All India Civil Services Coaching Centre

(Under the aegis of Government of Tamil Nadu)

Science and Technology

Answer Key Explanation

Maximum Questions: 100 **Maximum Marks: 200**

1. **Correct Option : (d)**
Exp: Main categories of food additives are as follows:
- Food colours
- Flavours and sweeteners
- Fat emulsifiers and stabilising agents
- Flour improvers - antistaling agents and bleaches
- Antioxidants
- Preservatives

Nutritional supplements such as minerals, vitamins and amino acids.

Except for Nutritional supplements, none of the above additives have nutritive value. These are added either to increase the shelf life of stored food or for cosmetic purposes.

Source: Page 449: Unit 16: NCERT XIIth: Chemistry

2. **Correct Option : (a)**
Exp: Indiscriminate use of antibiotics causes anti-biotic resistance. Antibiotic resistance occurs when an antibiotic has lost its ability to effectively control or kill bacterial growth; in other words, the bacteria are "resistant" and continue to multiply in the presence of therapeutic levels of an antibiotic.

The evolution of resistant strains is a natural phenomenon that occurs when microorganisms replicate themselves erroneously or when resistant traits are exchanged between them. The use and misuse of antimicrobial drugs accelerates the emergence of drug-resistant strains. So, 1 is correct. Some bacteria are naturally resistant to certain types of antibiotics.

However, bacteria may also become resistant in two ways:
1) by a genetic mutation or
2) by acquiring resistance from another bacterium.

Mutations, rare spontaneous changes of the bacteria's genetic material, are thought to occur in about one in one million to one in ten million cells. Some mutations enable the bacteria to produce potent chemicals (enzymes) that inactivate antibiotics, while other mutations eliminate the cell target that the antibiotic attacks.

Statement 2: Colonization resistance is the mechanism whereby the intestinal microflora protects itself against incursion by new and often harmful microorganisms. So, 2 is incorrect.

Source: Page 446: Unit 16: NCERT XIIth: Chemistry

3. **Correct Option : (c)**
Exp: Statement 1: Methanol, also known as methyl alcohol amongst other names, is a chemical with the formula CH_3OH (a methyl group linked to a hydroxyl group, often abbreviated MeOH). It is a light, volatile,

colourless, flammable liquid with a distinctive alcoholic odour similar to that of ethanol.

A polar solvent, methanol acquired the name wood alcohol because it was once produced chiefly by the destructive distillation of wood. Today, methanol is mainly produced industrially by hydrogenation of carbon monoxide.

Statement 2: Hydrogen peroxide is the simplest peroxide (a compound with an oxygen–oxygen single bond). It is used as an oxidizer, bleaching agent, and antiseptic. Concentrated hydrogen peroxide, or "high-test peroxide", is a reactive oxygen species and has been used as a propellant in rocketry. Its chemistry is dominated by the nature of its unstable peroxide bond.

Hydrogen peroxide is unstable and slowly decomposes in the presence of light. Because of its instability, hydrogen peroxide is typically stored with a stabilizer in a weakly acidic solution in a dark coloured bottle. Hydrogen peroxide is found in biological systems including the human body. Enzymes that use or decompose hydrogen peroxide are classified as peroxidases.

Statement 3: Acetaldehyde (systematic name ethanal) is an organic chemical compound with the formula CH3CHO.

It is one of the most important aldehydes, occurring widely in nature and being produced on a large scale in industry. Acetaldehyde occurs naturally in coffee, bread, and ripe fruit, and is produced by plants.

It is also produced by the partial oxidation of ethanol by the liver enzyme alcohol dehydrogenase and is a contributing cause of hangover after alcohol consumption. Pathways of exposure include air, water, land, or groundwater, as well as drink and smoke. Consumption of disulfiram inhibits acetaldehyde dehydrogenase, the enzyme responsible for the metabolism of acetaldehyde, thereby causing it to build up in the body.

The International Agency for Research on Cancer (IARC) has listed acetaldehyde as a Group 1 carcinogen. Acetaldehyde is "one of the most frequently found air toxins with cancer risk greater than one in a million".

Source: Based on UPSC papers

4. **Correct Option : (a)**

Exp: Statement 1: Histamine stimulates the secretion of pepsin and hydrochloric acid in the stomach.

A drug cimetidine (Tegamet), was designed to prevent the interaction of histamine with the receptors present in the stomach wall. This resulted in release of lesser amount of acid. The importance of the drug was so much that it remained the largest selling drug in the world until another drug, ranitidine (Zantac), was discovered.

Statement 2 & 3 and additional info: Histamine is a potent vasodilator. It has various functions. It contracts the smooth muscles in the bronchi and gut and relaxes other muscles, such as those in the walls of fine blood vessels. Histamine is also responsible for the nasal congestion associated with common cold and allergic response to pollen.

Source: Page 443: Unit 16: NCERT XIIth: Chemistry

5. **Correct Option: (b)**

Exp: Statement 1 is incorrect: Fast radio bursts (FRB) are bright bursts of radio waves from astronomical objects across galaxies. Gravitational Waves are disturbances in the curvature of space-time that propagate as

waves outward from their source at the speed of light.

Statement 3 is incorrect: As per NASA, a magnetar is a neutron star, "the crushed, city-size remains of a star many times more massive than our Sun." A pulsaris a highly magnetized rotating compact star that emits beams of electromagnetic radiation out of its magnetic poles.

Fast Radio Burst (FRB) NASA has reported that on April 28, it observed a mix of X-ray and radio signals never observed before in the Milky Way. Signifi cantly, the flare-up it observed included the first fast radio burst (FRB) seen within the galaxy.

Essentially, FRBs are bright bursts of radio waves (radio waves can be produced by astronomical objects with changing magnetic fi elds) whose durations lie in the millisecond-scale, because of which it is difficult to detect them and determine their position in the sky.

The source of the FRB detected in April in the Milky Way is a very powerful magnetic neutron star, referred to as a magnetar, called SGR 1935+2154 or SGR 1935, which is located in the constellation Vulpecula and is estimated to be between 14,000-41,000 light-years away.

Before April this year, scientists did not have any evidence to show that FRBs could be blasted out of a magnetar. Therefore, the observation is especially signifi cant.

As per NASA, a magnetar is a neutron star, "the crushed, city-size remains of a star many times more massive than our Sun."

The magnetic fi eld of such a star is very powerful, which can be over 10 trillion times stronger than a refrigerator magnet and up to a thousand times stronger than a typical neutron star's.

Neutron stars are formed when the core of a massive star undergoes gravitational collapse when it reaches the end of its life.

6. **Correct Option: (b)**

Exp: Recently, the successful demonstration of the indigenously developed propulsion technology is expected to accelerate the development of long range air-to-air missiles.

- The technology is called the Solid Fuel Ducted Ramjet (SFDR).
- The missile was guided to high altitude to simulate aircraft release conditions and subsequently the nozzle-less booster was ignited.
- The Defence Research and Development Laboratory (DRDL), Hyderabad is the lead agency for the collaborative mission project.
- The major difference between this missile and the regular air-to-air missiles is the air breathing ramjet propulsion technology, which helps propel the missile at high supersonic speeds (above Mach 2) for engaging targets at long ranges.
- The SFDR Mission Project started in 2013 with an estimated funding of nearly Rs 500 cr to develop the technology and demonstrate it in 5 years.

7. **Correct Option: (b)**

Exp: The Experimental Advance Superconducting Tokamak (EAST) reactor is an "Artificial Sun" designed to replicate the process our natural Sun uses to generate energy.

EAST is an experimental superconducting tokamak magnetic fusion energy reactor in Hefei, China.

It uses a ring to house heavy and super- heavy isotopes — atomic variations — of hydrogen, known as deuterium and tritium.

The isotopes are heated by powerful electric currents within the tokamak, tearing electrons away from their atoms and forming a charged plasma of hydrogen ions.

Powerful magnets lining the inner walls of EAST then contain the plasma to a tiny area to maximize the chance that the ions will fuse together.

When the ions fuse, they give off a large amount of energy, which can then be harnessed to run a power plant and produce electricity.

8. Correct Option: (c)

Exp: Xafecopy Trojan Malware

- Xafecopy Trojan is disguised as a useful apps like Battery Master and operates normally. The trojan secretly loads malicious code onto the device.
- Once the app is activated, the Xafecopy malware clicks on web pages with the Wireless Application Protocol (WAP) billing - a form of mobile payment that charges costs directly to the user's mobile phone bill. After this the malware silently subscribes the phone to a number of services.
- The process also does not require user to register a debit or credit card, or set up a user-name and password.
- The malware uses technology to bypass 'captcha' systems designed to protect users by confirming the action is being performed by a human. In the captcha system, websites show a set of some letters or numbers, which are required to be manually filled by the user.

9. Correct Option: (c)

Exp: The space harpoon is a part of the RemoveDEBRIS project, a multi- organization European effort to create and test methods of reducing space debris. There are thousands of little pieces of who knows what clogging up our orbital neighbourhood, ranging in size from microscopic to potentially catastrophic.

- There are as many ways to take down these rogue items as there are sizes and shapes of space junk; perhaps it is enough to use a laser to edge a small piece down toward orbital decay, but larger items require more hands-on solutions.
- The harpoon is meant for larger targets, for example full-size satellites that have malfunctioned and are drifting from their orbits. A simple mass driver could knock them toward the Earth, but capturing them and controlling descent is a more controlled technique.

10. Correct Option: (a)

Exp: The Indian Ocean Biogeographic Information System (IndOBIS) is one of the seven regional nodes established by the OBIS (The Ocean Biogeographic Information System).

- IndOBIS supplies the global scientific community with various types of geo referenced information on the biodiversity of the Indian Ocean. The Centre for Marine Living Resources and Ecology (CMLRE), as the nodal agency, integrate and collate information from sources that lie scattered

among several agencies, institutions and individuals within the Indian Ocean region.

- The near shallow waters of the coastal belt (from intertidal to 30 m depths) of the Indian EEZ (Exclusive Economic Zone), which cannot be surveyed using FORV (Fishery Oceanographic Research Vessel) Sagar Sampada, is being studied with the active participation of several maritime universities and institutions. Beyond the 30 m depth zone, data will be gathered through FORV Sagar Sampada cruises by CMLRE.
- IndOBIS thus contains species occurrence data on habitat level as data bases which include, inter alia, variety of spatial querying tools for visualizing relationship among species and their environment.

11. Correct Option: (c)

Exp:

- Cyber Physical Systems (CPS) are new class of engineered systems that integrate computation and physical processes in a dynamic environment. CPS encompasses technology areas of Cybernetics; Mechatronics; Design and Embedded systems; Internet of Things (IoT); Big Data; Artificial Intelligence (AI) and many more.
- The CPS systems are intelligent, autonomous and efficient, and are expected to drive innovation in sectors as diverse as agriculture, water, energy, transportation, infrastructure, security, health and manufacturing. Thus, it is heralded as the next paradigm shift in technology that can exponentially spur growth and development.
- To harness the potential of this new wave of technology and make India a leading player in CPS, the Union Cabinet approved the launch of the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) to be implemented by the Department of Science and Technology (DST).
- The Mission aims to create a strong foundation and a seamless ecosystem for CPS technologies by co-ordinating and integrating nationwide efforts encompassing knowledge generation, human resource development, research, technology and product development, innovation and commercialization.

