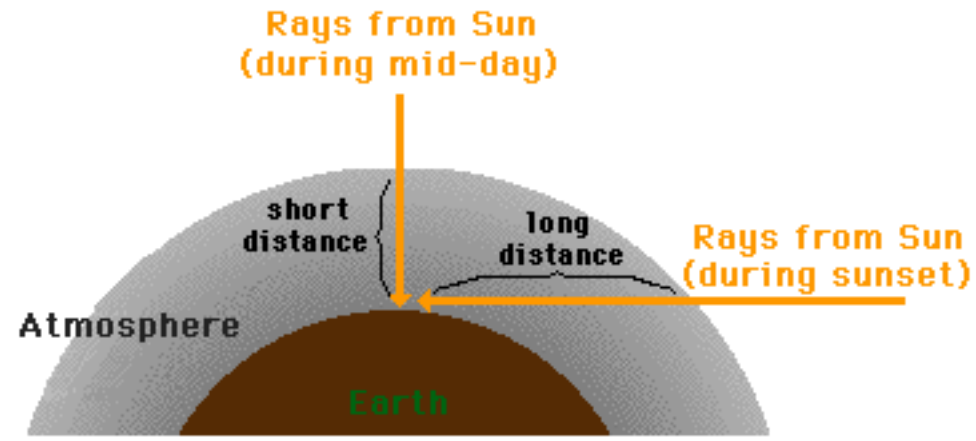
Q 28.B

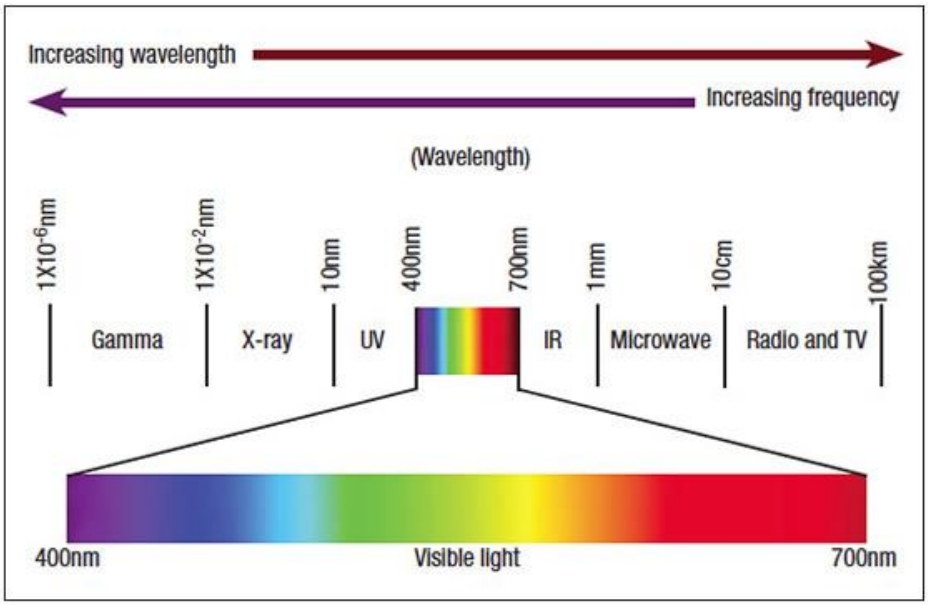
- **A ramjet is a form of air-breathing jet engine that uses the vehicle's forward motion to compress incoming air for combustion** without a rotating compressor. Fuel is injected in the combustion chamber where it mixes with the hot compressed air and ignites. A ramjet-powered vehicle requires an assisted take-off like a rocket assist to accelerate it to a speed where it begins to produce thrust. **Hence statement 1 is correct.**
    - Ramjets work most efficiently at supersonic speeds around Mach 3 (three times the speed of sound) and can operate up to speeds of Mach 6. **However, the ramjet efficiency starts to drop when the vehicle reaches hypersonic speeds**. **Hence statement 3 is not correct.**
- **A scramjet is a type of ramjet airbreathing jet engine where combustion occurs in supersonic airflow.** A scramjet engine is an improvement over the ramjet engine as it efficiently operates at hypersonic speeds and allows supersonic combustion. Thus it is known as Supersonic Combustion Ramjet, or Scramjet. **Hence statement 2 is correct.**

Q 29.C

- Blood cells are the cells which are produced during hematopoiesis and found mainly in the blood. Blood is composed of the blood cells which accounts for 45% of the blood tissue by volume, with the remaining 55% of the volume composed of plasma, the liquid portion of the blood.
- There are three types of blood cells. They are:
    - **Red blood cells (Erythrocytes). Hence, option 4 is not correct.**
    - White blood cells (Leukocytes)
    - Platelets (Thrombocytes)
- **What are White Blood Cells?**
    - **White blood cells** account for **only about 1% of our blood**, but their impact is big.
        - ✓ White blood cells are also called leukocytes. They **protect us against illness and disease.**
        - ✓ White blood cells are **made in the bone marrow.**
        - ✓ They are stored in our blood and lymph tissues.
        - ✓ Because some white blood cells have a **short life of 1 to 3 days**, your bone marrow is always making them.
- **What are the types of WBC?**
    - **Monocytes.** They have a longer lifespan than many white blood cells and help to break down bacteria.
    - **Lymphocytes.** They create antibodies to fight against bacteria, viruses, and other potentially harmful invaders. **Hence, option 2 is correct.**
    - **Neutrophils.** They kill and digest bacteria and fungi. They are the most numerous type of white blood cell and your first line of defense when infection strikes. **Hence, option 1 is correct.**
    - **Basophils.** These small cells seem to sound an alarm when infectious agents invade your blood. They secrete chemicals such as histamine, a marker of allergic disease, that help control the body's immune response. **Hence, option 3 is correct.**
    - **Eosinophils.** They attack and kill parasites and cancer cells, and help with allergic responses.

Q 30.C





- **As sunlight travels through the earth's atmosphere, it gets *scattered* (changes its direction) by the atmospheric particles.** Light of shorter wavelengths is scattered much more than light of longer wavelengths. (The amount of scattering is inversely proportional to the fourth power of the wavelength. This is known as Rayleigh scattering). At sunset or sunrise, the sun's rays have to pass through a larger distance in the atmosphere. Most of the blue and other shorter wavelengths are removed by scattering. The least scattered light reaching our eyes, therefore, the sun looks reddish. This explains the reddish appearance of the sun and full moon near the horizon.
- This is also the reason that the sky appears blue during the day, as blue has a shorter wavelength than red and is scattered much more strongly. In fact, violet gets scattered even more than blue, having a shorter wavelength. But since our eyes are more sensitive to blue than violet, we see the sky blue.
- **Hence option (c) is the correct answer.**

Q 31.D

- Immunity refers to the state of being insusceptible to a particular disease. It is a condition that permits either natural or acquired resistance to disease.
- It can be classified as:
  - **Active immunity -** It results when exposure to a disease organism triggers the immune system to produce antibodies to that disease. Exposure to the disease organism can occur through infection with the actual disease (resulting in natural immunity), or introduction of a killed or weakened form of the disease organism through vaccination (vaccine-induced immunity). Either way, if an immune person comes into contact with that disease in the future, their immune system will recognize it and immediately produce the antibodies needed to fight it. Active immunity is long-lasting, and sometimes life-long.
  - **Passive immunity -**
    - ✓ **It is provided when a person is given antibodies to a disease rather than producing them through his or her immune system. Hence statement 1 is correct.**

- ✓ **A newborn baby acquires passive immunity from its mother through the placenta.** A person can also get passive immunity through antibody-containing blood products such as immune globulin, which may be given when immediate protection from a specific disease is needed.
- ✓ **It can develop naturally when a mother's antibodies are transferred to a fetus or infant.** It can also occur artificially when antibodies are transferred, often through a blood or plasma transfusion. **Hence statement 2 is correct.**
- ✓ **This is the major advantage of passive immunity; protection is immediate, whereas active immunity takes time (usually several weeks) to develop. Hence statement 3 is correct.**
- ✓ **However, passive immunity lasts only for a few weeks or months. Only active immunity is long-lasting. Hence statement 4 is correct.**

Q 32.A

- A nuclear reactor is a complex system designed for the controlled release of nuclear energy. Its basic components include
  - **Fuel Assemblies**: The core of a nuclear reactor contains fuel assemblies, which are clusters of fuel rods. The fuel rods typically contain uranium-235 or plutonium-239 isotopes.
  - **Control Rods:** Control rods are inserted or withdrawn from the reactor core to control the rate of the nuclear reaction. **They are typically made of materials that can absorb neutrons**, such as boron or cadmium. Adjusting the position of control rods regulates the reactor power.
  - **Coolant**: Coolant circulates through the reactor core to transfer heat away from the fuel assemblies. Common coolants include water, heavy water (deuterium oxide), or liquid sodium. The coolant absorbs the heat generated during fission reactions.
  - **Steam Generator**: In pressurized water reactors (PWRs), the coolant transfers heat to a secondary loop, which generates steam. The steam is then used to turn turbines connected to generators, producing electricity.
  - The turbine converts the kinetic energy of steam into mechanical energy, which is then used to drive a generator. The generator converts this mechanical energy into electrical energy.
- These components work together to maintain a controlled and sustainable nuclear reaction, extract heat from the system, and generate electricity safely and efficiently. The specific design and configuration of nuclear reactors can vary based on the reactor type (e.g., pressurized water reactor, boiling water reactor) and the intended application.
- **Hence option (a) is the correct answer.**

Q 33.C

- The process of developing transgenic crops is an elaborate one as inserting transgenic genes into plants to elicit a sustained, protective response is a mix of both science and chance.
- There is an array of crops — brinjal, tomato, maize, chickpea — in various stages of trials that employ transgenic technology. **However, cotton remains the only transgenic crop that is being commercially cultivated in India. Hence statement 1 is correct.**
- India's biotech regulator Genetic Engineering Appraisal Committee (GEAC) gave approval to conduct BRL-1 trial for resistance against Pink Bollworm. The genetically modified cotton expresses Cry2Ai gene for resistance against Pink Bollworm. **Hence statement 2 is correct.**

Q 34.D

- **Recent Context: Biodiversity credits or biocredits** are increasingly being pushed as a means for financing work on the various targets set under the Kunming-Montreal Global Biodiversity Framework (KMGBF) adopted in 2022 at the 15th Conference of Parties (CoP15) of Convention on Biological Diversity (CBD). Through 2023, efforts were made to promote them at different fora. They were **discussed at CoP28 of the UNFCCC in Dubai in December 2023. Hence statement 2 is not correct.**
- While biocredits are similar to carbon credits used to control greenhouse gas emissions. But they are not designed to offset or compensate for actions with negative impacts on biodiversity. Instead, proceeds from the sale of bio credits are used to protect and restore biodiversity where it exists. **Hence statement 1 is not correct.**

Q 35.C

- **Galvanisation or galvanization is the process of applying a protective zinc coating to iron or steel, to prevent rusting.** The most common method is hot dip galvanizing, in which steel sections are submerged in a bath of molten zinc. **Hence statement 2 is correct.**

- **The primary purpose of galvanizing is to provide protection against corrosion for metal surfaces, particularly steel. Hence statement 1 is correct.**
- This process offers several advantages :
    - **Corrosion Resistance: The zinc coating acts as a sacrificial anode, meaning that it corrodes preferentially to the underlying steel or iron. This sacrificial corrosion helps protect the base metal from rust and corrosion.**
    - Durable Coating: Zinc is a highly durable and long-lasting metal, providing a protective layer that withstands environmental exposure, including moisture, humidity, and various atmospheric conditions.
    - Extended Lifespan: Galvanizing significantly extends the lifespan of steel or iron structures and components. The corrosion resistance provided by the zinc coating helps prevent the gradual deterioration of the underlying metal.
    - Low Maintenance: Galvanized surfaces require minimal maintenance. The protective zinc layer continues to provide corrosion resistance even if it becomes scratched or damaged, reducing the need for frequent reapplication of coatings.
    - Cost-Effective: While there is an initial cost associated with the galvanizing process, the long-term cost-effectiveness is high due to the extended lifespan of the galvanized metal and the reduced need for maintenance.
    - Cathodic Protection: The zinc coating acts as a cathode in the electrochemical corrosion process. This cathodic protection helps prevent the corrosion of the underlying steel, which serves as the anode.
    - Uniform Coating: Galvanizing provides a uniform and complete coating on all surfaces, including intricate shapes and hard-to-reach areas. This ensures comprehensive corrosion protection for the entire metal structure.
    - Environmentally Friendly: Zinc is a natural element and is recyclable. The galvanizing process generates minimal waste, and the zinc coating can be recycled at the end of its useful life.
- Common applications of galvanizing include the protection of structural steel in buildings, bridges, fences, guardrails, and various industrial equipment. Galvanized coatings are also used in the production of pipes, electrical conduits, and automotive components, among other applications.

