

ForumIAS

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Prelims Marathon

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HISTORY
ECONOMICS
POLITY
SCIENCE AND TECHNOLOGY
GEOGRAPHY AND ENVIRONMENT

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Space-Tech

1. Consider the following statements regarding space-based internet networks:

1. Mega-constellations can be deployed across both Low Earth Orbit (LEO) and Geostationary Orbit (GEO) architectures to attain global commercial coverage.
2. Space-based internet completely bypasses terrestrial infrastructure, removing any operational requirement for fixed ground transceiver stations or ISPs.
3. High latency remains a primary technical advantage of utilizing Low Earth Orbit (LEO) satellite constellations compared to standard optical-fiber broadband networks.

Which of the statements given above is/are correct?

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

Correct Answer: (a)

Explanation:

- **Statement 1 is correct:** Companies utilize combinations of LEO arrays (like Starlink) and legacy GEO satellites to establish broad data links.
- **Statement 2 is incorrect:** Space-based internet still fundamentally relies on planetary ground stations (gateways) to link the network satellite traffic back to core internet service providers.
- **Statement 3 is incorrect:** A defining advantage of LEO networks is their low latency due to closer planetary proximity, not high latency.

2. Consider the following statements regarding the new observation facilities sanctioned in Ladakh:

1. The National Large Solar Telescope (NLST) is a 2-metre aperture system designed for Merak to observe solar magnetism and dynamics, making it India's third active ground-based solar observatory.
2. The National Large Optical Telescope (NLOT) features a 13.7-metre segmented-mirror setup at Hanle, engineered to study exoplanets using optical-infrared wavelengths.
3. Upon completion, both NLST and NLOT will be operated entirely under the direct financial control of the Kodaikanal Solar Observatory.

How many of the statements given above are correct?

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

Correct Answer: (b)

Explanation:

- **Statements 1 and 2 are correct:** These capture the precise technical dimensions and tracking goals for both the NLST (solar dynamics) and NLOT (segmented-mirror optical deep space array) architectures.
- **Statement 3 is incorrect:** The Kodaikanal Solar Observatory (established 1899) is an asset under the Indian Institute of Astrophysics (IIA), not an independent administrative body that controls new national infrastructure projects.

3. Consider the following statements regarding the Moonshot Project launched by IISc and the Pratiksha Trust:

1. The project aims to develop bidirectional brain co-processors that can decode neural recordings, analyze cognitive states, and re-encode signals back via neural stimulation.
2. The technology acts as a standard one-way conventional Brain-Computer Interface (BCI) aimed exclusively at capturing motor cortex outputs.

Which of the statements given above is/are correct?

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

Correct Answer: (a)

Explanation:

- **Statement 1 is correct:** Brain co-processors are AI-driven, closed-loop neural structures intended to interact with the brain dynamically.
- **Statement 2 is incorrect:** Unlike standard one-way BCIs, these devices focus on the full cognitive loop (perception, decision-making, attention) to specifically help restore reach and grasp functions in stroke survivors.

4. Consider the following statements:

1. ISRO first demonstrated its foundational structural capability to safely recover an orbiting craft using the Space Capsule Recovery Experiment (SRE) in 2007.
2. The planned winged Orbital Re-entry Vehicle (ORV) must be manually steered via a ground pilot crew throughout its descent to land safely on a standard runway.

Which of the statements given above is/are correct?

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

Correct Answer: (a)

Explanation:

- **Statement 1 is correct:** The 2007 SRE mission followed by the 2014 Crew Module Atmospheric Re-entry Experiment (CARE) laid down the thermal shielding and design data for India's re-entry profiles.
- **Statement 2 is incorrect:** The ORV is designed to perform its atmospheric re-entry and runway glide landing autonomously, requiring no human piloting during descent.

5. Consider the following statements regarding Mission MITRA:

- a) It is an astronomical observation program utilizing the Astrosat platform to trace electromagnetic stress anomalies across distant star systems.
- b) It represents a behavioral and physiological assessment program conducted at Leh, Ladakh, to evaluate Gaganyaan crew capabilities under extreme stress profiles like hypoxia and isolation.
- c) The mission is carried out as a defense venture controlled exclusively by the Defense Research and Development Organisation (DRDO).
- d) Its primary design goal is to train international space tourists for low Earth orbit civilian spaceflights.