12. Correct Option: (b)

Exp:

- RISC-V (pronounced “risk-five”) is a free and open ISA (Instruction Set Architecture) enabling a new era of processor innovation through open standard collaboration.
- Born in academia and research, the RISC-V ISA delivers a new level of free, extensible software and hardware freedom on architecture, paving the way for the next 50 years of computing design and innovation. The RISC-V ISA was originally developed by the University of California, Berkeley.
- Lack of royalties making RISC-V less costly than employing a commercial ISA.
- Unline chips based on proprietary designs; those involving RISC-V can be used without lengthy and expensive contractual negotiations. It is an open source technology. Since the instruction set is already published online, American export controls do notapply to it.

13. Correct Option: (a)

Exp: The Kessler Syndrome (also called the Kessler Effect, collisional cascading, or ablation cascade), proposed by the NASA scientist Donald J. Kessler in 1978, is a theoretical scenario in which the density of objects in the Low Earth Orbit (LEO) due to the space pollution is high enough that collisions between objects could cause a cascade in which each collision generates space debris that increases the likelihood of further collisions.

One implication is that the distribution of debris in the orbit could render space activities and the use of satellites in specific orbital ranges difficult for many generations.

14. Correct Option: (d)

Exp: Virtual reality (VR) is an artificial, computer - generated simulation or recreation of a real life environment or situation.

- On the other hand, augmented reality (AR) is a technology that layers computer-generated enhancements atop an existing reality in order to make it more meaningful through the ability to interact with it.
- AR is developed into apps and used on mobile devices to blend digital components into the real world in such a way that they enhance one another, but can also be told apart easily.
- Augmented reality and virtual reality are inverse reflections of one in another with what each technology seeks to accomplish and deliver for the user Virtual reality offers a digital recreation of a real life setting, while augmented reality delivers virtual elements as an overlay to the real world.

15. Correct Option: (d)

Exp: A liquid apogee Motor (LAM)/ liquid apogee engine (LAE) or apogee engine refers to a type of chemical rocket engine, typically used as the main engine in a spacecraft.

- It is basically a propeller used to put the satellite in the desired orbit.
- Flawless functioning of the LAM was pivotal to the Mars Orbiter Mission (MOM).
- If the activation of the engine after 300 days of space journey had failed, it would have compromised the mission.
- ISRO was confident of this 440-newton liquid apogee motor or LAM engine. It had been its workhorse to nudge the spacecraft from the temporary orbit to which PSLV rockets could take in near Earth orbit to permanent location in space. Even during the Chandrayaan-1 mission, it is the very same engine that nudged the spacecraft towards the Moon and was again used to decelerate so as to be captured by the Moon's gravity.
- However, for the Chandrayaan mission the engine hibernated only for two weeks, but for the Mars mission the engine had to survive treacherous deep space with dangerous radiation and thermal conditions.

16. Correct Option: (b)

Exp: Red shift is the displacement of the spectrum of an astronomical object toward longer (red) wavelengths.

- It is generally attributed to the Doppler Effect, a change in the wavelength that results when a given source of waves (e.g., light or radio waves) and an observer are in rapid motion with respect to each other.
- The light from the distant stars and more distant galaxies has distinct spectral characteristics. When these spectra are examined, they are found to be shifted toward the red end of the spectrum. This shift indicates that essentially all of the galaxies are moving away from us.
- A related phenomenon in which distant objects appear to be coming closer to the observer is the Blue Shift.

17. Correct Option: (b)

Exp: A cryogenic engine/ cryogenic stage is the last stage of space launch vehicles which makes use of cryogenics.

- Cryogenics is the study of the production and behaviour of materials at extremely low temperatures (below - 150 degree Centigrade) to lift and place heavier objects in the space.
- 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.

- However, cryogenic stage is technically a very complex system, compared to solid or earth-storable liquid propellant stages, due to its use of propellants at extremely low temperatures and the associated thermal and structural problems.
- ISRO has successfully developed an indigenous cryogenic engine after years of delay and eventual cancellation of the supply of technology by Russia.

18. Correct Option: (c)

Exp: The pancreas is a large cream coloured gland located just below the stomach. The pancreatic juice acts on carbohydrates, fats and proteins, and changes them into simpler forms.

- The large intestine is wider and shorter than the small intestine. It is about 1.5 metre in length. Its function is to absorb water and some salts from the undigested food material.
- The remaining waste passes into the rectum and remains there as semi-solid faeces. The faecal matter is removed through the anus from time-to- time. This is called egestion.

19. Correct Option: (b)

Exp: A fixed-dose-combination (FDC) drug is a cocktail of two or more active drug ingredients in a fixed ratio of doses.

- FDCs have been drawing attention from the pharmaceutical industries, because of the government's ban on 328 irrational FDCs in September, 2018. (FDCs are not completely banned in India).
- It is recommended that irrational FDCs should be avoided, because the interaction of ingredients used in FDCs are not well studied.
- Another reason for people using FDCs is the prevalence of self-medication. People buy the drugs on the recommendation of chemists, presuming that at least one of the compounds in the combination would give relief.
- A drug taken without doctor's prescription can lead to complications. One such complication is proliferation of anti-microbial resistance.

20. Correct Option: (c)

Exp: Phil and Anthony Butler (New Zealand based scientists) have, for the first time, X-rayed a human using a MARS spectral scanner that they have developed.

- Their company, MARS Bioimaging, is linked to the Universities of Otago and Canterbury, which helped develop it.
- The MARS scanner combines Medipix3 technology and computer algorithms to produce coloured, 3D X- rays.
- Medipix3 works like a camera, which detects and counts each individual particle hitting the pixels when its electronic shutter is open, thus allowing for high-resolution and high- contrast images which are very reliable.
- This scanner records the precise energy levels of the X-rays, as they hit each particle in your body, unlike the black and white scanners, which only record X-rays that pass through the body or get absorbed by the bones.
- This makes it unique for imaging applications, especially in the medical field. This particle-tracking technology had been developed for CERN's Large Hadron Collider, which had discovered the elusive Higgs Boson particle in 2012.
- The images can clearly differentiate between bone, muscle and cartilage, which makes it possible to even show the position and size of the cancerous tumours.
- Conventional X-rays were not helpful apart from diagnosing bone fractures, as they could not detect muscle and tissue surrounding the bone, but this new technology can show a clear view of the human body, including bones, lipids and soft tissue.

- Medipix is a family of read-out chips for particle imaging and detection. The original concept of Medipix is that it works like a camera, detecting and counting each individual particle hitting the pixels when its electronic shutter is open. This enables high-resolution, high-contrast, very reliable images, making it unique for imaging applications, in particular in the medical field.
- Hybrid pixel-detector technology was initially developed to address the needs of particle tracking at the Large Hadron Collider and successive generations of Medipix chips have demonstrated over 20 years the great potential of the technology outside of high-energy physics.

21. Correct Option: (d)

Exp: Recognizing that used cooking oil (UCO) is a potential feedstock for biodiesel and the cornerstone of this supply chain mechanism, FSSAI (The Food Safety and Standards Authority of India) is implementing an Education, Enforcement and Ecosystem (EEE) strategy to divert UCO from the food value chain and curb current illegal practices.

- Using the same cooking oil for repeated frying has adverse health effects. This used cooking oil is also a potential feedstock for manufacturing biodiesel.
- Therefore, FSSAI has launched the 'Repurpose Used Cooking Oil' (RUCO) – an ecosystem to enable the collection and conversion of used cooking oil to biodiesel.

Impacts of RUCO

RUCO will help bring:

- Health benefits by avoiding ill effects of UCO.
- Employment generation and economic growth.
- Infrastructural investment in rural areas.
- Cleaner environment with reduced carbon footprint.

22. Correct Option: (c)

Exp: A genetic mutation, known as CCR5-delta 32 is responsible for the two types of HIV resistance that exist. CCR5-delta 32 hampers HIV's ability to infiltrate immune cells. The mutation causes the CCR5 co- receptor on the outside of the cells to develop smaller than usual and no longer sit outside of the cell.

- CCR5 co-receptor is like a door that allows HIV entrance into the cell. The CCR5-delta 32 mutation, in a sense, locks "the door", which prevents HIV from entering into the cell.
- 1% of people descended from the Northern Europeans, particularly Swedes, are immune to HIV infection.
- These lucky people are homozygous carriers of the mutated gene - meaning that they inherited a copy from both of their parents. Another 10-15% (the number has even suggested to be 18%) of people with the European heritage inherited one copy of the gene.
- Just one copy of the mutation does not prevent against infection. It does, however, reduce the carrier's chances of infection and delays the progress of AIDS.
- Since the CCR5- delta 32 is tied primarily to the Eurasia region, the mutation has not been found in the Africans, East Asians, or Amerindians.
- The twins, called Lulu and Nana, reportedly had their genes modified before birth by a Chinese scientific team using the new editing tool CRISPR.
- The goal was to make the girls immune to infection by HIV, the virus that causes AIDS.

23. Correct Option: (c)

Exp: In human genetics, Mitochondrial Eve is the matrilineal most recent common ancestor for all living humans i.e., the most recent woman from

whom all living humans descend, in an unbroken line, purely through their mothers and through the mothers of those mothers, back until all lines converge on one woman.

The male analog to the Mitochondrial Eve is the Y-chromosome ADAM, the individual from whom all living humans are patrilineally descended. Scientists in 2019, traced the Mitochondrial Eve to Makgadikgadi Paleo Wetland in the Kalahari desert.

24. Correct Option: (d)

Exp: FOOD IRRADIATION

- Food irradiation (the application of ionizing radiation to the food) is a technology that improves the safety and extends the shelf life of foods by reducing or eliminating micro-organisms and insects.
- Like pasteurizing milk, and canning fruits and vegetables, irradiation can make food safer for the consumer. Irradiation does not make foods radioactive, compromise nutritional quality, or noticeably change the taste, texture or appearance of the food.

Advantages of irradiation

- Prevention of Foodborne Illness – to effectively eliminate organisms that cause foodborne illness, such as Salmonella and Escherichia coli (E. coli).
- Preservation – to destroy or inactivate organisms that cause spoilage and decomposition, and extend the shelf life of foods.
- Control of Insects – to destroy insects in or on tropical fruits imported into the United States.
- Irradiation also decreases the need for other pest-control practices that may harm the fruit.
- Delay of Sprouting and Ripening – to inhibit sprouting (e.g., potatoes) and delay ripening of fruit to increase longevity.
- Sterilization – irradiation can be used to sterilize foods, which can then be stored for years without refrigeration.
- Sterilized foods are useful in hospitals for patients with severely impaired immune systems, such as patients with AIDS or undergoing chemotherapy.
- Foods that are sterilized by irradiation are exposed to substantially higher levels of treatment than those approved for general use.

25. Correct Option: (b)

Exp: Carotenoids are a class of more than 750 naturally occurring pigments synthesized by plants, algae, and photosynthetic bacteria.

- They are naturally occurring fat- soluble pigments. These richly coloured molecules are the sources of yellow, orange and red colours of many plants.
- Animals are unable to synthesize carotenoids, depending completely in plants.
- Carotenoids act as anti- oxidants in the human body. They have strong cancer-fighting properties.