Q 36.B

- Luminol is a chemical compound with the molecular formula $C_8H_7N_3O_2$. It contains carbon, hydrogen, nitrogen, and oxygen atoms.
- **Luminol exhibits chemiluminescence, a phenomenon where a chemical reaction produces light. The reaction involves the oxidation of luminol, typically catalyzed by the presence of iron or other catalysts found in blood.**
- **Hemoglobin, the iron-containing protein in red blood cells, acts as a catalyst for the reaction. When luminol comes into contact with blood, the iron in hemoglobin catalyzes the oxidation of luminol, resulting in the release of energy in the form of light.**
- The emitted light is in the blue part of the spectrum and is often faint. However, even small amounts of blood can produce a detectable glow. The chemiluminescent reaction enhances the visibility of bloodstains, especially in low-light or dark conditions.
- **Luminol is particularly useful in crime scene investigations where investigators need to identify and locate potential bloodstains that may not be visible under normal lighting. This includes situations where attempts have been made to clean or conceal blood.**
- The use of luminol raises ethical considerations related to the potential destruction of evidence. The chemiluminescent reaction involves the oxidation of blood, which could hinder subsequent DNA analysis. Therefore, its application is carefully considered in conjunction with other forensic techniques.
- **Hence option (b) is the correct answer.**

Q 37.B

- **Electric eels generate electric shocks through specialized chemical reactions in cells called electrolytes**. These cells are unique to electric fish, such as electric eels, and allow them to produce electric discharges for various purposes, including hunting, navigation, communication, and self-defense.
- **Electric eels have thousands of electrolytes stacked in series, forming electric organs along the length of their bodies. These electrolytes are specialized cells that function as biological batteries.**
- When the electric eel wants to generate an electric shock, its nervous system sends a signal to the electrolytes, triggering an action potential.

- The action potential opens ion channels in the electrocyte cell membranes. This allows the movement of ions, particularly sodium and potassium ions, across the cell membrane.
- The controlled movement of ions creates a voltage potential across the electrocyte cell membrane. This is similar to the process that occurs in nerve cells but is highly specialized in electric fish for generating electric discharges.
- The electrolytes are stacked in a series arrangement. This stacking increases the voltage potential, allowing electric eels to generate electric shocks of considerable strength.
- The electrolytes are activated sequentially along the length of the electric organ, creating a wave of electric discharges. This sequential activation contributes to the production of a continuous electric shock.
- Electric eels can modulate the frequency, duration, and intensity of their electric discharges. They can produce both low-voltage pulses for navigation and higher-voltage shocks for hunting and self-defense.
- **Hence option (b) is the correct answer.**

Q 38.D

- **Teflon coating, also known by the brand name Teflon®, is a synthetic polymer coating applied to various surfaces to create a non-stick, hydrophobic (water-repellent), and low-friction surface. It's widely used in cookware, kitchen appliances, textiles, and numerous other industrial applications.**
- **Polytetrafluoroethylene (PTFE) is specifically chosen for non-stick cookware due to its unique properties, which include:**
  - Low Friction: PTFE has an extremely low coefficient of friction, making it an excellent material for non-stick surfaces. This property prevents food from sticking to the cookware, allowing for easy release and cleaning.
  - Chemical Inertness: PTFE is highly resistant to chemicals and does not react with most substances. This chemical inertness ensures that the material remains stable and does not release harmful substances when exposed to cooking temperatures.
  - Thermal Stability: PTFE can withstand high temperatures without degradation. This is crucial for cookware, as it needs to endure the heat generated during cooking without losing its non-stick properties or releasing harmful fumes.
  - Non-Toxic: PTFE is considered non-toxic when used in cookware under normal cooking conditions. However, it is important to avoid overheating the cookware, as extreme temperatures can lead to the release of fumes that may be harmful to birds and can cause flu-like symptoms in humans (a phenomenon known as polymer fume fever).
- The other polymers mentioned (Polyethylene, Polypropylene, Polyvinyl chloride - PVC) do not possess the combination of low friction, high chemical inertness, and thermal stability that make PTFE ideal for non-stick cookware.
- **Hence option (d) is the correct answer.**

Q 39.C

- **ISRO initiated a project called Project NETRA, which is an early warning system in space to detect debris and other hazards to Indian satellites.**
- Under NETRA the ISRO plans to put up many observational facilities: connected radars, telescopes; data processing units and a control centre. They can, among others, spot, track and catalogue objects as small as 10 cm, up to a range of 3,400 km and equal to a space orbit of around 2,000 km.
- Project NETRA consists of high-precision, long-range telescope in Leh and a radar in the North East. Along with them, the Multi-Object Tracking Radar (MOTR) at the Satish Dhawan Space Centre in Sriharikota, and the telescopes at Ponmudi and Mount Abu.
- **Hence option (c) is the correct answer.**

Q 40.B

- **Genetic engineering** is a set of technologies used to change the genetic makeup of cells, including the transfer of genes within and across species boundaries to produce improved or novel organisms. **Genome mapping** describes the methods used to identify the location of a gene on a chromosome and the distances between genes.
- Rate of crossing over (also referred to as recombination frequency) between two or more genes or loci has been successfully used to measure the relative genetic distance between them. One map unit is equal to one percent of observed cross-over (recombinants). **The unit centimorgan (cM) is used to denote the genetic distance between genes based on offspring phenotype frequency.**

- Genome engineering technology is used to modify the genome. It is often carried out to introduce or remove one or more genes. The goal of this engineering is to introduce a new functionality or to modify (or remove) the existing functionality of a biological organism.
- One of the approaches uses **transposon or jumping genes to inactivate or delete a gene(s) in a genome. Transposons are DNA sequences also known as 'Jumping Genes'** that move from one location to another on the genome found in almost all organisms (both prokaryotes and eukaryotes). DNA transposon generally moves by a 'cut and paste' mechanism in which the transposon is excised from one location and integrated elsewhere in the genome.
- **Hence option (b) is the correct answer.**

Q 41.A

- **Transformers facilitate the long-distance transmission of electrical power by adjusting the voltage of the electrical current. This process is crucial for ensuring efficient and economical power transmission.**
- Transformers have coils of wire, and when electricity flows through one coil, it creates a changing magnetic field.
- **Transformers can either increase (step up) or decrease (step down) the voltage. For long-distance transmission, they often use step-up transformers to increase the voltage.**
- **Higher voltage means lower current and lower current reduces energy loss during transmission. This makes it more efficient and cheaper to send electricity over long power lines. Thus it facilitates the long-distance transmission of electrical power**
- Power plants generate electricity at a lower voltage. Transformers increase the voltage for efficient long-distance travel over transmission lines.
- Closer to homes, other transformers decrease the voltage for safe use in households.
- **Hence option (a) is the correct answer.**

Q 42.A

- **Recent Context:** Tea Board has mandated all tea producers to limit generation of tea waste not exceeding 0.2% of production for quality produce.
  - Presently, tea waste is being used for producing instant tea, bio-fertiliser and caffeine.
  - Board is in process of allowing tea waste being used only for production of instant tea.
- **About Tea Board India**
  - **Nature:** Statutory body set up under Tea Act 1953. **Hence, statement 1 is correct.**
  - **Ministry:** Ministry of Commerce and Industry. **Hence, statement 2 is correct.**
  - **Head Office:** Kolkata. **Hence, statement 3 is not correct.**
  - **Functions:** Financial and technical assistance for cultivation, manufacture and marketing of tea, export promotion etc.

Q 43.A

- In evolutionary biology, **adaptive radiation** is a process in which organisms diversify rapidly from an ancestral species into a multitude of new forms, particularly when a change in the environment makes new resources available, creates new challenges, or opens new environmental niches. Starting with a recent single ancestor, this process results in the speciation and phenotypic adaptation of an array of species exhibiting different morphological and physiological traits. Example - Darwin Finch & Australian marsupials. **Hence option (a) is the correct answer.**
- In evolutionary biology, **convergent evolution** is the process whereby organisms not closely related (not monophyletic), independently evolve similar traits as a result of having to adapt to similar environments or ecological niches. It is the opposite of divergent evolution, where related species evolve different traits.
- **Secondary succession** is one of the two types of ecological succession of plant life. secondary succession is a process started by an event (e.g. forest fire, harvesting, hurricane, etc.) that reduces an already established ecosystem (e.g. a forest or a wheat field) to a smaller population of species, and as such secondary succession occurs on preexisting soil whereas primary succession usually occurs in a place lacking soil.
- **Sequential evolution** involves relatively minor changes in the gene pool of a particular population from one generation to the next. No new species result from such change, but the descendant population is not genetically identical to the preceding population. Such evolution of gene pools from one generation to the next is called sequential evolution.

Q 44.C

- **Statement 1 is correct:** A rainbow is a natural spectrum appearing in the sky after a rain shower. It is caused by the dispersion of sunlight by tiny water droplets, present in the atmosphere. A rainbow is always formed in a direction opposite to that of the Sun.
- **Statement 2 is correct:** The water droplets act like small prisms. They refract and disperse the incident sunlight, then reflect it internally, and finally refract it again when it comes out of the raindrop. Due to the dispersion of light and internal reflection, different colors reach the observer's eye.
- Since it involves the total internal reflection of sunlight, the light is reflected back in the direction it originally came from. Hence you can only see a rainbow if your back is facing the sun.

Q 45.D

- A cell consists of three parts: **the cell membrane, the nucleus, and, between the two, the cytoplasm.** Within the cytoplasm lie intricate arrangements of fine fibers and hundreds or even thousands of miniscule but distinct structures called organelles.
- **Cell membrane:** Every cell in the body is enclosed by a **cell (Plasma) membrane.** The cell membrane separates the material outside the cell, extracellular, from the material inside the cell, intracellular. It maintains **the integrity of a cell and controls passage of materials (ions and molecules) into and out of the cell. Hence pair 2 is correctly matched.**
- **Nucleus and Nucleolus:** The nucleus, formed by a nuclear membrane around a fluid nucleoplasm, is the control center of the cell. Threads of chromatin in the nucleus contain deoxyribonucleic acid (DNA), the genetic material of the cell. The nucleolus is a dense region of ribonucleic acid (RNA) in the nucleus and is the site of ribosome formation.
- **Cytoplasm:** The cytoplasm is the gel-like fluid inside the cell. It is the medium for chemical reaction. It provides a platform upon which other organelles can operate within the cell. All of the functions for cell expansion, growth and replication are carried out in the cytoplasm of a cell.
- **Cytoplasmic organelles are "little organs"** that are suspended in the cytoplasm of the cell. Each type of organelle has a definite structure and a specific role in the function of the cell. Examples of cytoplasmic organelles are **mitochondrion, ribosomes, endoplasmic reticulum, golgi apparatus, and lysosomes.**
    - **The Endoplasmic reticulum (ER) and Golgi body** are single membrane bound structures. The membrane has the same structure (lipid-protein) as the plasma membrane but ribosomes do not have membranes. Ribosomes are involved in synthesis of proteins in the cell, Golgi bodies in secreting and the ER in transporting and storing the products. These three organelles operate together.
    - **Ribosomes** are present either as free particles in cytoplasm or attached to ER. Also found stored in nucleolus inside the nucleus. 80S types found in eukaryotes and 70S in prokaryotes (S- svedberg unit of measuring ribosomes). **Ribosomes are sites in a cell lin which protein synthesis takes place. Hence pair 1 is correctly matched.**
    - **The Golgi apparatus, or Golgi complex,** functions as a factory in which **proteins received from the ER are further processed and sorted for transport** to their eventual destinations: lysosomes, the plasma membrane, or secretion. In addition, as noted earlier, glycolipids and sphingomyelin are synthesized within the Golgi. **Hence pair 3 is correctly matched.**
    - **Lysosomes** are present in almost all animal cells and some non-green plant cells. They perform **intracellular digestion. Lysosomes are called 'suicidal bags'** as enzymes contained in them can digest the cell's own material when damaged or dead. **Hence pair 4 is correctly matched.**