Correct Answer: (b)

Explanation:

- Mission MITRA (Mapping of Interoperable Traits and Response Assessment) was conducted in collaboration with the IAF's Institute of Aerospace Medicine (IAM) to check the real-world operational strengths of the Gaganyaan astronauts under simulation.
- Mission MITRA (Mapping of Interoperable Traits and Response Assessment) is an ISRO terrestrial analog space mission conducted in Leh, Ladakh. Designed for the Gaganyaan programme, it evaluates astronauts and ground teams on psychological resilience, teamwork, and decision-making under stress caused by isolation, extreme cold, and hypoxia (low oxygen).

6. Consider the following statements:

1. Mons Mouton is a massive, flat-topped lunar mountain structure located near the Moon's South Pole, which has been identified as a target site for the Chandrayaan-4 mission.
2. The primary objective of the Chandrayaan-4 mission is to establish a permanent human outpost on Mons Mouton by the end of 2026.

Which of the statements given above is/are correct?

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

Correct Answer: (a)

Explanation:

- **Statement 1 is correct:** Named after NASA mathematician Melba Roy Mouton, this structure features a flat top spanning roughly 100 kilometers, rising 6,000 meters above surrounding areas.
- **Statement 2 is incorrect:** Chandrayaan-4 is a robotic sample-return mission meant to demonstrate lunar takeoff and sample retrieval capabilities, not a human habitation mission.

7. Consider the following statements regarding Solid Fuel Ducted Ramjet (SFDR) propulsion technology:

1. The propulsion structure merges the benefits of standard solid-fuel rocket boosters with an air-breathing ramjet engine system.
2. By utilizing atmospheric oxygen as an oxidizer for sustained cruise phases, the system significantly reduces the required structural weight of onboard oxidizers.
3. Because it requires a constant, highly pressurized internal turbopump array, the SFDR system cannot be used for compact long-range air-to-air missiles.

Which of the statements given above are correct?

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

Correct Answer: (a)

Explanation:

- **Statements 1 and 2 are correct:** These highlight the performance edge of SFDR, which allows missiles to maintain high-speed cruise phases over long interception distances.
- **Statement 3 is incorrect:** A ramjet relies on forward motion to compress incoming air, meaning it has no moving compressor parts or complex turbopump arrays, making it highly suitable for advanced long-range air-to-air missiles.

8. Consider the following statements regarding India's first commercial EOSS project under the Public-Private Partnership (PPP) model:

1. The PixxelSpace India consortium won the IN-SPACE proposal to design, construct, and operate a planned constellation of 12 state-of-the-art Earth Observation satellites.
2. Under this specialized PPP framework, the private sector manages satellite operations while the government offers policy, technical, and strategic back-end support.
3. The proposed satellite constellation will integrate diverse sensory instruments, including panchromatic, multispectral, hyperspectral, and microwave SAR sensors.

Which of the statements given above are correct?

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

Correct Answer: (d)

Explanation: All statements are factually correct. The project combines private agility with state oversight to deploy varied remote sensing arrays (hyperspectral, multispectral, and Synthetic Aperture Radar) within a multi-year deployment cycle.

9. Consider the following statements regarding polar orbits and related human spaceflights:

1. A satellite orbit that exhibits a structural deviation of up to 10 degrees from the precise North and South rotational poles is still classified under the polar orbit domain.
2. Polar orbits typically operate within Low Earth Orbit (LEO) parameter altitudes ranging roughly between 200 km and 1,000 km.
3. As the planet rotates beneath a polar-orbiting spacecraft, the satellite can achieve visual scanning coverage over the entire surface of the globe over time.

Which of the statements given above are correct?

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

Correct Answer: (d)

Explanation: All statements are correct. Polar orbits are widely chosen for mapping, intelligence surveillance, and weather systems due to their global surface sweep properties. The SpaceX "Fram2" mission is an example of a human spaceflight mission path crossing these polar boundaries.

10. Consider the following statements regarding the historical Kodaikanal Solar Observatory:

1. It is administratively managed and operated by the Indian Institute of Astrophysics (IIA), which functions under the Department of Science and Technology (DST).
2. The facility is internationally recognized for discovering the Evershed Effect the nearly horizontal outflow of gases observed within the sunspot penumbra layer.