26. Correct Option: (b)

Exp: Deoxyribonucleic acid (DNA) is the chemical compound that contains the instructions needed to develop and direct the activities of nearly all living organisms.

- Each DNA strand is made of four chemical units, called nucleotide bases: adenine (A), thymine (T), guanine (G) and cytosine (C). Bases on opposite strands pair specifically for example an A always pairs with a T; a C always pairs with a G.
- These nucleotide bases get attached with sugar and phosphate molecule. Together, a base, sugar, and phosphate are called a nucleotide.
- Nucleotides are arranged in two long strands that form a spiral called a double helix.

- DNA contains the information needed to build the entire human body. The order, or sequence, of these bases determines the information available for building and maintaining an organism.
- DNA can replicate itself. Each strand of DNA in the double helix can serve as a pattern for duplicating the sequence of bases. This is critical when cells divide, because each new cell needs to have an exact copy of the DNA present in the old cell.

27. Correct Option: (d)

Exp: King cobra is the longest venomous snake in the world. It belongs to the Reptilia group of animalia kingdom. Its generic name Ophiophagus ('snake-eater') is indicative of its cannibalistic tendencies; its diet is comprised almost exclusively of snakes, including its own kind.

- It is a common misconception that snakes build nests for their eggs. Only one species of snake, the king cobra, builds a nest for its young.
- Not all snakes lay eggs, either. Snakes do not need to eat as often as other animals, because they have a very slow metabolism rate.
- King cobras, for example, can live for months without food.

28. Correct Option: (d)

Exp: Bioinks

- Bioinks are substances made of living cells (bioactive) that can be used for 3D printing of complex tissue models. (They are not used for regular paper printing).
- Bioinks are materials that mimic an extra-cellular matrix environment to support the adhesion, proliferation, and differentiation of living cells.
- These bioinks are often adopted from existing hydrogel biomaterials and derived from natural polymers, such as gelatins, alginates, fibrin, chitosan and hyaluronic acids that are sensitive to their processing conditions.
- Unlike traditional additive manufacturing materials, such as thermoplastic polymers, ceramics and metals, which require the use of harsh solvents, cross-linking modalities and high temperatures to be printed, bioinks are processed under much milder conditions. These mild conditions are necessary to preserve compatibility with living cells and prevent degradation of bioactive molecules and macro-proteins.

29. Correct Option: (b)

Exp: Robo-insects

- Robo-insects soar by fluttering tiny wings because they are too small to use propellers, like those seen on their larger drones.
- They need solar cells to fly. The reason is that the robot cannot lift the kind of battery that it would need to power its wings. So off-board power is necessary.
- Hence, it uses a tiny onboard circuit that converts the laser energy into enough electricity to operate its wings.
- Research is going on to convert solar power into electricity through photovoltaic cells.
- Robo-insects can carry out pollination services.

30. Correct Option: (a)

Exp: Carotenoids are plant pigments responsible for bright red, yellow and orange hues in many fruits and vegetables. These pigments play an important role in plant health. People who eat foods containing carotenoids get protective health benefits as well.

- Carotenoids are a class of phytonutrients ("plant chemicals") and are found in the cells of a wide variety of plants, algae and bacteria.
- They help plants absorb light energy for use in photosynthesis. They also have an

important anti-oxidant function of deactivating free radicals.

- Carotenoids act as anti-oxidants in the human body. They have strong cancer-fighting properties.

31. Correct Option: (b)

Exp: The Quadrantids, which peak during early-January each year, are considered to be one of the best annual meteor showers.

- Most meteor showers have a two-day peak, which makes catching sight of these other meteors much more possible.
- The Quadrantids peak, on the other hand, is much shorter – only a few hours. (The reason the peak is so short is due to the shower's thin stream of particles and the fact that the Earth crosses the stream at a perpendicular angle.) During its peak, 60 to as many as 200 Quadrantid meteors can be seen per hour under perfect conditions.
- Quadrantids are also known for their bright fireball meteors. Fireballs are the larger explosions of light and colour that can persist longer than an average meteor streak. This is due to the fact that the fireballs originate from the larger particles of the material.

32. Correct Option: (d)

Exp: Lagrange Points are the positions in the space where the objects sent there tend to stay put. At the Lagrange Points, the gravitational pull of two large masses precisely equals the centripetal force required for a small object to move with them.

- These points in the space can be used by the spacecraft to reduce fuel consumption needed to remain in position.
- The L1 point of the Earth-Sun system affords an uninterrupted view of the Sun and is currently home to the Solar and Heliospheric Observatory Satellite 'SOHO'.
- Note: The Aditya-1 mission was conceived as a 400 kg class satellite carrying one payload, the Visible Emission Line Coronagraph (VELC), and was planned to launch in a 800 km Low Earth Orbit.
- A satellite placed in the halo orbit around the Lagrangian Point 1 (L1) of the Sun-Earth system has the major advantage of continuously viewing the Sun without any occultation/eclipses.
- Therefore, the Aditya-1 mission has now been revised to "Aditya- L1 mission" and will be inserted in a halo orbit around the L1, which is 1.5 million km from the Earth.

33. Correct Option: (b)

Exp: China's "artificial sun", called EAST (Experimental Advanced Superconducting Tokamak), is a nuclear fusion reactor.

- It set a world record for reaching temperatures 5 times hotter than the Sun and staying there for 17 minutes.
- The EAST is one of 3 major domestic tokamaks that are presently being operated across the country.

34. Correct Option: (c)

Exp: The MUSE mission will help the scientists understand the forces driving the heating of the Sun's corona and the eruptions in that outer-most region that are at the foundation of the space weather.

- The mission will offer deeper insight into the physics of the solar atmosphere by using a powerful instrument, known as a multi-slit spectrometer, to observe the Sun's extreme ultraviolet radiation and obtain the highest resolution images ever captured of the solar transition region and the corona.
- The mission will also provide complementary observations from heliophysics research, such as the Extreme Ultraviolet Spectroscopic Telescope and ground-based observatories.
- MUSE will help us fill crucial gaps in the knowledge pertaining to the Sun-Earth connection.

35. Correct Option: (b)

Exp: Radio Frequency Identification (RFID) refers to a wireless system comprised of two components: tags and readers.

- The reader is a device that has one or more antennas that emit radio waves and receive signals back from the RFID tag. Tags, which use radio waves to communicate their identity and other information to the nearby readers, can be passive or active.
- Passive RFID tags are powered by the reader and do not have a battery. Active RFID tags are powered by batteries.
- RFID tags can store a range of information from one serial number to several pages of data.
- The readers can be mobile so that they can be carried by hand, or they can be mounted on a post or overhead. Reader systems can also be built into the architecture of a cabinet, room or building.

Advantages of RFID:

- RFID technology automates data collection and vastly reduces human effort and error.
- RFID supports tag reading with no line-of-sight or item-by-item scans required.
- RFID readers can read multiple RFID tags simultaneously, offering increase in efficiency.
- All RFID tags within range can be detected instantly and matched with the information in your database.
- Assets can be cross-referenced against assigned locations and recorded as present, missing or relocated.
- RFID can be integrated with active scanning and fixed readers for a totally automated tracking solution.
- Assets and employees can be tracked and located automatically for everything from supply chain and asset management, to facility security and emergency planning.
- Available scanners support both RFID and bar-coding, so you can upgrade at your own pace.

36. Correct Option: (c)

Exp: Graphite:

- The anodes of the Lithium-ion batteries are made from graphite.
- China is the world's largest producer of graphite.
- However, the world's largest known reserves of graphite are present in Turkey.
- India has ample reserves of graphite in the country.
- Major states producing graphite in India are: Jharkhand, Odisha and Tamil Nadu.

37. Correct Option: (b)

Exp: Under Mission Shakti, India demonstrated the capability to destroy a satellite in the 'Low Earth Orbit' using an Anti-Satellite missile.

- India became only the 4th country to conduct an Anti-Satellite missile test, after USA, Russia and China.
- The A-SAT missile was based on the exo atmospheric kill vehicle technology.
- Note: 'Vajra Prahar' is a Special Forces joint training exercise conducted alternately between India and USA.

38. Correct Option: (d)

Exp: The European and Japanese BepiColombo mission has made its first fly-by of Mercury, passing just 199 kilometres above the planet's surface.

- It captured black-and-white pictures of Mercury's crater-filled surface from a distance of about 1,000 kilometres.
- BepiColombo flew around Mercury's nightside, so it was not able to take photographs at its closest approach.
- Fly-bys are 'gravity assist' manoeuvres, which enable the interplanetary ships to either gain or lose momentum and modify

their orbits around the Sun, without consuming large amounts of fuel.

- BepiColombo uses them to brake, so that it falls towards the inner solar system. This way, the spacecraft will ultimately synchronize its trajectory with that of the innermost planet, Mercury, so it can enter the orbit.
- Once in the orbit, a major focus for the craft will be water-ice deposits inside the permanently shaded craters in Mercury's Polar Regions.

39. Correct Option: (b)

Exp: When the rays of sunlight take a longer path through the atmosphere much more scattering can occur.

- The molecules of air and other fine particles in the atmosphere have size smaller than the wavelength of visible light.
- These are more effective in scattering light of shorter wavelengths at the blue end, than the light of longer wavelengths at the red end.
- The red light has a wavelength, about 1.8 times greater than the blue light. Thus, when the sunlight passes through the atmosphere, the fine particles in air scatter the blue colour (shorter wavelengths) more strongly than red.
- The scattered blue light enters our eyes. If the Earth had no atmosphere, there would not have been any scattering. Then, the sky would have looked dark.
- The sky appears dark to the passengers flying at very high altitudes, as scattering is not prominent at such heights.
- Light from the Sun near the horizon passes through thicker layers of air and larger distance in the Earth's atmosphere before reaching our eyes.
- However, light from the Sun overhead would travel relatively shorter distance. At noon, the Sun appears white as only a little of the blue and violet colours are scattered. Near the horizon, most of the blue light and shorter wavelengths are scattered away by the particles. Therefore, the light that reaches our eyes is of longer wavelengths. This gives rise to the reddish appearance of the Sun.

40. Correct Option: (c)

Exp: Option c is the correct answer.

- A ball bearing is a type of rolling-element bearing that serves three main functions while it facilitates motion: it carries loads, reduces friction and positions moving machine parts.
- Ball bearings are used in bicycles, cars, etc., because the effective area of contact between the wheel and axle is reduced, this reduces friction.

Source: UPSC Prelims 2013

41. Correct Option: (b)

Exp: Option b is the correct answer.

- Statement a is incorrect. Aluminium is highly malleable material and thus can be made into very thin sheets or foils that can be later used for keeping food items.
- Statement b is correct. Aluminium as such does not react with the food items kept in the aluminium foil and hence is used for storing food in it.
- Statement c is incorrect. Yes, aluminium is very ductile which means it can be made into very thin wires. However, it is not the reason that aluminium is used for storing food.
- Statement d is incorrect. Although aluminium foil does keep the food warm for longer by trapping the hotter air inside, which then serves as an insulator, and by preventing heat loss due to radiation.
- The foil does not provide insulation as such because aluminium is a poor insulator.
- When hot food is left out, the biggest sources of heat loss tend to be radiation and evaporation. Hot food radiates heat out into

the room, and as moisture evaporates off the surface of the food, it carries heat with it.