Q 46.C

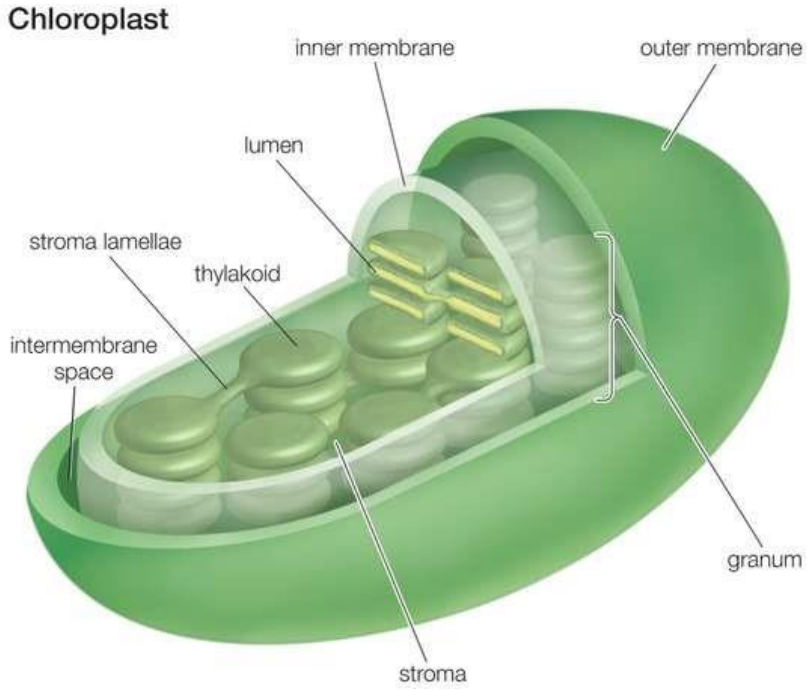
- **Recent Context: Prime Minister Narendra Modi recently paid tribute to Savitribai Phule on her birth anniversaries, saying she inspired society with her compassion and courage.**
- Savitribai Jyotirao Phule (3 January 1831 – 10 March 1897) was an Indian social reformer and poet. Along with her husband, Jyotirao Phule, she played an important role in improving women's rights in India during British rule. The couple founded the first women's school at Bhide Wada in Pune in 1848.
- She established **Balyata Pratibandak Gruha**, a home for widowed mothers and children born out of wedlock.
- She authored **"Kavya Phule"** which was published in 1854, when she was only 23. This includes 41 poems on nature, social issues and teaching. The second **"Bavan Kashi Subodh Ratnakar"** appeared in 1892.
- **Hence option (c) is the correct answer.**

Q 47.A

- **Recent Context:** Switzerland and India have reached consensus on Free-Trade Agreement after 16 years of negotiation.
  - **Political features**
    - ✓ Landlocked country of central Europe.
    - ✓ Bordered to France (west), Germany (north), Austria and Liechtenstein (east), and Italy (south).
  - **Geographical features**
    - ✓ **Major Rivers:** River Rhine, Rhone.
    - ✓ **Highest Point:** Dufourspitze.
    - ✓ **Major mountain ranges:** Alps, Jura.
  - **Danube River, river, the second longest in Europe after the Volga.** It rises in the Black Forest mountains of western Germany and flows for some 1,770 miles (2,850 km) to its mouth on the Black Sea. **Along its course it passes through 10 countries: Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Bulgaria, Romania, Moldova, and Ukraine.**
- **Hence option (a) is the correct answer.**

Q 48.C

- **Chloroplasts:** They are green-colored plastids, which comprise green-colored pigments within the plant cell and are called chlorophyll. **Hence, statement 1 is correct.**
- Chloroplast is an organelle that contains the photosynthetic pigment chlorophyll that captures sunlight and converts it into useful energy, thereby, releasing oxygen from water.
- **Chloroplasts are found in all green plants and algae**. They are the food producers of plants. These are found in the guard cells located in the leaves of the plants. They contain a high concentration of chlorophyll that traps sunlight. This cell organelle is not present in animal cells. **Hence, statement 2 is correct.**
- Chloroplast has its DNA and can reproduce independently, from the rest of the cell. They also produce amino acids and lipids required for the production of chloroplast membranes.
- **Functions of Chloroplast:** Following are the important chloroplast functions:
  - The most important function of the chloroplast is to synthesize food by the process of photosynthesis.
  - Absorbs light energy and converts it into chemical energy.
  - Chloroplast has a structure called chlorophyll which functions by trapping solar energy and is used for the synthesis of food in all green plants.
  - Produces NADPH and molecular oxygen (O2) by photolysis of water.
  - Produces ATP – Adenosine triphosphate by the process of photosynthesis.
  - The carbon dioxide (CO2) obtained from the air is used to generate carbon and sugar during the Calvin Cycle or dark reaction of photosynthesis.
  - Where does the photosynthesis process occur in the plant cell?
  - In all green plants, photosynthesis takes place within the thylakoid membrane of the Chloroplast.



Q 49.C

- **Hydroponics is a method of growing plants without soil, using water enriched with balance mineral nutrients essential for plant growth and yield.** The nutrients and PH level are maintained suiting to the selected crop for better growth. With increasing water scarcity due to frequent droughts and declining land availability for farming, government agencies are promoting hydroponic for growing vegetables, fruits and fodder. **Hence statement 1 is correct.**
- **Aquaponics is a sustainable farming method that combines aquaculture (the cultivation of aquatic organisms like fish) with hydroponics (the growing of plants in nutrient-rich water without soil).** This combination creates biological processes that occur in both systems to create a closed-loop environment where fish and plants thrive together. **Hence statement 2 is correct.**
- **Unlike hydroponics, in which one needs to add nutrients to the water for the plants to grow,in aquaponics the nutrients come from fish**. The fish produce ammonia,which gets converted by two types of bacteria: first to nitrite and then to nitrate that in turn serve as fertilisers for plants. **Hence statement 3 is correct.**

Q 50.A

- X-ray Polarimeter Satellite (XPoSat) is India's maiden mission dedicated to analysing the polarisation of X-rays emanating from bright celestial sources in the medium frequency band.
- X-ray Polarimeter Satellite (XPoSat) is **India's first and world's second mission** dedicated to analyzing the polarization of X-rays emanating from bright celestial sources in the **medium frequency band (8 to 30keV).** In 2021, NASA launched Imaging X-ray Polarimetry Explorer (IXPE). It has been designed to operate and perform X-ray polarisation measurements **within the soft X-ray band (2 to 8 keV energy band)**.**Hence statement 1 is not correct.**
- XPoSat comprises primarily two payloads, including Indian X-ray Polarimeter (POLIX) and X-ray Spectroscopy and Timing (XSPECT).
- POLIX: It is the world's first instrument designed to operate in the medium **X-ray of 8 to 30 kilo electron Volt (keV) energy band**. It comprises a collimator, which is the key component to filter light originating from bright sources in the field of view.**Hence statement 2 is correct.**
- XSPECT: It is designed to conduct fast timing and high spectroscopic resolution in a soft X-ray energy band (0.8-15 keV).
- It has an estimated mission life of about five years during which XPoSat will observe sources that emit polarized X-rays. The observations will be done when the magnetars or neutron stars are in transit through the Earth's shadow, for instance, during the eclipse period.
- The spacecraft is designated **for observation from low earth orbit (~ 650 km, low inclination of ~ 6 degree). Hence statement 3 is not correct.**

Q 51.C

- Direct seeding is a crop establishment system wherein rice seeds are sown directly into the field, as opposed to the traditional method of growing seedlings in a nursery, then transplanting into flooded fields.
- Direct-seeded rice is seen to be one of the most efficient, sustainable, and economically viable rice production systems used today. Compared to the conventional puddled transplanted rice (PTR) method prevalent in Asia, DSR delivers faster planting and maturing, conserves scarce resources like water and labor, is more conducive to mechanization, and reduces emissions of greenhouse gases that contribute to climate change.
- Advantages of direct seeding
  - No significant reduction of yield under optimal conditions
  - **Savings on irrigation water by 12-35% under efficient water management practices**
  - Reduces labor and drudgery by eliminating seedling uprooting and transplanting
  - **Reduces cultivation time**, energy, and cost
  - No plant stress from transplanting
  - Faster maturation of crops
  - **Lower GHG emissions**
  - Mechanized DSR provides employment opportunities for youth through service provision business model
  - Increases total income by reducing cost of cultivation
- Current constraints
  - **Higher seed rates**
  - Seeds exposed to birds and pests

- Weed management
- Higher risk of lodging
- Risk of poor or non-uniform crop establishment

- **Hence option (c) is the correct answer.**

Q 52.B

- **Recent Context:** Centre seeks data from States to assess the functioning of Surrogacy Act, 2021. Union Ministry for Health and Family Welfare sought category-wise data on the total number of couples and single and unmarried women who have opted for surrogacy.
  - Ministry also sought category-wise data on women who have opted for Assisted Reproductive Technology (ART), since enactment of ART (Regulation) Act, 2021.
- Surrogacy is a practice whereby one woman bears and gives birth to a child for an intending couple.
  - Two types of Surrogacy: Altruistic and Commercial.
- **Surrogacy(Regulation) Act, 2021**
  - **Only altruistic surrogacy is allowed** and prohibits commercial surrogacy. **Hence statement 1 is not correct.**
  - A woman can act as a surrogate only once in her lifetime. **Hence statement 2 is correct.**
  - **Eligibility for Surrogate mother**
    - ✓ a married woman having a child of her own, and 25 to 35 years old;
    - ✓ possess a certificate of medical and psychological fitness for surrogacy.
  - **Eligibility criteria for couples**
    - ✓ married for five years, wife (25-50 years) and husband (26-55 years);
    - ✓ Couple must not have any living child (biological, adopted or surrogate);
    - ✓ Should have 'essential' certificate of proven infertility of either partner certified by a District Medical Board.

Q 53.A

- **The direction of conventional current flow in an electrical circuit is considered to be from positive to negative. This convention was established historically before the discovery of the electron, which is a negatively charged particle and is the actual charge carrier in most electric circuits.**
- In the early days of electrical theory, scientists were not aware of the existence of electrons or their negative charge. When they observed the flow of electric charge in conductors, they assigned a positive charge to the hypothetical charge carriers.
- Benjamin Franklin introduced the concept of electric charge, suggesting that there were two types of charges: positive and negative. However, he initially assigned a positive charge to the carrier that moved. This convention became widely accepted.
- Later, it was discovered that electrons are the primary charge carriers in conductors, and they have a negative charge. However, by the time this discovery was made, the convention of positive to negative-current flow had become firmly established.
- **Despite knowing that electrons carry a negative charge, the positive-to-negative convention has been retained for the sake of consistency and convenience. Changing the convention could lead to confusion and make it more challenging to interpret existing circuit diagrams and literature.**
- **Hence option (a) is the correct answer.**

Q 54.D

- **Recent Context:** As per fourth advanced estimate from **Directorate of Economics and Statistics Ministry of Agriculture & Farmers Welfare**, Govt. of India, In **2022 Uttar Pradesh is the leading lentil producing state in India (0.47 million tonnes from 0.49 ha. acreage, 36.43 % of national production),** followed by Madhya Pradesh (0.44 million tonnes from 0.49 million ha. acreage. 34.55% of national production), West Bengal (10.53%), Bihar (8.84%) and Jharkhand (4.50%). **Hence statement 1 is not correct.**
- India is the second largest producer of Lentils after Canada. India is set to become the world's largest producer of lentil (masoor) during the 2023-24 crop year on account of higher acreage.**Hence statement 2 is not correct.**
- India, despite being among the world's top five lentil growers, second only to Canada, depends on imports to meet its domestic demands. **Hence statement 3 is not correct.**

Q 55.B

- In an escalation of its ongoing Cold War with the United States over access to critical technologies, China announced control measures over the export of certain strategic minerals including Gallium and Germanium.
- **Germanium and gallium are rare metals that are used in a variety of high-tech applications. Germanium is a silvery-white metal that is transparent to infrared radiation. It is used in fiber optic cables, night vision devices, and solar cells. Gallium is a silvery-gray metal that is liquid at room temperature. It is used in semiconductor devices, such as lasers and LEDs. Hence, statement 2 is correct.**
- Since these metals are relatively rare, there is a risk of supply disruptions. In addition, the production of germanium and gallium requires specialized facilities, so there are a limited number of companies that can produce these metals.
- The demand for germanium and gallium is expected to increase in the coming years due to the growth of the semiconductor industry and the development of new technologies such as 5G, artificial intelligence, quantum computing and renewable energy. The prices of these metals have also risen significantly in recent years due to supply constraints and geopolitical tensions.
- **Germanium is found in small amounts in zinc ores, coal fly ash, and some other minerals. Gallium is more abundant than germanium, but it is still considered a strategic material. It is found in trace amounts in bauxite and zinc ores, and it is produced as a byproduct of the aluminum and zinc industries. Hence, statement 1 is correct.**
- In line with the country's Atmanirbhar (self-reliance) roadmap and considering the requirements of sectors such as defence, agriculture, energy, pharmaceuticals, and telecom, India has identified 30 critical minerals including the two said minerals. The Ministry of Mines unveiled the first-ever report titled 'Critical Minerals for India'.
- **According to the ministry's report, Germanium is not available in India. India is 100% dependent on imports to meet its germanium requirements. China, South Africa, Australia, France and the US are leading import sources for germanium. Meanwhile, Gallium is recovered as a by-product while producing alumina. Two plants, namely, HINDALCO at Renukoot, Uttar Pradesh and NALCO Damanjodi alumina refinery, Odisha, had recovered Gallium in the past, the ministry said in its report. Hence, statement 3 is not correct.**