Which of the statements given above is/are correct?

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

Correct Answer: (c)

Explanation: Both statements are correct. Established in 1899, this observatory houses long-term, high-quality data archives that continue to serve researchers in reconstructing solar magnetic behavior and understanding historical solar cycles.

Defence Technology

1. Consider the following statements regarding India's domestic Ballistic Missile Defense (BMD) initiative:

1. Phase 1 of the BMD program is structurally configured to track and intercept incoming hostile ballistic missile threats with an operational range of up to 2000 km.
2. Phase 2 of the program, designed to expand India's strategic defense envelope, is engineered to detect and neutralize longer-range ballistic threats up to 5000 km.

Which of the statements given above is/are correct?

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

Correct Answer: (c)

Explanation: Both statements are correct. India's BMD architecture is built as a multi-layered shield. Phase 1 provides protection against medium-range missile systems, whereas Phase 2 expands capabilities against Intermediate-Range Ballistic Missiles (IRBMs) and intercontinental threats up to 5000 km.

2. Match the tactical missile interceptors and anti-satellite assets (Column A) with their corresponding operational domains (Column B):

Interceptor System	Operational Characterization
I. Prithvi Air Defense (PAD) / Pradyumna	A. Endo-atmospheric interceptor engineered to destroy threats in the lower atmosphere.
II. Advanced Air Defense (AAD) / Ashwin	B. Exo-atmospheric interceptor boasting a maximum altitude threshold of 80 km.
III. Prithvi Defense Vehicle (PDV)	C. Advanced interceptor variant with an elevated altitude engagement capacity of 150 km.
IV. Prithvi Defense Vehicle Mk-2	D. Specialized exo-atmospheric interceptor capable of destroying low earth orbit satellites.

Select the correct matching combination using the options below:

- (a) I - B, II - A, III - C, IV - D
- (b) I - A, II - B, III - D, IV - C

- (c) I - B, II - C, III - A, IV - D
(d) I - D, II - A, III - C, IV - B

Correct Answer: (a)

Explanation:

- PAD handles high-altitude exo-atmospheric threats up to 80 km, while AAD targets threats inside the atmosphere (endo-atmospheric).
- PDV updates legacy systems to clear targets up to 150 km, and PDV Mk-2 serves as India's proven Anti-Satellite (ASAT) kinetic intercept weapon tested in Mission Shakti.

3. Consider the following statements regarding prominent foreign air defense systems:

1. NASAMS-II is a specialized US-developed missile infrastructure designed to protect airspace from cruise missiles, drones, and fixed-wing aircraft.
2. The S-400 Triumf is a highly capable Russian long-range anti-aircraft weapon system built to intercept drones, ballistic missiles, and stealth targets.
3. The Iron Dome is an ultra-long-range strategic ballistic missile interceptor deployed exclusively by Israel to counter hypersonic intercontinental threats.

Which of the statements given above are correct?

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

Correct Answer: (a)

Explanation:

- **Statements 1 correct:** NASAMS-II (United States): Developed by Kongsberg Defence & Aerospace and Raytheon, the NASAMS-II is a highly adaptable, short-to-medium-range ground-based air defense system. It is specifically engineered to protect critical infrastructure and population centers against fixed-wing aircraft, helicopters, cruise missiles, and unmanned aerial vehicles (UAVs).
- **Statements 2 correct:** S-400 Triumf (Russia): Manufactured by Almaz-Antey, the S-400 Triumf is a long-to-medium-range, highly mobile anti-aircraft weapon system designed to intercept almost all types of aerial threats.
- **Statement 3 is incorrect** because the Iron Dome is a short-range defense system. It is designed to counter low-tech rocket artillery, mortars, and short-range projectiles fired from nearby borders, not long-range or hypersonic ballistic missiles.

4. Consider the following statements regarding military technologies developed in India:

1. The RUDRAM series represents India's first indigenous family of anti-radiation missiles designed to suppress enemy air defenses by homing in on radiation-emitting radars.
2. The Sudarshan is a domestic laser-guided precision bomb kit developed by DRDO with an extended standalone gliding range capability of up to 500 km.
3. RaIDER-X is a compact explosive detection device developed through a joint collaboration between DRDO and the Indian Institute of Science (IISc), Bengaluru.

Which of the statements given above is/are correct?