- Aluminium foil reduces both of these effects. It has very low emissivity, and so it lets relatively little radiation out, and it traps most of the moisture inside, reducing the rate of evaporation.
- Aluminium is extracted from the bauxite ore using the Bayer process.
- Odisha is largest producer of bauxite in India with more than half of the total production.

Source: NCERT Class VIII Science Ch-4 Materials – Metals and Non-metals

42. Correct Option: (d)

Exp: Option d is the correct answer.

- Statement 1 is correct: Albedo effect refers to the reflecting back of incoming solar radiation from white surfaces on the earth back into the atmosphere and space.
- White surfaces like snow covered mountain peaks and ice sheets in polar regions are responsible for this, as well as light colored aerosols and white clouds in the atmosphere.
- Statement 2 is correct: Greenhouse effect is the heat insulating effect that certain gases in the atmosphere (greenhouse gases) like carbon dioxide, fluorides, methane, water vapour, etc have - like the glass of a botanical greenhouse.
- These greenhouses gases allow solar radiation to reach the earth surface, but they don't allow the absorbed heat escaping from earth surface in long waves to escape to space, thus increasing the earth's temperature.
- Without human induced disturbances, this effect has played vital role in maintaining optimum temperatures for life on earth's surface (otherwise earth would have been too cold at night), but an unnatural increase in concentration in greenhouse gases post Industrial revolution, due to use of fossil fuels has disturbed this balance causing climate change and many other ecological disturbances threatening biodiversity.
- Statement 3 is correct: Global Dimming is a phenomenon noticed in the recent 50-70 years, where there has been a decline in the total solar irradiance reaching the earth's surface due to reflection midway from the atmosphere back into space.
- This has been caused due to an increase in aerosols such as light coloured sulfur particles (from industries, thermal power plants, etc), soot, ash, vapours, etc. These absorb solar radiations and reflect them back into space without letting them reach earth's surface.
- This creates a cooling effect which is in contrast to the Greenhouse effect and global warming. It does not occur uniformly over the world and varies regionally in intensity and trends.

Source: NCERT Class 12th Biology, Ch-16; https://www.npolar.no/en/fact/albedo/ https://www.conserveenergyfuture.com/causes-and-effects-of-global dimming.php

43. Correct Option: (b)

Exp: Option b is the correct answer.

- Statement 1 is incorrect: Nuclear Radiations are considered very harmful to humans as well as all other life forms.
- Whereas at high doses they can cause death of organisms, even at low doses they can cause genetic defects and abnormalities like cancers and deformations, including in the offspring of affected individuals, as it causes changes at chromosomal levels which can be passed down to offspring.
- This is because radioactive materials emit radiation (energy waves and particles that can ionise organic matter in their path changing its properties).
- Statement 2 is correct:

Various sources of radioactive wastes are:

1) nuclear weapon testing
2) fallout from nuclear accidents such as the Chernobyl accident in 1986
3) foundering of nuclear submarines,
4) dumping of nuclear waste into the deep ocean,
5) discharges from nuclear power plants and nuclear reprocessing plants
6) oil extraction
7) phosphate rock processing

44. Correct Option: (c)

Exp: Option c is the correct answer.

- Fruits are influenced by physiological processes, which are respiration and transpiration. Rate of respiration increases with increase in surrounding temperature – this decreases shelf life of the fruit.
- Similarly, Fruits stored in a cold chamber exhibit longer storage life because rate of respiration is decrease

Source: UPSC Pre 2013

45. Correct Option: (a)

Exp: Option a is correct.

- Option a is incorrect: Genetic engineering makes crops more tolerant to both biotic and abiotic stresses (cold, drought, salt, heat).
- Bt toxin gene has been cloned from the bacteria and been expressed in plants to provide resistance to insects without the need for insecticides; in effect created a bio pesticide.
- Examples are Bt cotton, Bt corn, rice, tomato, potato and soyabean etc.
- Option b is correct: Genetic engineering can increase efficiency of mineral usage by plants which prevents early exhaustion of fertility of soil. At the same time, it also enhances nutritional value of food, e.g., golden rice, i.e., Vitamin 'A' enriched rice. Thus, helps to reduce post-harvest losses.
- Option b is correct: Genetic engineering can be used to create tailor-made plants to supply alternative resources to industries, in the form of starches, fuels and pharmaceuticals.
- Option d is correct. Genetic engineering can be used to create artificial insulin in labs. Insulin used for diabetes was earlier extracted from pancreas of slaughtered cattle and pig. In 1983, an American company prepared human insulin

46. Correct Option: (a)

Exp: Option a is correct.

- Statement 1 is correct: Chrome plating is a technique of electroplating a thin layer of chromium onto a metal object. The chromed layer can be decorative, provide corrosion resistance, ease cleaning procedures, or increase surface hardness and improve overall durability.
- Statement 2 is incorrect: Zinc plating increases (not decreases) the corrosion resistance of a surface.
- Zinc plating is primarily used to protect metals from corrosion effects.
- Zinc coatings prevent corrosion of protected metal by forming a physical barrier.
- Zinc plating may improve hardness of a surface to some extent.

47. Correct Option: (b)

Exp: Option b is the correct answer.

- Sulphuric acid does not react with or harm gold in any way. Gold and other precious, non-reactive metals can be dissolved by a mixture of hydrochloric acid and nitric acid, in a three-to-one ratio by volume. This is called aqua regia. It is used in etching gold, as it is one of the few materials capable of dissolving it.
- When gold is dipped into the liquid of aqua regia (it is a mixture of hydrochloric acid and nitric acid,) the inner shiny layer appears and the outer layer of gold gets dissolved.

The dissolving of the layer causes a reduction in the weight of the jewelry.

1) Hydrochloric acid is a strong acid. It reacts chemically with a lot of things, including your skin, but not gold. The Hydrochloric acid will dissolve most of the material around the gold, such as the quartz or iron stone that typically surround a natural gold nugget, and leave the gold unharmed.
2) In mines, mercury is used to recover minute pieces of gold that is mixed in soil and sediments. Mercury and gold settle and combine together to form an amalgam. Gold is then extracted by vaporizing the mercury. Although mercury is a naturally occurring element, it is highly toxic to humans, animals, and the environment when not handled properly.

48. Correct Option: (c)

Exp: Ethylene glycol is a synthetic liquid substance that absorbs water. It is odorless but has a sweet taste.

- Ethylene glycol is used to make antifreeze and de-icing solutions for cars, airplanes, and boats. At high altitudes, the temperature is low. So, to prevent the freezing of fuel, Ethylene Glycol is added.
- It is also used in hydraulic brake fluids and inks used in stamp pads, ballpoint pens, and print shops. herefore, option (c) is the correct answer.

49. Correct Option: (d)

Exp: A Nuclear Reactor works on the principle of nuclear fission process where atoms split and release energy. Reactors use uranium for nuclear fuel.

- The uranium is processed into small ceramic pellets and stacked together into sealed metal tubes called fuel rods. So, statement 1 is correct.
- The neutrons unless slowed down will escape from the reactor without interacting with the uranium nuclei unless a very large amount of fissionable material is used for sustaining the chain reaction. This needs to be slowed down by elastic scattering with light nuclei.
- Therefore, in reactors, light nuclei called moderators (and not Controllers) are provided along with the fissionable nuclei for slowing down fast neutrons. The moderators commonly used are water, heavy water (D_2O) and graphite. So, statement 2 is not correct.
- The reaction rate is controlled through control rods (and not moderators) made out of neutron-absorbing material such as cadmium. Control rods can then be inserted into the reactor core to reduce the reaction rate or withdrawn to increase it.
- In addition, to control rods, reactors are provided with safety rods which, when required, can be inserted into the reactor and K can be reduced rapidly to less than unity. So, statement 3 is not correct.
- Inside the reactor vessel, the fuel rods are immersed in water which acts as both a coolant and moderator. The moderator helps slow down the neutrons produced by fission to sustain the chain reaction. So, statement 4 is correct.
- Therefore, option (d) is the correct answer.

50. Correct Option: (c)

Exp: Different metals show different reactivities towards oxygen.

- Metals such as potassium and sodium react so vigorously that they catch fire if kept in the open. Hence, to protect them and to prevent accidental fires, they are kept immersed in kerosene oil.
- Potassium and sodium are electrolytes that help your body maintain fluid and blood volume so it can function normally.
- However, consuming too little potassium and too much sodium can raise your blood pressure.

- Though the words “salt” and “sodium are often used interchangeably, they do not mean the same thing.
- Therefore, option (c) is the correct answer.

51. Correct Option: (c)

Exp: AlphaFold is an AI-based protein structure prediction tool. It is based on a computer system called a deep neural network.

- Inspired by the human brain, neural networks use a large amount of input data and provide the desired output exactly like how a human brain would.
- AlphaFold is fed with protein sequences as input. When protein sequences enter through one end, the predicted three dimensional structures come out through the other. It uses processes based on “training, learning, retraining and relearning.”
- Proteins carry out all the functions inside a living cell. Therefore, knowing protein structure and function is essential to understanding human diseases.
- AlphaFold is neither flawless nor the only AI based protein structure prediction tool.
- RoseTTaFold, developed by David Baker, is another tool. Although less accurate than AlphaFold, it can predict the structure of protein complexes.
- Therefore, option (c) is the correct answer. Relevance: DeepMind’s AlphaFold system predicted the 3D structure of proteins based on their amino acid sequences.

52. Correct Option: (c)

Exp: Initially due to inertia of rest, the dust particles tend to remain at rest.

- The inertia of rest is the tendency of a body to remain in its state of rest or its inability to change its state of rest by itself.
- When a carpet is beaten with a stick, it is set into motion. It moves back and forth due to the force exerted by the stick. However, dust particles remain at rest due to inertia and as a result, the dust particles comes off.
- It is based on Newton’s First Law of Motion. Therefore, option (c) is the correct answer.

53. Correct Option: (d)

Exp: Ultrasound is generally used to clean parts located in hard-to-reach places, for example, spiral tube, odd shaped parts, electronic components etc.

- Objects to be cleaned are placed in a cleaning solution and ultrasonic waves are sent into the solution. Due to the high frequency, the particles of dust, grease and dirt get detached and drop out. The objects thus get thoroughly cleaned. So, point 1 is correct.
- Ultrasounds can be used to detect cracks and flaws in metal blocks. The cracks or holes inside the metal blocks, which are invisible from outside reduces the strength of the structure.
- Ultrasonic waves are allowed to pass through the metal block and detectors are used to detect the transmitted waves. If there is even a small defect, the ultrasound gets reflected back indicating the presence of the flaw or defect. So, point 2 is correct.
- Ultrasound may be employed to break small ‘stones’ formed in the kidneys into fine grains. These grains later get flushed out with urine. So, point 3 is correct.
- Ultrasonography which is based on ultrasound is also used for examination of the foetus during pregnancy to detect congenial defects and growth abnormalities. So, point 4 is correct.
- Therefore, option (d) is the correct answer.

54. Correct Option: (c)

Exp: When a sound producing source moves with a speed higher than that of sound, it produces shock waves in air. These shock waves carry a large amount of energy.