Q 56.B

- **Lactic acid is produced through the fermentation of lactose (milk sugar) by bacteria, primarily Lactobacillus, during the process of curd formation. It gives curd its characteristic sour taste.**
- **Vinegar contains acetic acid**, not methanoic acid. Acetic acid is the primary component of vinegar, which is produced through the fermentation of ethanol by acetic acid bacteria.
- **Tamarind - Tartaric acid:** Tamarind contains tartaric acid. Tartaric acid is a naturally occurring organic acid found in various plants, including tamarind.
- Others
  - Orange - Citric acid
  - Ant sting - Methanoic acid
  - Lemon - Citric acid
  - Malic Acid: Present in apples and other fruits
  - Hydrochloric Acid: Found in the stomach as gastric acid, aiding in digestion
  - Oxalic Acid: Found in spinach, rhubarb, and beet greens.
- **Hence option (b) is the correct answer.**

Q 57.B

- New cells are required not only for replacement of worn out cells, but also for repair of cuts and injuries, for growth and for reproduction. New cells are obtained through cell division. There are two types of cell division.
  - **Mitosis:** In mitosis, a cell gives rise to two identical daughter cells. Mitosis is needed for growth, and repair of worn out parts.
  - **Meiosis:** Cell division involved in production of sex cells which give rise to the egg in female and sperm in male.
- **Mitotic cell division occurs in somatic cells or reproductive cells** that results in the formation of identical cells, both qualitatively and quantitively. The significance of mitosis is growth and reproduction where the product of reproduction is identical. **Hence statement 1 is not correct.**

- The nucleus divides first and then the whole cell divides. Division of one nucleus to produce two daughter nuclei a is called (karyokinesis). **Division of cytoplasm to give two daughter cells is called cytokinesis.**
- **Significance:**
  - The daughter cells receive the same number of chromosomes as the parent cell. In other words mitosis is an equational division in which **the two daughter cells are identical to each other and to their parent cell.**
  - Mitosis helps in wound healing and replacement of cells lost during wear and tear.
- **Meiosis** is characterized by two successive divisions of the nucleus (meiosis I and II) and cytoplasm, whereas the chromosomes divide only once. Meiosis occurs in germ cells only i.e. testis and ovary. This is a reduction division where the chromosome number becomes half.
- **Meiotic cell division occurs in the gonads for sexual reproduction** to produce gametes. The resultant cells, egg (in female) and sperms (in male), possess half the chromosome number of that present in the parent cell. **Meiotic cell division takes place only in diploid cells responsible for production of haploid spores or gametes.**
- **Significance:**
  - The Significance of meiosis is in sexual reproduction where ova and sperm both have half the number of chromosomes i.e. 23 each in human gametes (but normal number of chromosome of human is 46 or 23 pair) and on fertilization the chromosome number becomes normal.
  - **Also during meiosis, new combination of genes are obtained in the gametes that result from meiosis. Hence statement 2 is correct.**

Q 58.D

- **Hormones are body's chemical messengers.** Once released by glands into the bloodstream, they act on various organs and tissues to control everything from the way the body functions to how you feel.
- One group of hormones are nicknamed the **"feel-good hormones" because of the happy and, sometimes, euphoric feelings they produce.** They're also considered neurotransmitters, which means they carry messages across the spaces between nerve cells. **They are Dopamine, Serotonin, Endorphins, and Oxytocin. Hence option (d) is the correct answer.**
  - **Dopamine:** Dopamine is most notably involved in helping us feel pleasure as part of the brain's reward system. Sex, shopping, smelling cookies baking in the oven — all these things can trigger dopamine release, or a "dopamine rush." Neurons in the region at the base of the brain produce dopamine in a two-step process. First, the amino acid tyrosine is converted into another amino acid, called L-dopa. Then L-dopa undergoes another change, as enzymes turn it into dopamine.
  - **Serotonin:** This hormone is responsible for boosting mood, as well as a host of other functions. An area in the center of the brainstem produces serotonin, which then acts on many different parts of the brain to affect a variety of functions and behaviors, including memory, fear, the stress response, digestion, addiction and sexuality.
  - **Endorphin:** Endorphins are the body's natural painkillers. Endorphins are released by the hypothalamus and pituitary gland in response to pain or stress, this group of peptide hormones both relieves pain and creates a general feeling of well-being.
  - **Oxytocin:** Oxytocin is a hormone that's produced in the hypothalamus and released into the bloodstream by the pituitary gland. Its main function is to facilitate childbirth, which is one of the reasons it is called the "love drug" or "love hormone." Oxytocin, like endorphinsor serotonin, is a type of hormone in your body that promotes positive feelings.

Q 59.C

- **The maximum density of water at 4 degrees Celsius is a unique and anomalous behavior that arises from the structure of water molecules and the formation of hydrogen bonds. Unlike most substances that contract and become denser as they cool and transition from a liquid to a solid state, water behaves differently.**
- Here's why water achieves its maximum density at 4 degrees Celsius
  - **Hydrogen Bonding:** Water molecules are polar, meaning they have a partial positive charge on the hydrogen atoms and a partial negative charge on the oxygen atom. The oxygen atom is more electronegative, creating a dipole moment. This dipolar nature allows water molecules to form hydrogen bonds with each other.
  - **Tetrahedral Arrangement**: When water molecules are in the liquid state, they form a loose and constantly changing network of hydrogen bonds. However, as water cools and approaches 4 degrees

Celsius, a more ordered and stable arrangement occurs. At 4 degrees Celsius, water molecules tend to form a tetrahedral arrangement due to hydrogen bonding.
    - **Open Structure:** In the tetrahedral arrangement, water molecules are more spaced out, creating an open structure. This open structure leads to a maximum packing of water molecules, resulting in the highest density.
    - **Decrease in Density Below 4 Degrees Celsius:** As water continues to cool below 4 degrees Celsius, it undergoes a phase transition from a liquid to a solid (ice). In the process, the hydrogen bonding becomes more ordered, and water molecules form a hexagonal lattice in the ice structure. This hexagonal arrangement is less dense than the open structure at 4 degrees Celsius, causing a decrease in density as water freezes.
- **Specific heat capacity (often shortened to specific heat) refers to a material's property that describes how much heat energy it needs to absorb to raise its temperature by one degree**. The concept plays a crucial role in understanding heat transfer and temperature changes in various contexts.
    - **The specific heat of water is not maximum at zero degrees Celsius.** In fact, it gradually decreases as it approaches 0°C and reaches a minimum around 4°C. It then starts increasing again with rising temperature.
- **Hence option (c) is the correct answer.**

Q 60.A

- **Radiocarbon dating, also known as carbon-14 dating, is a widely used method for determining the age of organic materials by measuring the radioactive decay of Carbon-14 (^14C). Hence statement 1 is correct.**
- Radiocarbon dating relies on the radioactive isotope Carbon-14 (C-14), a naturally occurring isotope of carbon. Carbon-14 is produced in the atmosphere through the interaction of cosmic rays with nitrogen-14.
    - Living organisms take in carbon, including the radioactive C-14, through processes such as photosynthesis or consumption of other organisms.
    - When an organism dies, it stops taking in carbon, and the C-14 in its tissues undergoes radioactive decay.
    - By measuring the remaining C-14 in a sample, scientists can estimate the time that has elapsed since the death of the organism.
- **Radiocarbon dating has limitations on its effective dating range. The half-life of Carbon-14 is approximately 5,730 years. As a result, radiocarbon dating is most effective for dating materials up to around 50,000 years. Hence statement 2 is not correct.**
- Beyond this timeframe, the amount of remaining Carbon-14 becomes too small to provide accurate measurements.
- For dating fossils or materials that are millions of years old, other dating methods based on different isotopes, such as uranium-series dating or potassium-argon dating, are more appropriate

Q 61.C

- **Neutrons** are subatomic particles found in the nucleus of an atom. They have a mass of approximately **1 atomic mass unit (u) or 1.675 x 10^-27** kg.
- **Protons** are positively charged subatomic particles located in the nucleus of an atom. Like neutrons, they also have a mass of approximately 1 **atomic mass unit (u) or 1.675 x 10^-27 kg**.
- **Electrons** are negatively charged subatomic particles found outside the nucleus in electron shells. Electrons have a significantly smaller mass compared to protons and neutrons. The mass of an electron is about 1/1836 times the mass of a proton or neutron. It is approximately **9.109 x 10^-31 kg.**
- **An alpha particle** is a type of nuclear particle consisting of two protons and two neutrons. It is essentially the nucleus of a helium-4 atom. The mass of an alpha particle is approximately 4 atomic mass units (u) or 6.644 x 10^-27 kg.
- **Thus the electron has the least mass among the particles mentioned.**
- **Hence option (c) is the correct answer.**

Q 62.C

- The Department of Atomic Energy is getting ready to commission its ultra-modern indigenously designed fast breeder reactor. The world's only commercially operating fast breeder reactor is situated in the Ural Mountains of Russia at the Beloyarsk Nuclear Power Plant.
- A 'Fast Breeder Reactor', these are a special kind of nuclear reactor that generate more atomic fuel than they consume as they work. A fast breeder reactor can help extract up to 70 per cent more energy than

traditional reactors and are safer than traditional reactors while reducing long lived radioactive waste by several fold. **Hence Statement-I is correct.**Electricity generated by FBR would be a source of green energy as the waste from the first stage nuclear programme is reprocessed and used as fuel in FBR.

- **The spent fuel from this reactor can be fed back into the reactor core several times,** till the spent fuel contains only short lived fission products. This is the concept of FBR with closed fuel cycle. Hence, there is no need of large quantity of fuel materials for the annual external feed and thus eliminates the need for large capacity waste storage spaces with complex construction features.**Hence Statement-II is not correct.**
- **Hence option (c) is the correct answer.**

Q 63.B

- **Stripe Rust of wheat**
  - **Context:** Indian Institute of Wheat and Barley Research, Karnal (Haryana) has appealed to the farmers to remain vigilant against yellow rust. **Hence option (b) is the correct answer.**
  - Caused by a fungal pathogen, Puccinia striiformis.
  - It appears in the form of yellow stripes on wheat leaves.
  - Major States affected: Punjab, Himachal Pradesh, Haryana, Jammu & Kashmir, Uttar Pradesh and Uttarakhand.
  - Treatment: Spray Propiconazole Fungicides.