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

Correct Answer: (b)

Explanation: Statements 1 and 3 are correct. Statement 2 is incorrect, the Sudarshan laser-guided bomb has a standard operational range of up to 50 km, not 500 km.

5. Consider the following statements regarding advanced weapon delivery systems and components:

1. A Fractional Orbital Bombardment System (FOBS) uses a low Earth orbit trajectory to fly over unexpected paths before de-orbiting onto a target, giving it nearly unrestricted range.
2. Compounds such as CL-20, HMX, and LLM-105 are classified as high-energy materials (HEMs) primarily utilized as military explosives in rocket warheads, artillery, and detonators.

Which of the statements given above is/are correct?

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

Correct Answer: (c)

Explanation: Unlike traditional ballistic paths that trace a predictable, high parabolic arc, FOBS drops its payload out of orbit before reaching a full revolution. This makes it difficult for early-warning systems to track. CL-20, HMX, and LLM-105 are advanced explosives optimized to maximize the energy-to-weight ratio in military warheads.

6. Consider the following grid categorizing the generation profiles of current and historical fighter aircraft within the Indian Air Force:

Generation Category	Aircraft Designation	Primary Operational Role
1. First Generation	MiG-21	Supersonic interceptor used primarily for air defense and ground attacks.
2. Second Generation	MiG-29	Twin-engine multirole fighter known for its exceptional maneuverability.
3. Third Generation	Sukhoi Su-30MKI	Heavy twin-engine multirole air superiority fighter developed with Russia.
4. Fourth Generation	Dassault Rafale & HAL Tejas	High-tech multirole fighters featuring delta-wing designs and fly-by-wire controls.

How many of the rows presented above are correctly matched?

- (a) Only one row
- (b) Only two rows
- (c) Only three rows

(d) All four rows

Correct Answer: (d)

Explanation: All four rows are matched correctly. The iconic MiG-21 dates back to earlier design eras, the MiG-29 represents specialized twin-engine agile updates, the Su-30MKI provides long-range multirole capability, and the Rafale along with the indigenous HAL Tejas bring glass cockpits and fourth-generation electronic warfare suites.

7. Consider the following statements regarding the fifth-generation fighter jet configurations of India and Russia:

1. The Sukhoi Su-57, Russia's operational fifth-generation stealth fighter, features supercruise capabilities but utilizes conventional round exhaust nozzles.
2. Under proposed partnerships, Russia has offered a twin-seat variant of the Su-57, which allows a second crew member to manage manned-unmanned teaming operations with stealth drones.
3. India's indigenous fifth-generation Advanced Medium Combat Aircraft (AMCA) is being developed and manufactured solely under the Defence Research and Development Organisation (DRDO), with zero foreign collaboration for its engines.

Which of the statements given above is/are correct?

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

Correct Answer: (a) Explanation:

Statements 1 and 2 are correct. Statement 3 is incorrect, while the AMCA is an indigenous program designed by ADA/DRDO, India is actively pursuing international partnerships and joint ventures with foreign aerospace manufacturers to co-develop and manufacture the high-thrust engines required for the production variants of the aircraft.

8. Consider the following statements regarding advanced fighter jets proposed for global and regional maritime/air force acquisition pipelines:

1. The Boeing F/A-18 Super Hornet is an all-weather, carrier-capable multirole fighter integrated with advanced radar and multi-sensor target tracking systems.
2. The Eurofighter Typhoon is a twin-engine, delta-wing multirole combat aircraft designed by a European consortium for air superiority and ground attack operations.

Which of the statements given above is/are incorrect?

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

Correct Answer: (d) Explanation: Both statements are correct. These aircraft represent advanced multirole designs featuring heavy structural configurations, modern sensor networks, and precision weaponry. They are frequently evaluated in international defense tenders due to their combat-proven reliability.

9. Consider the following statements regarding Over-the-Horizon (OTH) early warning radar technology:

1. OTH radar systems bypass the physical limitation of the Earth's curvature by bouncing high-frequency (HF) electromagnetic signals off the ionosphere via skywave propagation.
2. These systems provide deep early warning coverage across thousands of kilometers, allowing the detection of incoming ballistic trajectories and low-observable stealth assets.

Which of the statements given above is/are incorrect?