- The air pressure variation associated with this type of shock waves produces a very sharp and loud sound called the "sonic boom".
- The shock waves produced by a supersonic aircraft have enough energy to shatter glass and even damage buildings.
- Frequencies higher than 20 kHz are called ultrasonic sound or ultrasound. The audible range of sound for human beings extends from about 20 Hz to 20000 Hz.
- Rhinoceroses communicate using infrasound of frequency as low as 5 Hz.
- Whales and elephants produce sound in the infrasound range.
- Therefore, option (c) is the correct answer.

55. Correct Option: (d)

Exp: A stationary truck generates greater friction force between its tires and the ground than the force applied.

- As friction is directly proportional to the mass of the body, so heavier the truck larger is the friction.
- The force applied by the person is not enough to overcome the friction between the surface and tyres of the truck. Hence, the truck will only move if a force greater than the friction force is applied to it.
- Friction is a force that resists the sliding or rolling of one solid object over another.
- Frictional forces, such as the traction needed to walk without slipping, may be beneficial, but they also present a great measure of opposition to motion.
- About 20 percent of the engine power of automobiles is consumed in overcoming frictional forces in the moving parts.
- Therefore, option (d) is the correct answer.

56. Correct Option: (b)

Exp: NASA launched its new Laser Communications Relay Demonstration (LCRD) — the agency's first two-way, end-to-end optical relay. So, statement 1 is not correct.

- With relays, missions are not required to have direct line-of-sight to antennas on Earth, increasing communications coverage. LCRD creates a continuous path for data flowing from missions in space to ground stations on Earth, making a complete end-to-end system.
- Additionally, LCRD's ability to both send and receive data from missions and the ground stations makes the system two-way.
- Together, these capabilities make LCRD NASA's first two-way, end-to-end optical relay.
- LCRD has two optical terminals – one to receive data from a user spacecraft, and the other to transmit data to ground stations.
- The modems will translate the digital data into laser signals. This will then be transmitted via encoded beams of infrared light. So, statement 2 is correct.
- Unlike radio frequency communications, optical signals cannot penetrate clouds. LCRD will transmit data received from missions to two ground stations, located in Table Mountain, California, and Haleakalā, Hawaii. These locations were chosen for their minimal cloud coverage. So, statement 3 is not correct.
- Optical communications systems are smaller in size, weight, and require less power compared with radio instruments.
- A smaller size means more room for science instruments. Less weight means a less expensive launch. Less power means less drain on the spacecraft's batteries.
- With optical communications supplementing radio, missions will have unparalleled communications capabilities.
- Therefore, option (b) is the correct answer. Relevance: Recently, NASA launched its new Laser Communications Relay Demonstration
- (LCRD), the agency's first-ever laser communications system, from Cape
- Canaveral Space Force Station in Florida.

57. Correct Option: (a)

Exp: Statement 1 is not correct: The Information Fusion Centre for the Indian Ocean Region (IFC-IOR) is an initiative of the Indian Navy and is supported by the Government of India.

- Statement 2 is correct: Under the IFC- IOR collaborative, inclusive and high tech approach would be adopted to detect and deter maritime security threats of the region.
- The ocean is susceptible to threats such as maritime terrorism, piracy, human and contraband trafficking, illegal and unregulated fishing, arms running and poaching.
- To effectively control these, collaborative efforts between countries are required. An important aspect of this collaboration is information sharing.
- Currently, the exchange of information is done using telephone calls, faxes, emails and video conferencing over Internet. This is set to change with the IFC-IOR, which will host liaison officers from partner countries.
- Statement 3 is correct: Maldives,Mauritius, Sri Lanka and Seychelles have already joined the initiative while talks are on with Bangladesh and Thailand.

58. Correct Option: (d)

Exp: Statement 1 is not correct:

- Kyasanur Forest Disease (KFD) was first identified in 1957 in a sick monkey from the Kyasanur Forest in Karnataka.
- Since then, between 400-500 humans cases per year have been reported. KFD is endemic to the Indian state of Karnataka.
- Statement 2 is not correct: It is caused by Kyasanur Forest disease Virus (KFDV), a member of the virus family Flaviviridae.
- It derives its name from the forest range where the virus was first isolated. It is also known as "monkey disease/monkey fever" because of its association with monkey deaths.
- Transmission to humans may occur after a tick bite or contact with an infected animal, most importantly a sick or recently dead monkey.
- No person-to-person transmission has been described.

59. Correct Option: (b)

Exp: Statement 1 is not correct:

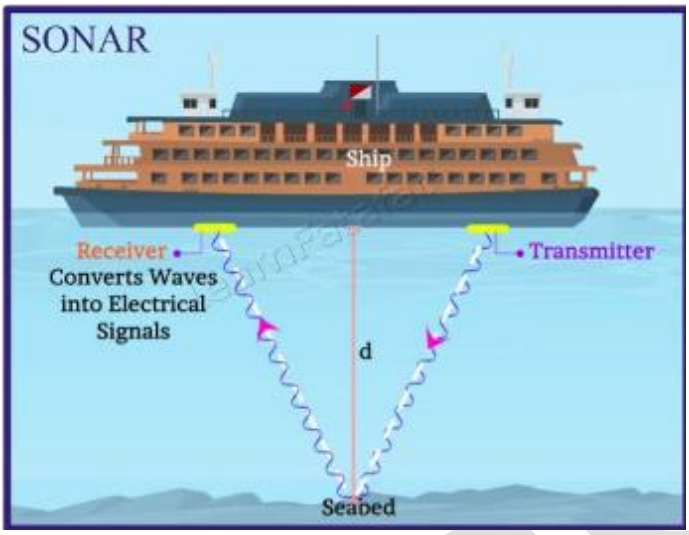
- Pollution from stubble burning in winter has been the key contributor to the sharp decline in air quality in Delhi. But stubble burning continues unabated.
- To find a solution to this issue, India tested a Swedish technology — torrefaction that can convert rice stubble into 'bio-coal'.
- Statement 2 is correct: The technology involves heating up straw, grass, saw mill residue and wood biomass to 250 degrees Celsius - 350 degrees Celsius.
- Statement 3 is correct: The heating up changes the elements of the biomass into 'coal-like' pellets. These pellets can be used for combustion along with coal for industrial applications like steel and cement production.

60. Correct Option: (b)

Exp: Sound is a mechanical wave and needs a material medium like air, water, steel etc. for its propagation.

- It cannot travel through vacuum, which can be demonstrated by the following experiment.
- Statement 1 is not correct: The sonar technique is used to determine the depth of the sea and to locate underwater hills, valleys, submarine, icebergs, sunken ship. Statement 2 is correct: Stethoscope is a medical instrument used for listening to sounds produced within the body, chiefly in the heart or lungs.
- In stethoscopes, the sound of the patient's heartbeat reaches the doctor's ears by multiple reflection of sound.

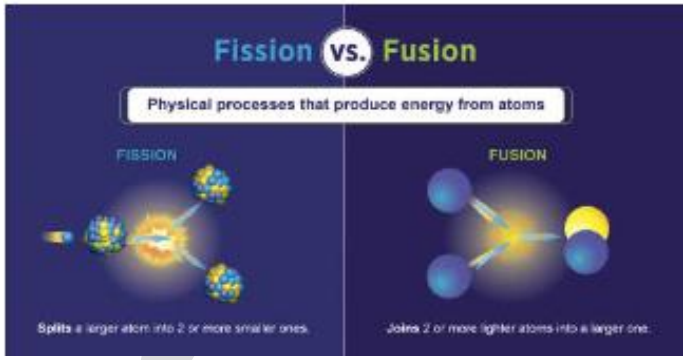
- Statement 3 is correct: Echoes may be heard more than once due to successive or multiple reflections. The rolling of thunder is due to the successive reflections of the sound from a number of reflecting surfaces, such as the clouds and the land.



61. Correct Option: (d)

Exp: Statement 1 is correct:

- When a free neutron hits the nucleus of a fissile atom like uranium-235 (235-U), the uranium splits into two smaller atoms called fission fragments, plus more neutrons. Energy is released when less tightly bound nuclei are transmuted into more tightly bound nuclei.
- Statement 2 is correct: Fission can be self-sustaining because it produces more neutrons with the speed required to cause new fissions. This creates the chain reaction. The chain reaction is uncontrolled and rapid in a nuclear bomb explosion. It is controlled and steady in a nuclear reactor. In a reactor, the value of the neutron multiplication factor k is maintained at 1.
- Statement 3 is correct: In fusion, lighter nuclei combine to form a larger nucleus. Fusion of hydrogen nuclei into helium nuclei is the source of energy of all stars including our sun.



62. Correct Option: (b)

Exp: Option (a) is not correct:

- Kwashiorkar is produced by protein deficiency unaccompanied by calorie deficiency. It results from the replacement of mother's milk by a high calorie low protein diet in a child more than one year in age.
- Unlike marasmus, some fat is still left under the skin; moreover, extensive oedema and swelling of body parts are seen.
- Option (b) is correct: Marasmus is produced by a simultaneous deficiency of proteins and calories. It is found in infants less than a year in age, if mother's milk is replaced too early by other foods which are poor in both proteins and caloric value.
- Option (c) is not correct: Emphysema is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased. One of the major causes of this is cigarette smoking.
- Option (d) is not correct: Osteoporosis is an age-related disorder characterised by decreased bone mass and increased chances of fractures. Decreased levels of estrogen is a common cause.

63. Correct Option: (c)

Exp: For effective treatment of a disease, early diagnosis and understanding its pathophysiology is very important.

- Using conventional methods of diagnosis (serum and urine analysis, etc.) early detection is not possible.

- Recombinant DNA technology, Polymerase Chain Reaction (PCR) and Enzyme Linked Immuno-sorbent Assay (ELISA) are some of the techniques that serve the purpose of early diagnosis.

64. Correct Option: (a)

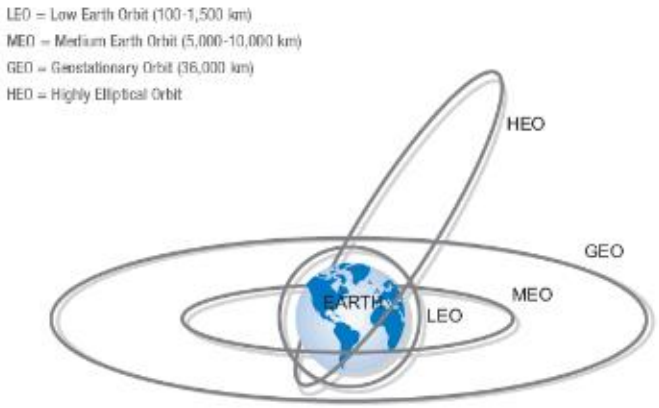
Exp: Statement 1 is correct:

- Bile is a yellowish, green liquid secreted by liver. The yellowish green colour of the bile is due to the pigments biliverdin and bilirubin produced by the breakdown of the dead and worn out RBCs (Red Blood corpuscles).
- These pigments are excreted in faces (solid or semi-solid waste and undigested food) that is thrown out through the anus.
- Statement 2 is not correct: Bile is an alkaline liquid (pH about 8). It consists of
  (i) water (98%),
  (ii) sodium carbonate in large quantity which neutralizes the acid of the chyme (semi digested food) received from stomach; makes it alkaline, and
  (iii) bile salts (sodium glycocholate and sodium taurocholate) which emulsify fats.
- Statement 3 is not correct: Bile has no digestive enzymes. It simply emulsifies fats.