Q 64.C

- The Internet of Things refers to the rapidly growing network of connected objects that are able to collect and exchange data in real time using embedded sensors. Smart agriculture is mostly used to denote the application of IoT solutions in agriculture. By using IoT sensors to collect environmental and machine metrics, farmers can make informed decisions, and improve just about every aspect of their work – from livestock to crop farming.
- **Some of the applications of IoT in agriculture:**
  - **Monitoring of climate conditions:** Probably the most popular smart agriculture gadgets are weather stations, combining various smart farming sensors. Located across the field, they collect various data from the environment and send it to the cloud.
  - **Greenhouse automation:** The use of IoT sensors enables them to get accurate real-time information on greenhouse conditions such as lighting, temperature, soil condition, and humidity. In addition to sourcing environmental data, weather stations can automatically adjust the conditions to match the given parameters. Specifically, greenhouse automation systems use a similar principle.
  - **Crop management:** Just like weather stations, they should be placed in the field to collect data specific to crop farming; from temperature and precipitation to leaf water potential and overall crop health. You can monitor your crop growth and any anomalies to effectively prevent any diseases or infestations that can harm your yield.
  - **Cattle monitoring and management:** Just like crop monitoring, there are IoT agriculture sensors that can be attached to the animals on a farm monitoring their health and log performance. Livestock tracking and monitoring help collect data on stock health, well-being, and physical location.
  - **Precision farming:** Also known as precision agriculture, precision farming is all about efficiency and making accurate data-driven decisions. It's also one of the most widespread and effective applications of IoT in agriculture. By using IoT sensors, farmers can collect a vast array of metrics on every facet of the field microclimate and ecosystem: lighting, temperature, soil condition, humidity, CO_2 levels, and pest infections. This data enables farmers to estimate optimal amounts of water, fertilizers, and pesticides that their crops need, reduce expenses, and raise better and healthier crops.
  - **Agricultural drones:** Perhaps one of the most promising agritech advancements is the use of agricultural drones in smart farming. Also known as UAVs (unmanned aerial vehicles), drones are better equipped than airplanes and satellites to collect agricultural data.
  - **Predictive analytics for smart farming:** Precision agriculture and predictive data analytics go hand in hand. While IoT and smart sensor technology are a goldmine for highly relevant real-time data, the use of data analytics helps farmers make sense of it and come up with important predictions: crop harvesting time, the risks of diseases and infestations, yield volume, etc.
  - **End-to-end farm management systems:** A more complex approach to IoT products in agriculture can be represented by the so-called farm productivity management systems. They usually include a number of agriculture IoT devices and sensors, installed on the premises as well as a powerful dashboard with analytical capabilities and in-built accounting/reporting features.
  - **Thus, The passage describes the applications of IoT in farm management. Hence, option (c) is correct.**

Q 65.B

- Sublimation is the process where a substance transitions directly from the solid phase to the gas phase without passing through the liquid phase. Not all materials sublimate readily at standard temperature and pressure, but there are several examples of substances that exhibit sublimation under certain conditions
- Dry Ice (Solid Carbon Dioxide): Dry ice is a common example of a substance that sublimates. It transforms directly from a solid to a gas at temperatures above -78.5 degrees Celsius (-109.3 degrees Fahrenheit) at standard pressure.
- **Camphor: Solid camphor can sublimate at room temperature, producing vapors with a distinct, aromatic odor. This property makes camphor useful in mothballs and other applications.**
- Naphthalene: Often used as the primary ingredient in mothballs, naphthalene sublimates at room temperature. The vapors help repel insects.
- **Iodine: Iodine can sublimate when heated, producing a purple vapor. This property is exploited in laboratory demonstrations.**
- Moth Crystals (Para-dichlorobenzene): Similar to naphthalene, para-dichlorobenzene, commonly found in moth crystals, can sublimate at room temperature.
- Anthracene: A crystalline solid that sublimates when heated, anthracene is often used in laboratory settings.
- Benzoic Acid: Solid benzoic acid can undergo sublimation under specific conditions, such as heating.
- Ammonium Chloride: Ammonium chloride sublimates when heated, and this property is utilized in some chemistry experiments.
- **Cellulose ($C_6H_{10}O_5$)n: The main component of plant cell walls, cellulose has a complex structure with strong hydrogen bonds. It decomposes well below its melting point, preventing sublimation altogether.**
- **Hence option (b) is the correct answer.**

Q 66.C

- Nanomaterials have always attracted researchers due to their size, which are comparable to most of the biological macromolecules such as DNA, enzymes and antibodies. Rapid advancements in nanotechnology and the discovery of carbon nanotubes (CNTs) in 1991 opened up new vistas in material sciences. These carbon allotropic tubes have a unique array of electronic, magnetic and chemical properties. The uniqueness of CNTs is attributed to the presence of strong bonding pattern which exists between the atoms and their extreme aspect ratio.
- A CNT can be as thin as a few nanometers and as long as hundreds of microns. The structure, length and number of layers vary in different CNTs' forms. Single-walled carbon nanotubes (SWCNTs) and multi-walled carbon nanotubes (MWCNTs) are the two major classifications of CNTs depending upon their side walls configuration. Due to its unique properties, it has many applications in wearable technology, drug delivery, climate action, etc.
- **Devices embedded in the clothes we wear are en route to become the order of the day for applications like health-care monitoring, point-of-care diagnostics, military defense and homeland security.** The major hurdle for these devices is suitable systems for instantaneously charging them. Indian scientists have developed carbon nanotube-coated cotton yarns (CNT-wires) that convert the electrical insulating yarn into a metallic conductor thereby behaving like a flexible and pliable electrode. They combined the electrode (CNT-wire) with the electrolyte sheet by a simple and elegant approach of interweaving the CNT wire across the electrolyte to create junctions. These junctions are super capacitive in nature and can store electrical energy. Since the supercapacitors are created by sewing, they are referred it to as "sewcap". **Hence, statement 1 is correct.**
- Carbon nanotubes (CNT) are the front-running candidates owing to their classical performance as adsorbents. CNTs are pure carbon cylinders with a radius of a few nm and variable lengths (100 nm to mm). **CNTs are extraordinarily light and highly porous and very suitable for gas storage applications due to their high surface area. CNTs also have elevated conductivity (thermal and electrical) and are rich in chemistry. The properties mentioned above make them a competent candidate for CO2 adsorption and desorption, efficiently and selectively. Hence, statement 2 is correct.**
- **The easy uptake of CNTs into many different cell types enables these nanomaterials to be desirable for biomedical applications such as drug and gene delivery.** CNTs can be directly penetrated through the cell membrane as well as through passive uptake, which allows them to be suitable candidates for drug and gene delivery. CNTs can be utilized in drug and gene delivery through functionalization, which

allows specific cell types to be targeted for the gene or drug to be delivered effectively, enabling medical intervention for many types of diseases. **Hence, statement 3 is correct.**

- With the development and application of nanotechnology, large amounts of nanoparticles will be potentially released to the environment and possibly cause many severe health problems. **Pulmonary exposure to CNTs leads to lung inflammation, the pathological condition that has been linked to the development of lung fibrosis and cancer.** Animal studies demonstrated the involvement of various inflammatory cytokines and growth factors. **Numerous data and reports have been reported to determine the nature of toxicity arising due to the applications of CNTs in living systems, precisely during the drug delivery process. Hence, statement 4 is not correct.**

Q 67.C

- The effects of forces of the same magnitude on different areas are different. When the person stands on loose sand, the force, that is, the weight of his body is acting on an area equal to the area of his feet. When he lies down, the same force acts on an area equal to the contact area of his whole body, which is larger than the area of his feet. In both cases, the force exerted on the sand is the weight of his body and the force is acting perpendicular to the surface of the sand. The force acting on an object perpendicular to the surface is called thrust. The effect of thrust on sand is larger while standing than while lying. The thrust on the unit area is called pressure.
- Pressure = Thrust/Area
- **Thus, higher pressure is exerted by the body on the sand while standing and the person goes down deeper into it as compared to when he is lying down.**

Q 68.D

- Antifreeze is a substance added to a liquid, usually water, to lower its freezing point and raise its boiling point. I**n the context of automotive applications, antifreeze is commonly used in the radiator coolant to prevent the engine coolant from freezing in cold temperatures and to protect the engine from overheating in hot conditions.**
- **Ethylene glycol is a carbon-based compound commonly used as an antifreeze in automobile radiators to prevent the coolant from freezing. It is added to the radiator fluid to lower the freezing point of the mixture, allowing the engine coolant to remain in a liquid state even at low temperatures.**
    - Additionally, ethylene glycol has a high boiling point, which helps in preventing the engine from overheating in high-temperature conditions.
- Acetone has a low boiling point, which means it would evaporate quickly at the elevated temperatures within an automobile engine. This makes it less effective in preventing overheating.
    - Acetone is flammable and can be toxic, posing safety concerns. Additionally, it is not an ideal choice due to its low flash point.
- Butanol: It has a higher freezing point than ethylene glycol and can corrode engine parts.
- Isopropyl alcohol has a lower boiling point compared to ethylene glycol. It would evaporate more easily at the high temperatures found in an automobile engine, reducing its effectiveness.
    - Isopropyl alcohol is flammable, posing safety concerns in an environment where the engine may reach high temperatures.
- **Hence option (d) is the correct answer.**

Q 69.B

- The relationship between India and the Maldives has evolved over the year. Both the countries cooperate in maritime security, culture, economy, tourism, etc. However, in the recent times, there is a growing disagreement between both countries with reference to presence of Indian troops in Maldives. Maldives refused to renew a 2019 Hyderographic Survey with India. Both India and Maldives are part of regional grouping SAARC (Members: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka). **However, Maldives is not the part of sub regional grouping BIMSTEC (Members: Bhutan, Bangladesh, India, Myanmar, Nepal, Thailand, Sri Lanka). Hence statement 1 is not correct.**
- Around 30% of Maldives economy is dependents upon to tourism. The number of Indian tourists to the Maldives rose from 90474 in 2018 to around 241000 in 2022 as per Maldivian Tourist Ministry. Even in 2023 Indian tourists made more than 209000 trips to Maldives, making up 11% of its tourism market. Russia and China are at number two and three respectively, in terms of number of tourist visited Maldives. **Hence statement 2 is correct.**

- India is an important developmental partner for Maldives. India provides grant to Maldives for High Impact Community Development Projects (HICDPs). **Greater Male Connectivity Project being developed by India is the Maldives' largest infrastructure project.** It will involve the construction of a 6.74 km bridge and causeway link connecting the Capital, Male to 3 adjacent islands. Apart from this, India has established Indira Gandhi Memorial Hospital, Institute for Technical Education, Faculty of Hospitality and Tourism Studies, National Colleges for Police and Law Enforcement, etc. **Hence statement 3 is correct.**

Q 70.D

- **Recent Context:** Havisure-India's **first indigenously developed Hepatitis A vaccine** launched. **Hence, statement 1 is correct.**
- Havisure was **developed by Indian Immunologicals Ltd (IIL),** a wholly-owned subsidiary of National Dairy Development Board (NDDB). **Hence, statement 2 is not correct.**
- Havisure is a **two-dose vaccine** wherein first dose is administered at above 12 months of age and second dose is given at least after 6 months of the first dose. **Hence, statement 3 is not correct.**
- It is also recommended for individuals who are at risk of exposure or travel to the regions with high hepatitis A prevalence.
- Hepatitis is an inflammation of liver that is caused by a variety of infectious viruses and non-infectious agents.
- There are five main strains of hepatitis virus i.e. A, B, C, D and E.

Q 71.B

- The root cells need oxygen to generate energy. Roots take up air from the air space present between the soil particles.
- **When a potted plant is overwatered, these air spaces are filled up with water and roots are starved for oxygen. Eventually, the plant dies.**
- **Hence option (b) is the correct answer.**

Q 72.C

- Nano Urea is a nanotechnology-based revolutionary Agri-input which provides nitrogen to plants. Nano Urea is a sustainable option for farmers towards smart agriculture and combat climate change.
- These fulfil the plant nutrient requirement as a fertilizer since **Nano urea is bio-available to plants because of its desirable particle size about 20-50 nm and more surface area (10,000 times over 1 mm urea prill)** and number of particles (55,000 nitrogen particles over 1 mm urea prill). **Hence statement II is not correct.**
- **Hence, Nano Urea increases its availability to crop by more than 80% resulting in higher Nutrient Use efficiency**. In addition to this, Nano urea helps in minimizing the environmental footprint by reducing the loss of nutrients from agriculture fields in the form of leaching and gaseous emissions which used to cause environmental pollution and climate change. **Hence statement I is correct.**
- **Nano urea (liquid) contains 4% N as encapsulated nitrogen analogues or forms embedded on an organic matrix.** It has a small size (20-50 nm); and more surface area and number of particles per unit area than conventional urea.

Q 73.C

- **Both 3D printing and nanotechnology often join forces to provide novel structures and application methods. Nanomaterials are utilized to enhance the features of printed materials such as electrical conductivity and sensing properties while 3D printing technologies are utilized to obtain nanosized structures that are not feasible by any other method.**
- The convergence of nanotechnology and quantum science is rapidly expanding and proving to be mutually beneficial to both fields. Quantum nanoscience is a vital research area that intersects nanoscale science and quantum science, providing essential insights for developing nanotechnologies. It leverages quantum mechanics to explore and exploit coherent quantum effects in engineered nanostructures, offering possibilities for new nanodevices and nanoscale materials. N**anoscale materials and devices are used for quantum metrology and sensing, building blocks for quantum computing, and sources and detectors for quantum communication. They enable investigations into quantum behavior and unconventional states in nano- and opto-mechanical systems, low-dimensional systems, molecular devices, nano-plasmonics, quantum electrodynamics, scanning tunneling microscopy, and more.**

- The benefits of nanotechnology for the food industry are many and are expected to grow with time. This new, rapidly developing technology impacts every aspect of the food system from cultivation to food production to processing, packaging, transportation, shelf life and bioavailability of nutrients.
- **Nanomaterials are used as sensors to detect contamination and regulate the food environment. They can detect microbial and other food contaminants. Therefore, they are used as sensors in food production and at packaging plants. They can monitor the condition of food during transport and storage.** They can detect nutrient deficiency in edible plants, and dispensers containing nutrients can deliver them to plants when needed. Therefore, nanomaterials can be used as nanosensors and nanotracers with almost unlimited potential by the food industry. **Hence, option (c) is the correct answer.**
- **Other applications of nanotechnology include:**
    - Nanoscale additives to or surface treatments of fabrics can provide lightweight ballistic energy deflection in personal body armor or can help them resist wrinkling, staining, and bacterial growth.
    - Clear nanoscale films on eyeglasses, computer and camera displays, windows, and other surfaces can make them water- and residue-repellent, antireflective, self-cleaning, resistant to ultraviolet or infrared light, antifog, antimicrobial, scratch-resistant, or electrically conductive.
    - Nanoscale materials are beginning to enable washable, durable "smart fabrics" equipped with flexible nanoscale sensors and electronics with capabilities for health monitoring, solar energy capture, and energy harvesting through movement.
    - Lightweighting of cars, trucks, airplanes, boats, and spacecraft could lead to significant fuel savings. Nanoscale additives in polymer composite materials are being used in baseball bats, tennis rackets, bicycles, motorcycle helmets, automobile parts, luggage, and power tool housings, making them lightweight, stiff, durable, and resilient.