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

Correct Answer: (c)

Explanation: Both statements are correct. Standard line-of-sight radar arrays fail to track distant low-flying targets once they drop below the horizon due to Earth's curvature. By reflecting long-range high-frequency waves off the ionosphere down to the surface, systems like Russia's Container-S or Voronezh OTH radars can spot aircraft and missile launches from massive distances.

10. Which of the following military aircraft types is correctly matched with its primary operational role?

- (a) Dornier-228 — Heavy strategic transport aircraft designed for inter-continental large cargo military airlifts.
- (b) Ilyushin Il-76 — Twin-engine supersonic air superiority fighter equipped with nuclear striking capabilities.
- (c) C-17 Globemaster III — Supersonic close-air support fighter engineered for high-speed tactical intercepts.
- (d) Dassault Rafale — Supersonic multirole combat aircraft built for high-speed air defense and offensive strike operations.

Correct Answer: (d)

Explanation: Option (d) is correct; the Rafale is a supersonic multirole combat aircraft. The Dornier-228 is a light utility aircraft for maritime patrol and pollution control, while the Ilyushin Il-76 and C-17 Globemaster III are heavy strategic airlift transport platforms. They are not supersonic interceptors or fighter jets.

Defence Technology - II

1. Consider the following statements:

1. INS Vikramaditya is a refurbished Russian aircraft carrier (formerly Admiral Gorshkov) that features specialized landing architectures including the LUNA system for MiG-29K fighters.
2. INS Vikrant is India's premier indigenous aircraft carrier operating via Catapult-Assisted Take-Off But Arrested Recovery (CATOBAR) launch mechanisms to deploy twin-engine fighters.
3. Both aircraft carriers maintain operational configurations capable of handling approximately 30 air assets, including fixed-wing combat jets and rotary-wing surveillance platforms.

Which of the statements given above are correct?

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

Correct Answer: (c) Explanation:

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- **Statements 1 and 3 are correct:** INS Vikramaditya is an intensive conversion ship housing over 1,600 personnel with an operational range exceeding 13,000 km. Both platforms support around 30 aircraft including combat aircraft (MiG-29K) and utility/anti-submarine warfare helicopters.
- **Statement 2 is incorrect:** INS Vikrant does not use CATOBAR (catapults). It employs STOBAR (Short Take-Off But Arrested Landing) mode utilizing an indigenous angled ski-jump ramp for launch and three arrester wires for recovery.

2. Consider the following table regarding the surface combatants of the Indian Navy:

Row	Vessel Class / Project	Type and Area of Operation	Primary Mission Objective
1.	INS Astradharini	Torpedo Launch and Recovery Vessel; operates primarily on high seas.	Technical trials of indigenous underwater weapons and systems developed by NSTL.
2.	INS Kavaratti	Project 28 Kamorta-class Stealth Corvette; features carbon composites.	Dedicated long-range anti-submarine warfare (ASW) tracking and prosecution.
3.	Project 17A	Guided-Missile Frigate; designed for comprehensive "Blue Water" environments.	Countering conventional and non-conventional threats using Shivalik-class follow-ons.
4.	Project 15B	Advanced variants of Kolkata-class Guided-Missile Destroyers.	Fleet-level multi-mission strike defense using heavy, highly indigenous platforms.

How many of the rows presented above are correctly matched?

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

Correct Answer: (d)

Explanation: All four rows are accurately matched. INS Astradharini replaced legacy assets for testing underwater weapons. INS Kavaratti represents India's push into carbon composite naval integration for lower acoustic signatures under Project 28. Project 17A (Nilgiri class frigate fleet) and Project 15B (Visakhapatnam class destroyer fleet) represent high-priority surface acquisition pipelines with overall domestic material components exceeding 75%.

3. Consider the following statements regarding the conventional submarine fleets of the Indian Navy:

1. Diesel-electric submarines (SSKs) utilize electric propulsion motors powered by battery banks that require periodic surfacing or snorkeling to run air-breathing diesel generators.
2. The Shishumar-class represents a series of four conventional patrol submarines procured and built under a technology transfer collaboration with France.

3. The Kilo-class (Sindhughosh-class) was acquired from Russia, while the modern Kalvari-class (Scorpene design) is being constructed domestically in partnership with French naval design firms.

Which of the statements given above are correct?