65. Correct Option: (b)

Exp: Statement 1 is not correct:

- Sun synchronous satellites have orbit at height of around 800 km while for geosynchronous satellites, altitude is around 36000 km. Thus, Satellites in geosynchronous orbits have higher altitude than those in sun synchronous orbits.
- Statement 2 is correct: Sun synchronous satellite arrives at the same latitude at the same time every day. During repeated crossing, the satellite can scan the whole earth as it spins about its axis. Such satellites are used for collecting data for weather prediction, monitoring floods, crops, bushfires, etc.
- Statement 3 is correct: Geo-synchronous satellites have the same orbital period as the period of rotation of the earth, equal to 24 hours. Since their orbital period matches that of the earth, they appear to be hovering above the same spot on the earth.
- A combination of such satellites covers the entire globe, and signals can be sent from any place on the globe to any other place.
- Since a geo-synchronous satellite observes the same spot on the earth all the time, it can also be used for monitoring any peculiar happening that takes a long time to develop, such as severe storms and hurricanes.



66. Correct Option: (a)

Exp: Option (a) is correct:

- In quantum computing, quantum supremacy is the goal of demonstrating that a programmable quantum device can solve a problem that classical computers practically cannot.
- In near future, Quantum Computers could leave standard computers in the dust on a variety of problems, such as database searches, chemistry calculations and machine-learning tasks.
- Option (b) is not correct: Harnessing and exploiting the laws of quantum mechanics to process information is the basic definition of Quantum Computing.

- Option (c) is not correct: Applying the principles of quantum mechanics to encrypt messages in a way that it is never read by anyone outside of the intended recipient, means Quantum cryptography, also called as quantum encryption.
- Option (d) is not correct: Running workloads remotely over the internet in a commercial provider's data is related to Cloud Computing. It is the "public cloud" model.

67. Correct Option: (c)

Exp: Gold nanoparticles

- The National Centre for Polar and Ocean Research (NCPOR) and the Goa University (GU) have successfully synthesized gold nanoparticles (GNPs) using psychrotolerant Antarctic bacteria through a non-toxic, low-cost, and eco- friendly way.
- These GNPs can be used as a composite therapeutic agent in clinical trials, especially in anti-cancer, anti-viral, anti-diabetic, and cholesterol-lowering drugs.
- GNPs are melted at much lower temperatures (300 °C) than bulk gold (1064 °C).
- GNPs are found to have greater solar radiation absorbing ability than the conventional bulk gold, which makes them a better candidate for use in the photovoltaic cell manufacturing industry.
- Gold nanoparticles are designed for use as conductors from printable inks to electronic chip.
- The surface of a gold nanoparticle can be used for selective oxidation or in certain cases the surface can reduce a reaction (nitrogen oxides).
- Gold nanoparticles are being developed for fuel cell applications. These technologies would be useful in the automotive and display industry.

68. Correct Option: (c)

Exp: Statement 1 is correct:

- The Defence Trade and Technology Initiative (DTTI) was formed in 2012 between the US and India, to enhance the bilateral relations in defence by venturing into the field of advanced defence research and development and manufacturing.
- The aim was to strengthen the US and India's defence industrial base by moving away from the traditional "buyer-seller" dynamic toward a more collaborative approach.
- This would be through exploring new areas of technological collaboration through co-development and co-production. Co-development of a defence product between two nations may not be a new concept, but formalising the process to execute multiple projects of co-development is an ambitious innovation.
- Statement 2 is correct: The enabling agreements which have been signed between the two countries are GSOMIA, LEMOA and COMCASA. These agreements along with BECA, which is slated to be signed in the forthcoming 2+2 ministerial dialogue enhance cooperation and interoperability between the armed forces of the two democracies. All these steps provide greater avenues to identify and execute meaningful projects under DTTI.

69. Correct Option: (c)

Exp: Statement 1 is correct:

- A chaff is primarily an electronic counter measure technology used by militaries worldwide to protect high-value targets such as fighter jets or naval ships from radars and radio frequency (RF) guiding mechanisms of the enemy missiles.
- The chaff deployed in the air reflect multiple targets for the missile guidance systems, thus misleading the enemy radars or deflecting adversary missiles. To ensure survivability of aircraft, CounterMeasure Dispensing System (CMDS) is used which

provides passive jamming against infra-red and radar threats.

- Chaff is a critical defence technology used to protect fighter aircraft from hostile radar threats. The importance of this technology lies in he fact that very less quantity of chaff material deployed in the air acts as a decoy to deflect enemy's missiles for ensuring safety of the fighter aircraft.
- Statement 2 is correct: Pune and Jodhpur-based facilities of the Defence Research and Development Organisation (DRDO) have jointly developed an advanced chaff technology to safeguard fighter aircraft of the Indian Air Force (IAF) from enemy radar threats.
- Defence Laboratory, Jodhpur, and High Energy Materials Research Laboratory (HEMRL), Pune, have developed the chaff cartridge meeting qualitative requirements of IAF.

70. Correct Option: (a)

Exp: In a major boost to Atmanirbhar Bharat and strengthening Indian Army, Defence Research & Development Organisation (DRDO) successfully flight tested indigenously developed low weight, fire & forget Man-Portable Anti-Tank Guided Missile (MPATGM)

- The missile (Man-Portable Anti-Tank Guided Missile) has already been successfully flight-tested for the maximum range. The missile is incorporated with state-of-the-art Miniaturized Infrared Imaging Seeker along with advanced avionics.
- The man-portable missile is launched using a tripod designed for a maximum range of 2.5 km with a launch weight of less than 15 Kg, Control Flight Tests have been successfully carried out and Guided Flight Tests (with IIR Seeker) are planned.
- This missile is for infantry and Parachute (Special Forces) of the Indian Army. It is 'Soft' launched from a canister using an Ejection Motor. It uses a state-of-the-art IIR seeker for homing on to the target.

71. Correct Option: (d)

Exp: Nanopollution

- Nanopollution is a generic name for all waste generated by nanodevices or during the nanomaterials manufacturing process. Nanowaste is mainly the group of particles that are released into the environment
- The basic theme of nanotechnology is to use particles having size in nanometer range for various applications in medical fields, cosmetics industry, and agriculture and food technologies.
- It is considered that NPs may pose risks to the environment and biological systems. It is also becoming evident that the size, structure and type of nanomaterials, such as graphene/grapheme oxide with gold NPs, carbon and carbon nitride nanotubes, have different effects on plants and the environment.
- A recent study showed a high toxicity of carbon nanotubes which seemed to produce harmful effects by an entirely new mechanism, different from the normal model of toxic dusts.
- The pulmonary injury and inflammation resulting from the inhalation of nanosize urban particulate matter appears to be due to the oxidative stress that these particles cause in the cells. Persistent insoluble nanoparticles may cause problems in the environment that are much greater than those revealed by human health assessments.

72. Correct Option: (d)

Exp: Recently, Apollo Proton Cancer Centre (APCC), India has become the 16th country in the world to offer proton therapy for cancer.

- The centre offers proton therapy with pencil- beam technology that provides a high degree of precision.
- Proton therapy can be utilised for young adults and teenagers to reduce the risk of second cancer.
- It uses protons rather than x-rays to treat cancer. At high energy, protons can destroy cancer cells.
- It can also be combined with x-ray radiation therapy, surgery, chemotherapy, and/or immunotherapy.
- Like x-ray radiation, proton therapy is a type of external-beam radiation therapy.
- It is the most technologically advanced method to deliver radiation treatments to cancerous tumors. Proton therapy also may be used to treat these cancers:
- Central nervous system cancers, including chordoma, chondrosarcoma, and malignant meningioma
- Eye cancer, including uveal melanoma or choroidal melanoma
- Head and neck cancers, including nasal cavity and paranasal sinus cancer and some nasopharyngeal cancers
  - Lung cancer
  - Liver cancer
  - Prostate cancer
  - Spinal and pelvic sarcomas, which are cancers that occur in the soft-tissue and bone
  - Non Cancerous brain tumors

73. Correct Option: (c)

Exp: Recent context: IIT Madras has recently devised an eco-friendly method to degrade the physically stable and chemically inert plastic fluoropolymer - polytetrafluoroethylene (PTFE).

- Statement 1 is correct: The well-known brand name of PTFE-based formulas is Teflon. Teflon is manufactured by heating tetrafluoroethene with a free radical or persulphate catalyst at high pressures.
- It is chemically inert and resistant to attack by corrosive reagents.
- Statement 2 is correct: It is used in making oil seals and gaskets and also used for non – stick surface coated utensils.

74. Correct Option: (a)

Exp: Statement 1 is correct:

- Nanomaterials contain particles in the size scale range of 1 to 100 nm in at least in one dimension. A nanometer is a unit of spatial measurement that is 10 -9 meter, or one billionth of a meter.
- Statement 2 is not correct: The Nanomaterials can be categorized on the basis of their degradability.
- The basic difference between biodegradable and non-biodegradable is that biodegradable items decompose or break down naturally whereas non-biodegradable items do not.
- Similarly, Nanomaterials may be organic or inorganic in nature.
- Biodegradable nanoparticles have been used frequently as drug delivery vehicles due to its improved bioavailability, better encapsulation, control release and reduction of toxic potential. Examples of biodegradable nanoparticles are PEG, albumin, PLA, PLGA, chitosan, gelatin, polycaprolactone, poly-alkyl-cyanoacrylates, etc.
- Similarly, Organic Nanomaterials have been primarily developed for drug delivery to reduce or overcome the risk of toxicity due to the intracellular and/or tissue sequestration there by increased bioavilability at the site of action.

75. Correct Option: (d)

Exp: Tuberculosis is a highly contagious and fatal disease, and it is currently diagnosed by a DNA-based test called NAAT, short for Nucleic Acid Amplification Test. However, it is unreachable to a vast population especially in

remote and backward regions, as the equipment is expensive and is infrastructure dependent.

- A team of two researchers, Dr Bhushan J Toley and his PhD scholar Navjot Kaur from the IISc, Bengaluru, have now developed a compact, stand-alone and portable device that promises to overcome the limitation by drastically cutting down the costs.
- It has been named FLIPP-NAAT, short for Fluorescent Isothermal Paper-and- Plastic NAAT. It has a 'blister-pack' type assembly which can be stacked, transported and stored conveniently, especially in TB surveillance vehicles.

76. Correct Option: (a)

Exp: Statement 1 is correct:

- Genome editing (also called gene editing) is a group of technologies that give scientists the ability to change an organism's DNA. These technologies allow genetic material to be added, removed, or altered at particular locations in the genome. Several approaches to genome editing have been developed. A recent one is known as CRISPR-Cas9.
- Statement 2 is not correct: Indian scientists have developed a new variant of currently popular gene editing tool, CRISPR-Cas9, and have shown that this variant can increase precision in editing genome while avoiding unintended changes in DNA. The study has been done by researchers from the Delhi-based Institute of Genomics and Integrative Biology (IGIB) of the CSIR. One of the widely used Cas9 enzyme in gene editing is Streptococcus pyogenes Cas9 (SpCas9) and its engineered variants.
- They have been harnessed for several gene-editing applications across different platforms, but concerns remain regarding their off-targeting at multiple locations across the genome. To overcome these problems, Indian researchers used another naturally occurring Cas9 from a bacteria called Francisella novicida. This protein (FnCas9) has shown negligible binding affinity to off-targets.