Q 74.B

- **Recent Context:** Violations of the Wildlife (Protection) Act and the Forest Rights Act have exacerbated conflicts in Tiger Reserves between the forest bureaucracy and forest-dwellers.
- **In 1973, The Government of India introduced Project Tiger with 9 tiger reserves.** Today there are **54 tiger reserves** covering 78135 sq. km area. The Government adopted scientific approach to tiger conservation, which has 3 main components - Core/ Critical Tiger Habitats (CTHs), Buffer area to absorb external pressure and Corridor managing the "source-sink dynamics" by restoring habitat connectivity.
- **As of now the CTHs covers 42913 sq. km area, which is 54% of total tiger reserves areas. The Nagarjunsagar-Srisailam Tiger Reserve is India's largest Tiger reserves and spreading over 3727 Sq. Km.** The Krishna river traverses through this tiger reserves. The CTH area in this tiger reserves largely consists of the Rajiv Gandhi Wildlife Sanctuary (36.62%), with closed and opened forests. Also, it has the largest area under Critical Tiger Habitat. **Hence statements 1 and 2 are correct.**
- In March 2017, the NTCA (National Tiger Conservation Authority) refused to recognise rights under Forest Rights Act, 2006 (FRA). Later in 2018 the Environment Ministry issued the guidelines about **recognition of customary and traditional forest rights under FRA in Critical Tiger Habitat.** After this NTCA withdrew its earlier order. Thus now rights under FRA are recognised inside CTHs. Even as per NTCA, 574 villages are present in Core/Critical Tiger Habitats. **Hence statement 3 is not correct.**
- **Hence option (b) is the correct option.**

Q 75.A

- The gravitational force between two bodies is directly proportionate to the product of masses of the two objects and inversely proportionate to the square of the distance between them.
- The electromagnetic force between two bodies is directly proportionate to the product of charges of the two objects and inversely proportionate to the square of the distance between them. **Hence statement 3 is not correct.**
- Gravitational force is always attractive while Electromagnetic force can be both attractive and repulsive. The same charges repel each other while opposite charges attract. **Hence statement 1 is correct**
- The electromagnetic force is not dependent upon mass. **Hence statement 2 is not correct**.

Q 76.B

- **The photoelectric effect is a phenomenon in physics where electrons are emitted from a material when it is exposed to light or electromagnetic radiation. Hence statement 1 is not correct.**
    - When light (composed of photons) strikes the surface of a material, the energy of the photons can be transferred to electrons in the material.

- In the photoelectric effect, the energy of the incident photons must be above a certain threshold for electrons to be emitted. This threshold energy is specific to the material.
- **If the incident photons have sufficient energy to overcome the threshold, they transfer their energy to electrons in the material. This can lead to the ejection of electrons from the material.**
- The photoelectric effect supports the idea that light has both wave-like and particle-like properties. In the context of the photoelectric effect, the particle-like properties of light are emphasized. Each photon carries a specific amount of energy, and it behaves as a discrete particle in the interaction with electrons.
- One significant aspect of the photoelectric effect is that the emission of electrons is nearly instantaneous once the incident light reaches the threshold energy.

- **Solar panels utilize the photoelectric effect to convert sunlight into electrical energy. Hence statement 2 is correct.**
  - Solar panels are composed of semiconductor materials, usually silicon. When photons from sunlight strike the surface of the solar panel, they are absorbed by the semiconductor material.
  - The absorbed photons transfer their energy to electrons in the semiconductor atoms. This energy is sufficient to excite electrons from their normal energy levels to higher energy levels, or in some cases, completely release them from the atoms.
  - As a result of this process, electron-hole pairs are generated in the semiconductor material. An electron is excited to a higher energy level, leaving behind a "hole" in the lower energy level.
  - **The movement of these excited electrons (and the corresponding movement of holes) creates an electric current. This flow of electrons can be harnessed as electrical energy.**
  - The electrical energy generated by the solar panel is typically in the form of direct current (DC).
- The photoelectric effect is crucial in solar panels because it allows the conversion of sunlight directly into usable electrical power. This technology has become a cornerstone of renewable energy systems, providing a clean and sustainable source of electricity for various applications, including residential and industrial use.

Q 77.B

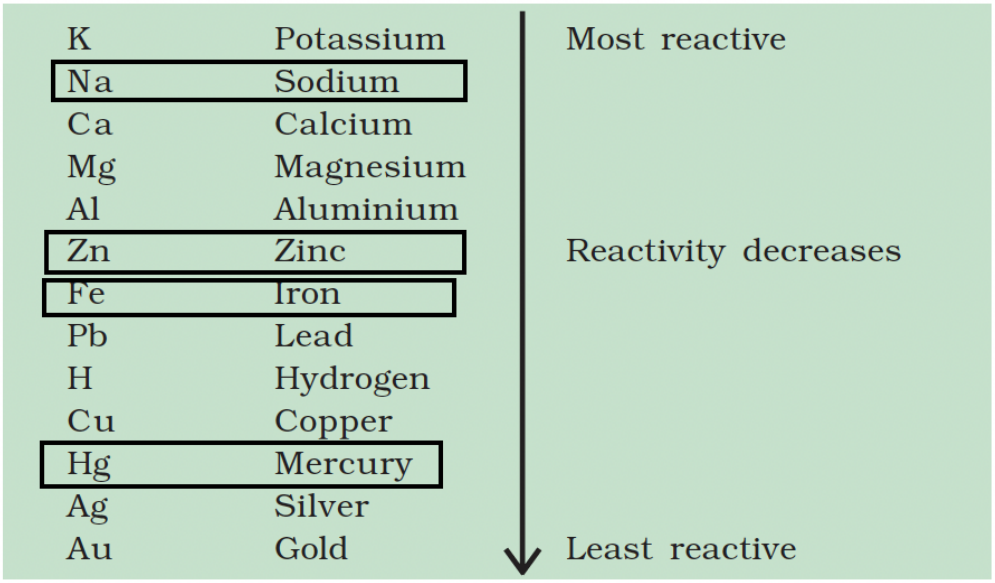
- **The Zeeman Effect is a phenomenon in atomic and molecular physics that describes the splitting of spectral lines in the presence of a magnetic field. Hence statement 1 is not correct.**
  - This effect was first observed by the Dutch physicist Pieter Zeeman in 1896 and later confirmed by Hendrik Lorentz. The Zeeman Effect provides valuable information about the magnetic properties of atoms and molecules.
- The Zeeman Effect occurs when an external magnetic field is applied to atoms or molecules. It influences the energy levels of electrons and the corresponding spectral lines.
- In the absence of a magnetic field, spectral lines in the atomic or molecular spectrum appear as single lines. However, when a magnetic field is applied, each spectral line is split into multiple components.
- **Applications**
  - Astronomy: The Zeeman Effect is used in astronomy to study the magnetic fields of stars. The splitting of spectral lines provides information about the strength and direction of the magnetic field.
  - Plasma Physics: It is applied in plasma diagnostics to measure magnetic fields within plasmas.
  - Materials Science: Used to study the magnetic properties of materials.
  - **Magnetic Resonance Imaging Scanners**
    - ✓ MRI relies on the magnetic properties of certain atomic nuclei, primarily hydrogen nuclei (protons), present in the body's tissues.
    - ✓ A strong static external magnetic field is applied to the patient within the MRI scanner. This magnetic field aligns the magnetic moments of the hydrogen nuclei in the body along the direction of the field.
    - ✓ **The signals detected by the MRI scanner are processed to generate detailed images of the internal structures of the body. Different tissues exhibit varying signal intensities, allowing for the differentiation of structures in the images.**
    - ✓ **Hence statement 2 is correct**.
- **Doppler effect** : The Doppler Effect is a phenomenon observed in waves, including sound waves and electromagnetic waves, such as light. It describes the change in frequency or wavelength of a wave in relation to an observer moving relative to the source of the wave. The Doppler Effect is named after the Austrian physicist Christian Doppler, who first proposed it in 1842.

Q 78.D

- A major characteristic of an atom is its **atomic number**, which is defined as the number of protons. The chemical properties of an atom are determined by its atomic number. The total number of nucleons (protons and neutrons) in an atom is the atomic **mass number**. Atoms with the same atomic number but with different atomic masses are called **isotopes**. Isotopes have identical chemical properties, yet have very different nuclear properties. For example, there are three isotopes of hydrogen. Two of these isotopes are stable (not radioactive), but tritium (one proton and two neutrons) is unstable. Most elements have stable isotopes.
- **Radioactive isotopes** can also be created for many elements. An isotope of uranium (Uranium-235) is used as a **fuel in nuclear reactors**. An isotope of cobalt (Cobalt-60) is used in the **treatment of cancer**. An isotope of iodine (Iodine-131) is used in the **treatment of goitre.**
- **Hence option (d) is the correct answer.**

Q 79.A

- Metals are a class of chemical elements characterized by:
  - **High electrical and thermal conductivity**: They readily conduct electricity and heat, making them ideal for electrical wiring, heat sinks, and cooking utensils.
  - **Malleability and ductility**: They can be hammered into thin sheets or drawn into wires without breaking, making them versatile for shaping and forming in various applications.
  - **Metallic luster:** They tend to have a shiny or reflective surface, although some exceptions exist (e.g., mercury).
  - **Positive oxidation state:** They typically lose electrons to form positively charged ions in compounds.
- **The reactivity of metals is a key characteristic determined by their ability to undergo chemical reactions with other substances. The reactivity series is a ranking of metals based on their tendency to lose electrons and form positive ions.**
- Factors Affecting Reactivity:
  - Atomic Size: Smaller atoms generally have higher reactivity.
  - Ionization Energy: Lower ionization energy corresponds to higher reactivity.
  - Electronegativity: Lower electronegativity indicates higher reactivity.
  - Metal-Oxygen Bond Strength: Weaker metal-oxygen bonds lead to higher reactivity with oxygen.
- **Reactivity series**



- **Hence option (a) is the correct answer.**

Q 80.A

- **Recent context:** South Africa's brought a genocide case against Israel before the International Court of Justice (ICJ).
- The ICJ, which is situated in the Peace Palace in **The Hague, a city in the Netherlands, was established in 1945** as a way of settling disputes between countries.
- Widely known as the "world court", the ICJ is **one of the six "principal organs" of the United Nations,** on the same footing as the General Assembly, Security Council, Economic and Social Council (ECOSOC), Trusteeship Council and the Secretariat, and the only one that is not located in New York.