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

Correct Answer: (b)

Explanation:

- **Statements 1 and 3 are correct:** Diesel-electric vessels are quiet when operating on battery charge but must surface or use a snorkel frequently to replenish air for their diesel combustion engines, making them more vulnerable to modern radar tracking than nuclear submarines.
- **Statement 2 is incorrect:** The Shishumar-class submarines were acquired and built in collaboration with Germany (HDW), not France. The Kalvari-class is the one linked to French collaborations.

4. Consider the following statements regarding the strategic submarine architecture of the Indian Navy:

1. Nuclear-Powered Attack Submarines (SSNs) are designed to hunt surface ships and other submarines, and can remain submerged almost indefinitely, limited only by crew provisions.
2. Nuclear-Powered Ballistic Missile Submarines (SSBNs) function as high-speed tactical front-line interceptors deployed to engage enemy vessels using short-range anti-ship cruise missiles.

Which of the statements given above is/are correct?

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

Correct Answer: (a)

Explanation:

- **Statement 1 is correct:** SSNs do not rely on external atmospheric air and utilize internal nuclear reactors for high-speed underwater endurance, carrying anti-ship and land-attack cruise missiles alongside torpedoes.
- **Statement 2 is incorrect:** SSBNs are not high-speed tactical front-line dogfighters. They are slow-moving, stealthy, strategic deterrent platforms designed to hide deep in oceans to preserve a country's second-strike capability using long-range Submarine-Launched Ballistic Missiles (SLBMs).

5. Consider the following statements regarding India's strategic nuclear triad:

1. A complete nuclear triad requires the verified operational capability to deliver nuclear payloads via airborne platforms, land-based ballistic systems, and submarine-launched missile architectures.
2. INS Arihant, commissioned in 2016 as India's first domestic Nuclear-Powered Ballistic Missile Submarine (SSBN), carries the K-15 SLBM with a range profile of 750 km.
3. INS Arighat is India's second indigenous nuclear-powered ballistic missile submarine, expanding the country's strategic second-strike capabilities under a strict "No First Use" policy.

Which of the statements given above are correct?

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

Correct Answer: (d)

Explanation: All statements are correct. India maintains a strict No First Use defensive doctrine, having a highly survivable sea-based retaliatory leg (SSBNs like Arihant and Arighat hiding at sea) is necessary to ensure credible strategic stability.

6. Consider the following statements regarding naval modernization programs:

1. Project 75 covers the domestic construction of six conventional hunter-killer submarines of Scorpene design by Mazagon Dock Shipbuilders Limited (MDSL).
2. Project 75 (I) is the follow-on program structured to procure advanced conventional submarines equipped with fuel-cell-based Air-Independent Propulsion (AIP) systems to extend submerged endurance.

Which of the statements given above is/are correct?

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

Correct Answer: (c)

Explanation: Both statements are correct. Project 75 delivered six assets (Kalvari, Khanderi, Karanj, Vela, Vagir, and Vagsheer). Project 75 (I) upgrades this by requiring an integrated AIP module, which removes the need for conventional submarines to surface daily to run their diesels, lowering their detection risk.

7. Consider the following table detailing indigenous Unmanned Aerial Vehicles (UAVs) developed by DRDO:

Row	Drone Platform	Production Origin	Core Tactical Utility Profile
1.	NETRA	Indigenous (DRDO)	Airborne Early Warning and Control (AEW&C) radar platform for wide-area tracking.
2.	Lakshya 2	Indigenous (DRDO)	Advanced pilotless target aircraft (PTA) used to simulate threat trajectories for weapons evaluation.
3.	Nishant	Indigenous (DRDO)	High-speed loitering munition optimized for armor penetration and anti-radiation radar strikes.
4.	Panchi	Indigenous (DRDO)	Wheeled derivative variant of a tactical UAV capable of conventional runway takeoff and landing.

How many of the rows presented above are correctly matched?

- (a) Only one row
- (b) Only two rows
- (c) Only three rows

(d) All four rows

Correct Answer: (c) Explanation:

- **Rows 1, 2, and 4 are correctly matched:** These accurately describe the tactical profiles of the NETRA radar dome system, the Lakshya target aircraft, and the wheeled Panchi UAV configuration.
- **Row 3 is incorrectly matched:** Nishant is designed for battlefield surveillance, reconnaissance, intelligence gathering, and electronic warfare support, not as an explosive loitering munition.