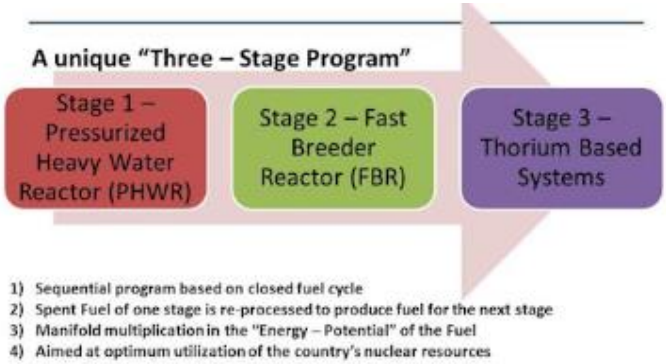
77. Correct Option: (a)

Exp: Statement 1 is correct:

- The first stage involved using Natural Uranium to fuel Pressurized Heavy Water Reactors to produce electricity and producing plutonium-239 as a byproduct.
- These Pressurized Heavy Water Reactors used unenriched uranium (Light Water Reactors required enriched Uranium).
- Statement 2 is not correct: The main use of Thorium is in the third stage, however, it is also used in the 2nd stage.
- India's second stage of nuclear power generation envisages the use of Pu-239 obtained from the first stage reactor operation, as the fuel core in fast breeder reactors (FBR).

The main features of FBTR are:

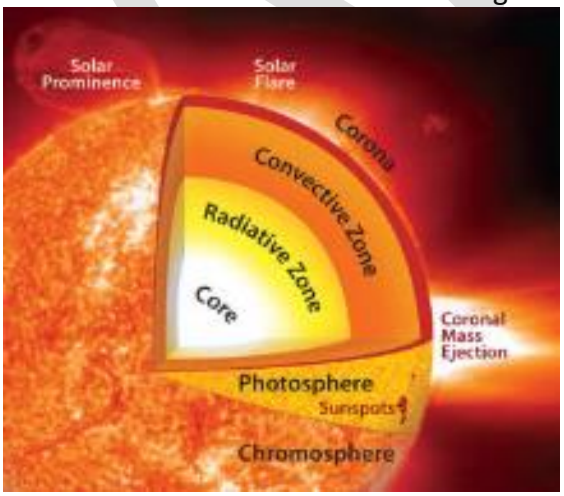
- Pu-239 serves as the main fissile element in the FBR.
- A blanket of U-238 surrounding the fuel core will undergo nuclear transmutation to produce fresh Pu-239 as more and more Pu-239 is consumed during the operation.
- Besides a blanket of Th-232 around the FBR core also undergoes neutron capture reactions leading to the formation of U-233.
- The main purpose of stage-3 is to achieve a sustainable nuclear fuel cycle. It would use a combination of Uranium-233 and Thorium.
- Thus India's vast thorium would be exploited, using a thermal breeder reactor.



78. Correct Option: (c)

Exp: Statement 1 is not correct:

- Sunspots are areas that appear dark on the surface of the Sun. They appear dark because they are cooler than other parts of the Sun's surface.
- Sunspots form at areas where magnetic fields are particularly strong. These magnetic fields are so strong that they keep some of the heat within the Sun from reaching the surface.
- Statement 2 is correct: Solar flare is sudden explosion of energy due to crossing of magnetic field lines near sunspots. Thus, Solar flares can temporarily alter the upper atmosphere creating disruptions with signal transmission from a GPS satellite to Earth.
- Statement 3 is correct: Coronal mass ejection is huge bubbles of radiation and particles from Sun which explode into space at high speed when Sun's magnetic field lines reorganize.



79. Correct Option: (a)

Exp: Statement 1 is correct:

- Mirage is an optical illusion caused by total internal reflection, which is observed in deserts or on tarred roads in hot summer days. This creates an illusion of water, which actually is not there.
- Due to excessive heat, the road gets very hot and the air in contact with it also gets heated up. The densities and the refractive indices of the layers immediately above the road are lower than those of the cooler higher layers.
- Since there is no abrupt change in medium, a ray of light from a distant object, such as a tree, bends more and more as it passes through these layers. And when it falls on a layer at an angle greater than the critical angle for the two consecutive layers, total internal reflection occurs.
- This produces an inverted image of the tree giving an illusion of reflection from a pool of water.
- Statement 2 is correct: An optical fibre is a hair-thin structure of glass or quartz. It has an inner core which is covered by a thin layer of a material of slightly lower refractive index. This arrangement ensures total internal reflection. When light is incident on one end of the fibre at a small angle, it undergoes multiple total internal reflections along the fibre. The light finally emerges with undiminished intensity at the other end.
- Even if the fibre is bent, this process is not affected. Statement 3 is not correct: Blue colour of sky is due to scattering of light. In accordance with Rayleigh's law the shorter wavelengths are scattered more than the longer wavelengths. Thus, the blue light is scattered almost six times more intensely than the red light. The scattered light

becomes rich in the shorter wavelengths of violet, blue and green colours.

- On further scattering, the violet light does not reach observe's eye as the eye is comparatively less sensitive to violet than blue and other wavelengths in its neighbourhood. So, when we look at the sky far away from the sun, it appears blue. Statement 4 is not correct: The clouds are formed by the assembly of small water drops whose size becomes more than the average wavelength of the visible light (5000Å). These droplets scatter all the wavelengths with almost equal intensity. The resultant scattered light is therefore white. So, a thin layer of clouds appears white. Thus the white colour of clouds is due to scattering of light.

80. Correct Option: (a)

Exp: Statement 1 is correct:

- Paramagnetic substances are the substances which are feebly attracted by a magnet. Some examples include aluminum, chromium, manganese, oxygen, platinum, alkali and alkaline earth metals.
- Statement 2 is correct: When placed in a magnetic field, diamagnetic substances are weakly repelled by it. Some examples of diamagnetic substances are antimony, copper, lead, gold, silver, zinc, quartz, mercury, alcohol, sodium chloride, water, hydrogen, air, argon etc.
- Statement 3 is not correct: Paramagnetism is due to the presence of one or more unpaired electrons in an atom, molecule or ion. Diamagnetism is shown by substances in which all the electrons are paired.

81. Correct Option: (a)

Exp: In late 2016, US diplomats and other employees stationed in Havana reported feeling ill after hearing strange sounds and experiencing odd physical sensations in their hotel rooms or homes.

- The symptoms included nausea, severe headaches, fatigue, dizziness, sleep problems, and hearing loss, which have since come to be known as "Havana Syndrome".
- Cuba had denied any knowledge of the illnesses even though the US had accused it of carrying out "sonic attacks", leading to an increase in tensions.

82. Correct Option: (c)

Exp: Most of the progress in Electric Vehicles has come in advances in Lithium-ion batteries which have become the batteries of choice for electric vehicles, largely because of high specific-energy, the ability to charge rapidly and their long cycle-lives.

- Lithium-ion batteries used in EVs have different chemistries. NMC-LTO cells use Nickel-Manganese-Cobalt (NMC) chemistry as cathode and Lithium-Titanium-Oxide (LTO) as anode (instead of graphite). They are powerful cells.
- However, their specific energy hovers around 80 Wh/ kg to 100 Wh/kg and the current cost exceeds $450 per kWh. They are, therefore, used only in specialized vehicles, where smaller batteries are used with charging and discharging very frequently.

83. Correct Option: (c)

Exp: Methane explosions occur in mines when a buildup of methane gas, a by-product of coal, comes into contact with a heat source, and there is not enough air to dilute the gas to levels below its explosion point.

- Methane, the main component of natural gas, is combustible, and mixtures ofabout 5 percent to 15 percent in air are explosive. When air contains approximately 9.5 percent of methane (the most dangerous concentration), it reaches the perfect oxidation point, which means that the right

amount of fuel is mixing with the right amount of oxygen.

84. Correct Option: (d)

Exp: Statement 1 is correct:

- Tetraethyl lead is added to petrol due to its anti-knock and octane-boosting properties. Knocking in an internal-combustion engine is sharp sound caused by premature combustion of part of the compressed air-fuel mixture in the cylinder.
- Statement 2 is correct: Leaded petrol causes heart disease, stroke and cancer and even affects the development of the human brain, especially harming children. It affects the brain, liver, kidneys and bones and can even effect the foetus in pregnant ladies.
- Statement 3 is correct: With Algeria finally stopping its use, the complete elimination of leaded automotive fuels worldwide has taken place.
- United Nations Environment Programme announced that the use of leaded petrol has been eradicated from the world.

85. Correct Option: (b)

Exp: Statement 1 is not correct:

- South Africa became the first country to grant patent to Artificial Intelligence System. Australia followed suit a few days later after a court judgment gave the go-ahead.
- Statement 2 is correct: DABUS stands for Device for the Autonomous Bootstrapping of Unified Sentience created by pioneer AI programmer Stephen Thaler. It is a particular type of AI often referred to as creativity machines because they are capable of independent and complex functioning.
- Prior to DABUS, Thaler built another AI which created novel sheet music, and which he credited with inventing the cross-bristle toothbrush design. He filed a patent for the cross-bristle design, and it was granted — proving AI's ability to generate truly novel inventions that meet the standards for patents.
- However, Thaler listed himself, rather than the AI, as the inventor at that time. So, DABUS became the first AI to get patent for its innovation for food containers

86. Correct Option: (b)

Exp: Statement 1 is correct:

- Helium has the lowest Boiling point and melting point of any element.
- Statement 2 is not correct: Helium is the second most abundant element in the universe, but preciously rare on Earth because it is light enough to simply escape from the top of our atmosphere.
- Statement 3 is not correct: Liquid helium (b.p. 4.2 K) finds use as cryogenic agent for carrying out various experiments at low temperatures.
- It is used to produce and sustain powerful superconducting magnets which form an essential part of modern NMR spectrometers and Magnetic Resonance Imaging (MRI) systems for clinical diagnosis.
- It is used as a diluent for oxygen in modern diving apparatus because of its very low solubility in blood.

87. Correct Option: (c)

Exp: Over production of acid in the stomach causes irritation and pain. In severe cases, ulcers are developed in the stomach.

- Statement 1 is correct: Until 1970, only treatment for acidity was administration of antacids, such as sodium hydrogencarbonate or a mixture of aluminium and magnesium hydroxide. Metal hydroxides are better alternatives because of being insoluble, these do not increase the pH above neutrality. These treatments control only symptoms, and not the cause.
- Therefore, with these metal salts, the patients cannot be treated easily. Statement 2 is correct: A major breakthrough in the

treatment of hyperacidity came through the discovery according to which a chemical, histamine, stimulates the secretion of pepsin and hydrochloric acid in the stomach. Histamine is a potent vasodilator. It has various functions.

- It contracts the smooth muscles in the bronchi and gut and relaxes other muscles, such as those in the walls of fine blood vessels.
- Histamine is also responsible for the nasal congestion associated with common cold and allergic response to pollen.