- The court is **composed of 15 judges, all of whom are elected to nine-year terms of office by the UN General Assembly and Security Council.**
  - **In order to be elected, a candidate must receive an absolute majority of the votes in both bodies. Voting is not done jointly but independently. In order to ensure a degree of continuity, one -third of the Court is elected every three years. Hence statement 1 is correct.**
  - Judges are eligible for re-election.Unlike most other organs of international organizations, the Court is not composed of representatives of governments.
  - Members of the Court are independent judges whose first task, before taking up their duties, is to make a solemn declaration in open court that they will exercise their powers impartially and conscientiously.
- The Court entertain two types of cases: Contentious cases and Advisory proceedings.
  - **Contentious cases** are legal disputes between States and advisory proceedings are requests for advisory opinions on legal questions. Only States (States Members of the United Nations and other States which have become parties to the Statute of the Court or which have accepted its jurisdiction under certain conditions) may be parties to contentious cases.
  - **Advisory proceedings** before the Court are **only open to five organs of the United Nations and 16 specialized agencies of the United Nations family or affiliated organizations.** Advisory proceedings are not binding in nature. **Individual state can not seek advisory proceedings. Hence statement 3 is not correct.**
- In order to guarantee his or her independence, **no Member of the Court can be dismissed unless, in the unanimous opinion of the other Members, he/she no longer fulfils the required conditions. This has in fact never happened. Hence statement 2 is correct.**

Q 81.C

- **Red Sea was in the news recently because of the drone attacks.**
- **The Red Sea is a semi-enclosed, inlet of the Indian Ocean between the continents of Africa and Asia.**
  - It **connects with Indian Ocean through Gulf of Aden and Bab-el-Mandeb Strait.**
  - To its North lies the **Sinai Peninsula, the Gulf of Aqaba and the Gulf of Suez.**
    - ✓ The **Gulf of Suez connects the Red Sea and Mediterranean Sea** whereas the **Gulf of Aden is in between the Red Sea and the Indian Ocean**. So, the **Gulf of Suez lies west to the Gulf of Aden. Hence statement 3 is correct.**
    - ✓ **Further, the Red Sea is the world's northernmost tropical sea and is also one of the most heavily traveled waterways. Hence statement 1 is correct.**
    - ✓ A total of 6 countries of Asia and Africa, border the Red Sea.
    - ✓ The countries of Yemen and Saudi Arabia border the Red Sea to the east. The Red Sea is bordered by Egypt to the north and west, and by Sudan, Eritrea, and Djibouti to the west.
    - ✓ Besides these 6 countries, some other areas including Somalia are also often recognized as Red Sea Territories, due to their proximity to the sea and the geographical similarities with the countries that border the Red Sea.
    - ✓ The Israel and the Jordan have access to Red Sea via the Gulf of Aqaba.**The port of Eilat is the only Israeli port on the Red Sea, located at the northern tip of the Gulf of Aqaba. Hence statement 2 is correct.**


RED SEA
©GraphicMaps.com
Lebanon
Syria
Mediterranean Sea
Damascus
Baghdad
Iran
Israel
Port Said
Jerusalem
Amman
Jordan River
Iraq
Suez Canal
Suez
Cairo
Jordan
Elat
SINAI
Gulf of Suez
Gulf of Aqaba
Kuwait
Jamsah
Sharm al-Sheikh
Al Ghardaqah
160 mi
160 km
Nile River
ASIA
Egypt
Riyadh
Medina
Aswan
AFRICA
Red Sea
Saudi Arabia
Jedda
Sudan
Mecca
Port Sudan
Nile River
Farasan Islands
Daklak Archipelago
Asmara
Yemen
Khartoum
Sana
Eritrea
Bab el Mandeb
Hanish Islands
Blue Nile
Aden
White Nile
Djibouti
Gulf of Aden
Djibouti
Ethiopia
©GraphicMaps.com
Somalia

Q 82.A

- Drishti 10 Starliner Unmanned Aerial Vehicle is an **advanced intelligence, surveillance, and reconnaissance (ISR) platform**, developed by **Adani Defence and Aerospace**. **Hence statement 1 is not correct.**
- Drishti 10 UAV, equipped with state-of-the-art sensors, enhanced endurance, advanced communication capabilities, and cutting-edge technologies. The UAV would play a pivotal role in shaping future naval operations and safeguarding India's national maritime interests.
- It is an indigenously built version of Hermes-900 UAV of Elbit Systems of Israel and has over 70% indigenous content. **Hence statement 2 is not correct.**
- In terms of its abilities, **it's a medium-altitude, low-endurance machine designed for a 1000-mile operational range**.The Drishti 10 UAV has **36 hours of endurance and a substantial 450 kg payload capacity**. It stands out as the only all-weather military platform certified with NATO's STANAG 4671 (standardized agreement 4671) for airworthiness, allowing it to operate in both segregated and unsegregated airspace. **Hence statement 3 is correct.**

Q 83.A

- A physical change is a type of change in which the form or state of matter is altered, but no new substances are created. The molecular composition remains the same.
- A chemical change is a process where one or more substances are converted into new substances with different properties. It involves the breaking and forming of chemical bonds.
- **Melting ice cream - Physical Change** Explanation: Melting ice cream is a physical change because it involves a change in the state of matter from solid to liquid without any new substances being formed.
- **Evaporation of water - Physical Change** Explanation: Evaporation of water is a physical change as it involves the transformation of water from a liquid state to a gaseous state without the formation of new substances.
- **Baking a cake - Chemical Change** Explanation: Baking a cake involves a chemical change. The ingredients undergo chemical reactions during the baking process, leading to the formation of new substances with different properties.
- **Hence option (a) is the correct answer.**

Q 84.D

- Salt plays a crucial role in inhibiting bacterial growth in the context of food preservation.
- **Osmosis: When salt is added to food, it creates a hypertonic environment. This means that the concentration of salt outside the bacterial cells is higher than inside. In response to this concentration difference, water moves out of the bacterial cells through a process called osmosis.**
- **Dehydration: As water is drawn out of the bacterial cells, it leads to dehydration of the cells. Bacteria require water for various metabolic processes, and the reduction in water availability inhibits their growth and reproduction.**
- **Inhibition of Bacterial Growth: The dehydrating effect of salt creates an environment that is inhospitable for the growth of bacteria. Without sufficient water, bacteria struggle to maintain their internal processes, and their ability to reproduce is hindered.**
- In addition to inhibiting harmful bacteria, the dehydration caused by salt also helps prevent spoilage by slowing down the activity of enzymes that contribute to food deterioration.
- One common application of salting for preservation is in curing and preserving meats. Salt is often used to create an environment where harmful bacteria cannot thrive, allowing meats to be stored for longer periods.
- Salt is also a key ingredient in pickling processes, where vegetables are preserved in a saltwater solution. The salt helps control bacterial growth and fermentation, preserving the texture and flavor of the vegetables.
- Thus, addition of salt in food preservation primarily involves the absorption of water from bacterial cells through osmosis. This dehydration mechanism is effective in inhibiting bacterial growth and plays a crucial role in preserving various types of food.
- **Hence option (d) is the correct answer.**

Q 85.C

- **Hydrogenation is a chemical process in which hydrogen is added to unsaturated fats, typically vegetable oils, to convert them into semi-solid or solid fats at room temperature.** This process is commonly used in the food industry to produce products like margarine and shortening. **Hence statement 2 is correct.**
    - Vegetable oils like Cottonseed oil, groundnut oil, etc. have double or triple bonds in their molecule. They are converted to ghee by Hydrogenation in the presence of Nickel
- **Hydrogenation increases the melting point of fats. Unsaturated fats, which are usually liquid at room temperature, become more saturated and solid after hydrogenation. Hence statement 1 is correct.**
    - This occurs because the addition of hydrogen leads to the saturation of double bonds in the fatty acid chains. Saturated fats have a higher melting point than unsaturated fats.
    - The process converts some of the cis-unsaturated fatty acids into trans-unsaturated fatty acids, contributing to the increased stability and higher melting point.
- Unsaturated fats have kinks in their molecular structure due to double bonds, preventing them from packing tightly. This results in lower melting points.
- Hydrogenation removes these kinks by saturating the double bonds, allowing the fatty acids to pack more closely together. The increased molecular order contributes to a higher melting point.
- Hydrogenated fats, with their higher melting points, provide a firmer texture to food products. This is desirable in applications where a solid fat is needed, such as in the production of margarine or certain baked goods.
- It's important to note that complete hydrogenation can lead to the formation of trans fats, which have been associated with health concerns. Trans fats are known to increase LDL cholesterol levels while decreasing HDL cholesterol, increasing the risk of cardiovascular diseases.

Q 86.A

- Anti-radiation missiles (ARM) are guided missiles designed to detect radio frequencies emitted from radar systems. As a crucial component of electronic warfare and defense strategies today, counter-radar missiles rely on electromagnetic radiation from enemy radar systems during combat. DRDO successfully tested indigenously manufactured RUDRAM, the new generation anti radiation missile (NGARM). **Hence pair 1 is not correctly matched.**
- **The MoD has given approval for the production of long-range guided-bomb 'Gaurav'.** This bomb which has a maximum gliding range of 80 km, will be launched exclusively launched by Su-30MKIs. The 'Gautham' glide-bomb, with a maximum range of 30 km, shares this exclusivity, and both bombs have a circular error probable of less than 15 meters. **Hence pair 2 is not correctly matched.**
- While BRAHMOS continues to maintain its forward trajectory as the world's best and fastest cruise missile system, rapid revolution in military technology worldwide has paved the way for the development of yet another futuristic supersonic cruise missile weapon - BRAHMOS-NG (Next Generation). BRAHMOS-NG promises to become one of the most potent weapon systems in future, carrying forward the excellent lineage of the existing world-class BRAHMOS. **Hence pair 3 is correctly matched.**

Q 87.D

- **In a landmark judgment on January 8, 2024, the Supreme Court nullified the remission orders in the Bilkis Bano case.**
- As per Article 141 of Indian Constitution, a judgment of the Supreme Court becomes the law of the land. It is final because it provides certainty for deciding future cases. However, as per article 137 of the Indian Constitution, the Supreme Court can review any of its judgments or orders. **Hence statement 1 is not correct.**
- The Supreme Court in 2013 laid down grounds for seeking review petition of its order or judgement- the discovery of new and important matter or evidence which was not within the knowledge of the petitioner or could not be produced by him, mistake or error apparent on the face of the record; or any other sufficient reason.
- It is not necessary that only parties to a case can seek a review of the judgment on it. As per the Civil Procedure Code and the Supreme Court Rules, any person aggrieved by a ruling can seek a review. However, the Supreme Court has discretion to allow a review petition only when it shows the grounds for seeking the review. **Hence statement 2 is not correct.**

- Review petitions are also heard, as far as practicable, by the same combination of judges who delivered the order or judgment that is sought to be reviewed. If a judge has retired or is unavailable, a replacement is made keeping in mind the seniority of judges. **Hence statement 3 is not correct.**

Q 88.D

- **DNA is a polynucleotide, a macromolecule (macro = large) made of units callednucleotides.** Each nucleotide consists of three subunits.
  - a pentose (5 carbon) sugar called deoxyribose
  - 4 nitrogenous bases Adenine (A), and Guanine (G) are purine bases and Thymine (T) and Cytosine (C) are pyrimidine bases
  - a phosphate group (PO4) positioned on the sugar
- **Chargaff's rule:** The four nucleotides are not present in equal amounts in a DNA molecule. But the amount of purines (A + G) and that of pyrimidines (T + C) is always equal. In other words, A = T and G = C. This is called Chargaff's rule. **Hence statement 2 is not correct.**
- A DNA molecule is three-dimensional and made of two strands helically coiled around each other. Franklin and Wilkins first showed through X-ray diffraction studies of DNA that it is a double helix. According to the Watson and Crick model
  - DNA molecule is a double helix consisting of two strands of DNA
  - The arrangement of the two strands is antiparallel, which means that the sequence of nucleotides goes up in 5′ to 3′ direction in one strand and the other strand comes down in 3′ to 5′ direction.
  - **The bases of the two strands are linked by hydrogen bonds. Hence statement 1 is not correct.**
- **Base pairing is very specific as per Chargaff's rule. Adenine, a purine base always pairs with thymine, a pyrimidine base. The purine base Guanine pairs with the pyrimidine, Cytosine. These pairs of bases are called complementary bases. Hence statement 3 is not correct.**
- There are two hydrogen bonds between A and T and three hydrogen bonds between G and C. A and T are complementary bases and so are G and C.

Q 89.D

- Plant propagation is the process of creating new plants. There are two types of propagation: sexual and asexual. Sexual reproduction is the union of the pollen and egg, drawing from the genes of two parents to create a new, third individual. Sexual propagation involves the floral parts of a plant.
- Asexual or vegetative propagation involves taking a part of one parent plant and causing it to regenerate itself into a new plant. The resulting new plant is genetically identical to its parent.
- **There are many plants in which parts like the root, stem, and leaves develop into new plants under appropriate conditions**. Unlike in most animals, plants can indeed use such a mode for reproduction. This property of vegetative propagation is used in methods such as layering or grafting to grow many plants like sugarcane, roses, or grapes for agricultural purposes. Plants raised by vegetative propagation can bear flowers and fruits earlier than those produced from seeds. Such methods also make possible the propagation of plants such as banana, orange, rose and jasmine that has lost the capacity to produce seeds.
- **Hence all the options are correct.**

Q 90.A

- **Centrosome: Centrosome is present only in animal cell cytoplasm near the nucleus.** It consists of two cylindrical centrioles placed perpendicular to each other, embedded in amorphous pericentriolar materials. During cell division, it duplicates in S phase and separates to the opposite direction during mitosis M-phase.
- Centrioles are two cylindrical structures composed of nine triplets of microtubules of tubulin, arranged around a central cavity. They act as a center of mitotic spindle assembly during cell division.
- **Plastids:** They are found in plant cells only. Plastids are of three types— chloroplasts, chromoplasts and leucoplasts.
  - Chloroplasts are green. They possess photosynthetic pigments—chlorophyll and carotenoids.
  - Chromoplasts contain yellow, orange or red coloured pigment.
  - Leucoplasts are colourless plastids.
- Chloroplasts help in photosynthesis. They provide colour to the flowers and the fruits. Leucoplasts help in the storage of food.
- **Cell wall: Cells of bacteria, algae, fungi, and higher plants are also surrounded by a rigid cell wall beside the plasma membrane. It is not found in animal cells.** It differs structurally in bacteria and eukaryotes. In bacteria, it is composed of polysaccharides cross-linked by small peptides, which provides

rigidity, shape and protection from osmotic pressure; and in eukaryotes (plants and fungi), it is primarily made up of polysaccharides. Cell wall not only determines the cell shape, but also prevents cell bursting caused due to osmotic pressure. It also helps in cell–cell interaction and provides mechanical strength and protection from infection.