8. Consider the following table detailing tactical robotic systems and imported unmanned systems:

Row	Asset Designation	Procurement Origin	Primary Operational Domain
1.	UXOR	Indigenous (DRDO)	Unexploded ordnance handling and remote neutralization of heavy bombs/missiles.
2.	Heron	Imported (Israel)	Medium-Altitude Long-Endurance (MALE) asset deployed for long-range ISR operations.
3.	FireFly	Imported (United States)	Heavy multi-mission strategic combat search and rescue aircraft platform.
4.	Harpy / Harop	Imported (Israel)	Loitering munitions designed to destroy radar arrays via precision kamikaze strikes.

How many of the rows presented above are correctly matched?

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

Correct Answer: (c) Explanation:

- **Rows 1, 2, and 4 are correctly matched:** UXOR manages high-risk ordnance disposal safely. The Israeli-origin Heron handles long-endurance reconnaissance, and the Harpy/Harop platforms act as radar-hunting kamikaze loitering munitions.
- **Row 3 is incorrectly matched:** FireFly is a light, man-portable loitering munition imported from Israel, not a heavy combat search and rescue platform from the United States.

9. Consider the following statements:

1. The Bhargavastra micro-missile asset is an indigenous weapon system explicitly developed to counter and neutralize incoming hostile swarm drone threats.
2. Modern Swarm Drones operate as an integrated Smart War-Fighting Array of Reconfigured Modules (SWARM) where multiple assets communicate and coordinate actions autonomously.

Which of the statements given above is/are correct?

- (a) 1 only
 (b) 2 only

- (c) Both 1 and 2
- (d) Neither 1 nor 2

Correct Answer: (c)

Explanation: Both statements are correct. Swarm technology utilizes decentralized algorithms to allow multiple low-cost drones to work together as a single unit. To defend against this, specialized defense networks like the Bhargavastra micro-missile are designed to intercept and disrupt these distributed threats.

10. Consider the following statements regarding global non-proliferation export control architectures:

1. The Australia Group is an informal forum where participating countries maintain export regulations to prevent the proliferation of chemical and biological weapons, without imposing legally binding treaties.
2. The Wassenaar Arrangement is a multilateral export control consensus framework that focuses on regulating the transfer of conventional armaments and dual-use goods and technologies across 42 member states.
3. The Missile Technology Control Regime (MTCR) focuses heavily on limiting the proliferation of rocket and delivery systems capable of carrying a minimum payload threshold of 500 kg over a minimum distance of 300 km.

Which of the statements given above are correct?

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

Correct Answer: (d)

Explanation: All statements are factually correct. India is a full member of all three export control cartels (joining MTCR in 2016, Wassenaar in 2017, and the Australia Group in 2018). These informal mechanisms help regulate sensitive technology exports to prevent global proliferation while verifying India's status as a responsible space and defense power.

Defence Technology and Conventional and Alternative Energy

1. Consider the following statements:

1. The Organisation for the Prohibition of Chemical Weapons (OPCW) is the Hague-based implementing body for the Chemical Weapons Convention, to which India is a signatory and state party.
2. The Biological Weapons Convention (BWC) functions as the first multilateral disarmament treaty banning an entire category of Weapons of Mass Destruction (WMD), and its provisions have been both signed and ratified by India.
3. The Nuclear Suppliers Group (NSG) is a 48-member export-control body that admitted India as a full member following its signing of the Nuclear Non-Proliferation Treaty (NPT).

Which of the statements given above are correct?

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

Correct Answer: (a)

Explanation:

- **Statements 1 and 2 are correct:** India has signed and ratified both the Chemical Weapons Convention (implemented by the OPCW in The Hague) and the Biological Weapons Convention (BWC), supporting complete, verifiable elimination of these WMD categories.
- **Statement 3 is incorrect:** India is not a member of the Nuclear Suppliers Group (NSG). The principal obstacle to India's admission is its persistent refusal to sign the Non-Proliferation Treaty (NPT), which the NSG traditionally considers a foundational benchmark for membership.