88. Correct Option: (a)

Exp: Correct option is (a):

- Formalin, derived from formaldehyde, is a known cancer-causing agent. It is commonly used to preserve bodies in mortuaries. It can also increase shelf life of fresh food.
- Some research suggests that while formalin can cause nausea, coughing and burning sensation in the eyes, nose and throat in the short term, it can cause cancer if consumed over a long period of time. Formalin (formaldehyde in water) is a common adulterant in fish.
- Traders and suppliers use it to extend the storage life of fresh or chilled fish and artificially improve the sensory attributes.

89. Correct Option: (a)

Exp: Statement 1 is correct:

- Optoelectronics is based on the quantum mechanical effects of light on electronic materials, especially semiconductors. Optoelectronics concerns the study and application of electronic devices that source, detect and control light.
- Optoelectronic devices consist of different semiconductor alloys lying on substrates.
- Statement 2 is not correct: The SERS can help detect harmful molecules present in water at ultra-low concentrations. Researchers have successfully demonstrated detection of Rhodamine 6G (R6G), an organic laser dye up to lowest limit of sub nano-molar concentration using rGO and MoS2 nanomaterials.

90. Correct Option: (c)

Exp: Statement 1 is incorrect:

- Metro Neo is a mass rapid transit system providing low- cost, energy-effi cient and eco-friendly urban transport solutions for tier 2 and tier 3 cities.
- Personal Rapid Transit (PRT) consists of driverless vehicles in the shape of pods, which can hold two to six people each.
- Statement 2 is incorrect: Drawing traction power from overhead wires, Metro Neo will not run on track but on road.

Metro Neo

- The government is set to approve national standard specifi cations for Metro Neo, a no-frills, low-cost urban rail transit system aimed at cities with population of less than 10 lakh or suburbs of bigger cities.
- Running on rubber tyres but drawing traction power from overhead wires, Metro Neo systems are lighter and smaller than conventional Metro trains — with a 10-tonne axle load instead of the normal 17 tonnes.
- It is suitable for places where the traffi c demand is around 8,000 passengers one way in peak time.
- Metro Neo systems are lighter and smaller than conventional Metro trains. They cost about 25% of conventional systems but with similar facilities, and are cheaper than the other budget option Metrolite, which costs about 40% of the normal Metro.
- Cities like Maharashtra's Nashik and Telangana's Warangal have pitched for Metro Neo systems.

91. Correct Option: (b)

Exp: Statement 2 is incorrect:

- Brucellosis is a bacterial disease that mainly infects cattle, swine, goats, sheep and dogs. Humans can get infected if they come in direct contact with infected animals or by eating or drinking contaminated animal products or by inhaling airborne agents. Hantavirus is contracted by humans from infected rodents.

Brucellosis Disease

- As the novel coronavirus pandemic continues, the health commission of Lanzhou City in China recently announced that a leak in a biopharmaceutical company last year caused an outbreak of brucellosis disease.
- More than 3,000 people have been infected with the disease since and no fatalities have been reported so far.
- Brucellosis is a bacterial disease that mainly infects cattle, swine, goats, sheep and dogs.
- Humans can get infected if they come in direct contact with infected animals or by eating or drinking contaminated animal products or by inhaling airborne agents.
- According to the WHO, most cases of the disease are caused by ingesting unpasteurized milk or cheese from infected goats or sheep.
- Symptoms of the disease include fever, sweats, malaise, anorexia, headache and muscle pain. While some signs and symptoms can last for long periods of time, others may never go away.
- These include recurrent fevers, arthritis, swelling of the testicles and scrotum area, swelling of the heart, neurologic symptoms, chronic fatigue, depression and swelling of the liver or spleen. Human to human transmission is rare.

92. Correct Option: (b)

Exp: Statement 1 is correct, so, using elimination method one can arrive at the right answer which is option (b).

- Statement 2 is incorrect : LiDAR's biggest challenge is that its performance gets affected in fog, rain, snow and dusty weather.
- Statement 3 is incorrect : Bathymetric LiDAR uses water-penetrating green light to also measure seafl oor and riverbed elevations

Light Detection and Ranging:

- LiDAR stands for light detection and ranging and is basically a remote sensing method that uses light in the form of a pulsed laser to measure distances to the subject. The light pulses along with other data
- generate accurate, high-resolution three-dimensional information of the object. There are two types of LiDAR namely topographic and bathymetric. Topographic LiDAR typically uses a near-infrared laser to map the land, while bathymetric lidar uses water- penetrating green light to also measure seafloor and riverbed elevations.

Challenges with LiDAR:

- Can't perform well in fog, rain, snow and dusty weather.
- Struggles to detect a glass wall or door, which is why smartphone manufacturers and self-driving cars makers use LiDAR along with secondary cameras and sensors.

93. Correct Option: (b)

Exp: Statement 1 is incorrect:

- Microwave is a form of electromagnetic radiation with wavelengths ranging from about one meter to one millimeter. The prefi x 'micro' in microwave is not meant to suggest a wavelength in the micrometer range.
- Rather, it indicates that microwaves are "small" (having shorter wavelengths), compared to the radio waves used prior to microwave technology.

Microwave Weapons

- The Indian Army has rejected "fake" a report which claimed that the Chinese army had used "microwave weapons" to drive Indian soldiers away from their positions in eastern Ladakh.
- Microwave Weapons are supposed to be a type of direct energy weapons, which aim highly focused energy in the form of sonic, laser, or microwaves, at a target.
- Microwave Weapons use beams of high-frequency electromagnetic radiation to heat the water in a human target's skin, causing pain and discomfort.
- A number of countries are thought to have developed these weapons to target both humans and electronic systems. According to a report in the 'The Daily Mail', China had first put on display its "microwave weapon", called Poly WB-1, at an air show in 2014.
- The United States has also developed a prototype microwave-style weapon, which it calls the "Active Denial System".

94. Correct Answer : (c)

Exp : Justification: Statement 1:

- Main problem that appears in the use of detergents is that if their hydrocarbon chain is highly branched, then bacteria cannot degrade this easily.
- Slow degradation of detergents leads to their accumulation. Therefore detergents with straight chain of hydrocarbons are preferred over branched chain as the latter are non-biodegradable and consequently cause environmental pollution.
- Statement 2: Effluents containing such detergents reach the rivers, ponds, etc. These persist in water even after sewage treatment and cause foaming in rivers, ponds and streams and their water gets polluted.
- These days the branching of the hydrocarbon chain is controlled and kept to the minimum.
- Unbranched chains can be biodegraded more easily and hence pollution is prevented.

Q Source: Page 452: Unit 16: NCERT XIIth: Chemistry

95. Correct Answer : (d)

Exp: Microbes are also used for commercial and industrial production of certain chemicals like organic acids, alcohols and enzymes.

- Examples of acid producers are Aspergillus niger (a fungus) of citric acid, Acetobacter aceti (a bacterium) of acetic acid; Clostridium butylicum (a bacterium) of butyric acid and Lactobacillus (a bacterium) of lactic acid.
- Yeast (Saccharomyces cerevisiae) is used for commercial production of ethanol. Microbes are also used for production of enzymes.
- Lipases are used in detergent formulations and are helpful in removing oily stains from the laundry.
- You must have noticed that bottled fruit juices bought from the market are clearer as compared to those made at home. This is because the bottled juices are clarified by the use of pectinases and proteases.

Q Source: Page 183: 12th Biology NCERT

96. Correct Answer : (c)

Exp: These are some excerpts from NCERT:

- "How long do the seeds remain alive after they are dispersed? This period again varies greatly. In a few species the seeds lose viability within a few months.
- Seeds of a large number of species live for several years. Some seeds can remain alive for hundreds of years. There are several records of very old yet viable seeds.
- The oldest is that of a lupine, Lupinus arcticus excavated from Arctic Tundra. The seed germinated and flowered after an estimated record of 10,000 years of dormancy.

- A recent record of 2000 years old viable seed is of the date palm, Phoenix dactylifera discovered during the archaeological excavation at King Herod's palace near the Dead Sea.:

Q Source: Ch2: 12th NCERT: Biology

97. Correct Answer : (b)

Exp: Statement 1: In anaerobic sludge digesters waste decomposing bacteria produce gases like Methane, Hydrogen sulphide, Carbon dioxide etc. However, they do reduce the need to have large landfills that emit a lot of methane in the atmosphere.

- Statement 2: Anaerobic digestion is particularly suited to organic material, and is commonly used for industrial effluent, wastewater and sewage sludge treatment.
- Anaerobic digestion, a simple process, can greatly reduce the amount of organic matter which might otherwise be destined to be dumped at sea, dumped in landfills, or burnt in incinerators.
- Therefore they help in replacement of fossil fuels and help displace industrially produced chemical fertilizers.

Q Source: NCERT XIIth: Biology

98. Correct Answer : (a)

Exp: There are several ways that animals respond to harsh winter: they migrate, adapt or hibernate.

- Hibernation essentially means going to deep sleep to conserve one's energy and chances of survival. Animals are known to accumulate some fat before they go to hibernation.
- There are other types of hibernators too. Obligate hibernators are defined as animals that spontaneously, and annually, enter hibernation regardless of ambient temperature and access to food.
- Obligate hibernators include many species of ground squirrels, other rodents, mouse lemurs.

Q Source: Page 225: NCERT XIIth: Biology

99. Correct Answer : (c)

Exp: Statement 1: Genetic modification (GM) is the alteration of the genome of a plant or animal by the addition of new genetic material.

- GM provides a way of expressing desirable characteristics in an organism that otherwise would not display them. It is the insertion of a gene into an organism, altering the genetic makeup.
- Selective breeding is a form of genetic modification which doesn't involve the addition of any foreign genetic material (DNA) into the organism. Rather, it is the conscious selection for desirable traits.
- So, we cannot control the exact genomes that will be a part of the desirable traits, which we can do comfortably in the GE technique.
- Statement 2: Over the centuries humans have tried to breed better crops and livestock.
- Traditionally this was done by carefully choosing parents for breeding that show the required characteristics - selective breeding. Traditional breeding was a slow process as asexual reproduction between plants requires time.

Q Source: Page 194: NCERT XIIth: Biology

100. Correct Answer: (c)

Exp: A single nucleotide polymorphism, or SNP (pronounced "snip"), is a variation at a single position in a DNA sequence among individuals. Recall that the DNA sequence is formed from a chain of four nucleotide bases: A, C, G, and T.

- If more than 1% of a population does not carry the same nucleotide at a specific position in the DNA sequence, then this variation can be classified as a SNP.
- Single nucleotide polymorphism are the places in the genome where people differ. In

about one out of every 1,000 letters of the code you'll run into one of these where one person might have a C and the other might have a T, and so it is called SNP.

- Most SNPs don't do very much, because they are in a part of the genome that doesn't have a critical function.
- But some of them confer a risk of disease like diabetes or heart disease, and those are of intense current interest because of what they teach us about why those diseases happen.
- If a SNP occurs within a gene, then the gene is described as having more than one allele. In these cases, SNPs may lead to variations in the amino acid sequence.
- SNPs, however, are not just associated with genes; they can also occur in noncoding regions of DNA.
- Although a particular SNP may not cause a disorder, some SNPs are associated with certain diseases. These associations allow scientists to look for SNPs in order to evaluate an individual's genetic predisposition to develop a disease.
- In addition, if certain SNPs are known to be associated with a trait, then scientists may examine stretches of DNA near these SNPs in an attempt to identify the gene or genes responsible for the trait.

Q Source: Ch 6: 12th Biology NCERT