- **Vacuoles: Vacuoles are membrane-bound intracellular organelles found in the cytoplasm of most plants, fungi and also some animal cells.** The term 'vacuole' meaning 'empty' comes from its transparent morphology and lack of cytoplasmic material. Its major functions is storage, structural support and recycling.
- **Hence option (a) is the correct answer.**

Q 91.A

- **Longer surfboards provide more stability due to their increased surface area and volume interacting with the water. This larger planing surface makes it easier for riders to maintain balance, especially for beginners who are still developing their skills.**
- **The extended length of the board distributes the rider's weight over a larger area, reducing the chances of tipping or wobbling.**
- Beginners often benefit from longer boards that prioritize stability, making it easier for them to learn the fundamentals of paddling, balance, and catching waves.
- Additional factors like thickness, rocker (curve of the board), and fin configurations also play a role in shaping a surfboard's performance.
- **Hence option (a) is the correct answer.**

Q 92.D

- Given the escalating cases of cancer, the shortage of specialists poses a significant challenge in curbing fatalities. To address this gap, Mumbai's Tata Memorial Hospital (TMH), the biggest cancer hospital in India, is turning to artificial intelligence (AI).
- **By establishing a 'Bio-Imaging Bank' for cancer, the hospital is utilizing deep learning to craft a cancer-specific tailored algorithm that aids in early-stage cancer detection. It incorporated data from 60,000 patients into the biobank in the last year.**
- The project's overarching goal is to create a robust repository encompassing radiology and pathology images, intricately linked with clinical information, outcome data, treatment specifics, and additional metadata. This comprehensive resource is strategically designed for the training, validation, and rigorous testing of AI algorithms. AI contributes significantly to cancer detection by emulating the human brain's information processing. In cancer diagnosis, AI analyses radiological and pathological images, learning from extensive datasets to recognize unique features associated with various cancers. This technology facilitates early detection by identifying tissue changes and potential malignancies.
- **Recently, a new artificial intelligence (AI) tool and a fully automated process have successfully detected, identified, and classified its first supernova. The AI tool is called BTSbot.** BTSBot stands for Bright Transient Survey Bot, and it was developed by an international group of researchers led by Northwestern University. Apart from rapidly accelerating the process of analyzing and classifying new supernovas, the bot might even be able to bypass human errors.
- **Also, recently, In a first, an artificial intelligence wrote a poetry anthology titled "I AM CODE" which featured poems and hinted at the dangers that humans may face with the rise of robots.** ChatGPT can also write poetry even though its authenticity is questionable at this stage of development.
- **In many countries, Artificial intelligence is bolstering the battles against wildfires. Pano AI is one of a new class of "firetech" startups that have emerged to tackle such threats.** Based in California, a U.S. state subjected to increasingly frequent and ferocious wildfires, the company uses a network of mountaintop cameras, each rotating 360 degrees every minute, to capture data that is uploaded to the cloud. In order to distinguish smoke from clouds, fog or dust, Pano uses a method of AI called object detection, which has been trained to distinguish between smoke and non-smoke images. Human analysts then review the boxes to dismiss any false positives, and once smoke is confirmed, its position is pinpointed and first responders are alerted. **Hence, option (d) is the correct answer.**

Q 93.C

- **Bharat Ratna Award**
  - **Context:** Government has decided to confer Bharat Ratna to former Bihar CM Karpoori Thakur, posthumously.

- **About Bharat Ratna**
  - ✓ India's highest civilian award, instituted in 1954. **Hence option 1 is correct.**
  - ✓ Awarded in recognition of exceptional service/performance of highest order in any field of human endeavour.
  - ✓ Recommended by Prime Minister to President of India.
  - ✓ Restricted to Maximum of three in a particular year. **Hence option 2 is correct.**
  - ✓ Recipient receives a Sanad (certificate) signed by President and a medallion.
  - ✓ Does not carry any monetary grant.
  - ✓ It is not a title under Article 18. **Hence option 3 is not correct.**

Q 94.B

- Sunscreen protects the skin from the harmful effects of the sun. These rays can cause damage to the skin, leading to issues such as sunburn, premature aging, and an increased risk of skin cancer.
- **Sunscreen contains specific chemical compounds known as UV filters. These filters are designed to absorb UV radiation. When applied to the skin, these compounds absorb the UV rays and transform them into harmless heat. The absorbed energy is then released from the skin.**
- **In addition to absorption, sunscreen also works by scattering UV rays. Some sunscreen formulations contain physical blockers, such as zinc oxide or titanium dioxide. These minerals act as a physical barrier on the skin's surface. When UV rays reach the skin, these minerals scatter the rays in different directions, preventing them from penetrating the skin and causing damage.**
- While not the primary mechanism, some sunscreen formulations may also reflect a small portion of UV rays away from the skin's surface. This reflection further contributes to the protection provided by the sunscreen.
- Sunscreen formulations are often designed to provide broad-spectrum protection, meaning they protect against both UVB and UVA rays. UVB rays are primarily responsible for sunburn, while UVA rays contribute to premature aging. Both types of rays can contribute to the development of skin cancer.
- While sunscreen's primary role is to protect the skin from UV damage, some formulations may include ingredients that provide a soothing or cooling effect on the skin. This is not the primary mechanism of protection but can enhance the overall user experience.
- **Hence option (b) is the correct answer.**

Q 95.C

- **Graphene:**
  - **Context:** Ministry of Electronics and Information Technology (MeitY) established India Innovation Centre for Graphene **(IICG) at Kochi, Kerala**
  - **IICG is India's first Graphene Centre.**
  - IICG is a joint venture of the Digital University of Kerala, Centre for Materials for Electronics Technology (C-MET) and Tata Steel Limited.
  - IICG aims to foster Research and development, product innovation and capacity building in the area of Graphene and twodimensional materials (2DM).
  - It will also support the Graphene-Aurora program of the MeitY.
  - This programme aims to fill the gap between R&D and commercialization by providing a complete facility to startup and industry.
  - **About Graphene:**
    - ✓ It is a two-dimensional form (allotrope) of carbon. **Hence, statement 1 is correct.**
    - ✓ Consists of a single layer of carbon atoms arranged in a hexagonal lattice like a honeycomb. **Hence, statement 2 is not correct.**
    - ✓ It is prepared by heating Graphite, Coal tar and or Shellac or a mixture of these three in an inert atmosphere. **Hence, statement 3 is correct.**
  - **Applications:**
    - ✓ **Electronics-** Super-capacitors, touchscreens, better energy storage etc.
    - ✓ **Biomedical-** Can be used in targeted drug delivery, etc.
    - ✓ **Defence-** Developing stealth coatings, etc.
    - ✓ **Ultra-sensitive sensors:** For environmental monitoring, etc.
    - ✓ Along with IICG, Centre of Excellence in Intelligent Internet of Things Sensors was also launched.
    - ✓ It aims at creating incubation facilities, build capacity in intelligent IoT sensors, promote research and innovation,
    - ✓ IoT is the interconnection of computing devices in everyday lives with the internet. Intelligent IOT is integrated with Artificial Intelligence.

Q 96.B

- The closer the molecules are to each other and the tighter their bonds, the less time it takes for them to pass the sound to each other and the faster sound can travel. It is easier for sound waves to go through solids than through liquids because the molecules are closer together and more tightly bonded in solids. Thus, speed travels fastest in solids and slowest in gas. **Hence statement 1 is not correct.**
- Heat, like sound, is a form of kinetic energy. Molecules at higher temperatures have more energy, thus they can vibrate faster. Since the molecules vibrate faster, sound waves can travel more quickly. The speed of sound in room temperature air is 346 meters per second. This is faster than 331 meters per second, which is the speed of sound in air at freezing temperatures. **Hence statement 2 is correct.**

Q 97.A

- **Recent Context: First death of polar bear due to Avian Influenza occurred in Arctic region recently.**
- About the species:
  - **Polar bear is both the largest bear and the largest land carnivore (main food source is seals) in the world**. **Hence statement 1 is correct.**
  - **Its habitat is Arctic region only (not in Antarctica)** and lives solitary lives except when mating. **Hence statement 2 is not correct.**
  - However, polar bear has adopted to climatic conditions which reflects in-
    - ✓ Its ability to swim (due to large paws) for long distances
    - ✓ White fur helps the bear remain camouflaged.
    - ✓ Thick layer of fat below the skin surface acts as insulation on the body to trap heat.
    - ✓ Large size reduces amount of surface area exposed to cold per unit of body mass.
  - **The International Union for Conservation of Nature (IUCN) designates the polar bear as Vulnerable on its Red List. Hence statement 3 is not correct.**

Q 98.B

- **Earth has only one satellite. The moon** is the brightest and largest object in our night sky. The Moon makes Earth a more livable planet by moderating our home planet's wobble on its axis, leading to a relatively stable climate. It also causes tides, creating a rhythm that has guided humans for thousands of years.
- **Mars has two moons, Phobos and Deimos**. Both are thought to be captured asteroids, or debris from early in the formation of our solar system. Phobos is the larger of Mars's two moons.
- **Jupiter has 95 moons that have been officially recognized by the International Astronomical Union**. But the number doesn't capture the complexity of the Jovian system of moons, rings, and asteroids. The giant planet has thousands of small objects in its orbit.
  - Europa, Ganymede, and Callisto are popular moons of Jupiter.
- The **planet Neptune has 14 known moons**, which are named for minor water deities in Greek mythology. By far the largest of them is Triton, discovered by William Lassell on October 10, 1846, 17 days after the discovery of Neptune itself.
  - Titan, Enceladus, Mimas, and Rhea are the popular moons of Saturn.
- **Uranus has 27 known moons**, including five major moons: Miranda, Ariel, Umbriel, Titania, and Oberon.
- **As of June 8, 2023, Saturn has 146 moons in its orbit.** The moons range in size from larger than the planet Mercury – the giant moon Titan – to as small as a sports arena. The small moon Enceladus has a global ocean under a thick, icy shell. Scientists have identified both moons as high-priority science destinations for future deep space missions.
- **Hence option (b) is the correct answer.**

Q 99.B

- Fission is a mode of reproduction, During fission, there is a division of an organism or a cell into two or more parts, and the regeneration of each part into a new organism or a new cell. Fission can be of two types, namely, binary fission and multiple fission. binary fission is a type of asexual reproduction where a parent cell divides, resulting in two identical cells, each having the potential to grow to the size of the original cell. For e.g. Leishmania (which causes kala-azar), Escherichia coli (E. Coli) bacteria, and Amoeba (Protozoa). multiple fission: In multiple fission, a single parent cell is divided into many daughter cells e.g. malarial parasite, Plasmodium (Protozoa), and Algae. **Hence options 1 and 3 are correct.**

- Since viruses do not have the organelles which are necessary for the reproduction of viral components. They rely on the host cells for reproduction. Therefore, the fission mode of production is not seen in Viruses. **Hence option 2 is not correct.**

Q 100.B

- When you cut an onion, it releases sulfur compounds into the air. The specific sulfur compounds involved are part of a class of compounds known as amino acid sulfoxides.
- **The most well-known compound in this group is syn-propanethial-S-oxide. When the onion is cut, enzymes in the onion cells react with these sulfur compounds, converting them into a volatile gas.**
- **When this gas comes into contact with the moisture in your eyes, it forms sulfuric acid. The presence of sulfuric acid in the eyes stimulates the eyes to produce tears as a defense mechanism to flush out the irritant.**
- **This tearing response is what causes the sensation of crying when cutting onions.**
- So, the release of sulfur compounds and the subsequent formation of sulfuric acid are the key factors that lead to tearing when cutting onions.
- **Hence option (b) is the correct answer.**