2. Consider the following statements regarding international nuclear frameworks:

1. The 1996 Comprehensive Test Ban Treaty (CTBT) bans all nuclear explosions for both military and peaceful purposes, but it has not officially entered into force because it lacks necessary ratifications from states like India, Pakistan, North Korea, and the United States.
2. The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) is a landmark agreement aimed at preventing the spread of nuclear arms, promoting peaceful nuclear energy cooperation, and pursuing disarmament, and India was one of its primary founding signatories.
3. The Treaty on the Prohibition of Nuclear Weapons (TPNW), which entered into force on January 22, 2021, prohibits state parties from developing, testing, or stockpiling nuclear explosive devices, and India has chosen neither to sign nor ratify it.

Which of the statements given above are correct?

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

Correct Answer: (c)

Explanation:

- **Statements 1 and 3 are correct:** The CTBT cannot enter into force until all 44 specific nuclear-capable states listed in its Annex 2 ratify it (India, Pakistan, and North Korea have not signed; the US, China, Egypt, Iran, and Israel have signed but not ratified). The TPNW is active globally, but India stays out of it, maintaining that it does not represent a truly universal or consensus-driven path to global disarmament.
- **Statement 2 is incorrect:** India has not signed the NPT. India views the NPT as a fundamentally flawed and discriminatory framework that splits the world into permanent nuclear haves (the five permanent UN Security Council members who tested before 1967) and have-nots.

3. Consider the following statements regarding Directed Energy Weapons:

1. High-Energy Lasers operate as non-kinetic precision weapons that concentrate intense electromagnetic energy to melt, blind, or cause structural failure in targets at the speed of light.
2. Under the domestic DURGA-II project, the Defence Research and Development Organisation (DRDO) is actively developing a conventional rocket-propelled kinetic interceptor shield to detonate artillery shells in mid-air.

Which of the statements given above is/are correct?

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

Correct Answer: (a) Explanation:

- **Statement 1 is correct:** DEWs use concentrated energy (lasers or microwaves) instead of solid projectiles. They move at light speed to instantly degrade, disable, or burn through electronics and structural hulls without fragmentation or explosive blast waves.
- **Statement 2 is incorrect:** DURGA-II (Directionally Unrestricted Ray-Gun Array) is a Directed Energy Weapon (Laser) project, not a conventional rocket-propelled kinetic missile interceptor shield. It provides a silent, reusable, and instant laser defense architecture against drone swarms and incoming missile threats.

4. Which of the following presents the correct chronological arrangement of different types of coal ordered from the HIGHEST carbon concentration percentage to the LOWEST carbon concentration percentage?

- (a) Anthracite -->Lignite -->Bituminous -->Peat
- (b) Anthracite -->Bituminous -->Lignite -->Peat
- (c) Bituminous -->Anthracite -->Peat -->Lignite
- (d) Peat -->Lignite -->Bituminous -->Anthracite

Correct Answer: (b)

Explanation:

The carbon content determines the heating quality and grade of the coal. The accurate structural hierarchy from highest density of carbon to lowest is:

1. **Anthracite:** Purest and hardest form.
2. **Bituminous:** Standard commercial or metallurgical coal.
3. **Lignite:** Low-grade brown coal.
4. **Peat:** Organic precursor layer formed during the first stage of coalification.

5. Consider the following statements:

1. Coke is a tough, porous, black, nearly pure carbon material manufactured through the destructive distillation of coal, which involves heating it at high temperatures in a completely oxygen-free chamber.
2. Fly ash is a fine particulate byproduct generated by coal-fired thermal power plants that cannot be integrated into building materials or blended with standard Portland cement due to structural breakdown risks.

Which of the statements given above is/are correct?

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

Correct Answer: (a)

Explanation:

- **Statement 1 is correct:** The coking process drives off volatile matter and moisture from coal without letting it burn, leaving behind strong carbon structures used for smelting iron ore into steel.
- **Statement 2 is incorrect:** Fly ash is highly useful and can be blended as a partial replacement for Portland cement in concrete mixtures. It is also widely used to manufacture strong, eco-friendly construction bricks, helping to recycle industrial waste.

6. Consider the following statements regarding fuel gases utilized in domestic and transport sectors:

1. Liquefied Petroleum Gas (LPG) is a flammable hydrocarbon mixture consisting primarily of propane, butane, and isobutane, containing added ethyl mercaptan to give it a distinct odor for rapid leak detection.
2. Compressed Natural Gas (CNG) consists primarily of methane stored under high pressure, serving as a lower-emission, cleaner-burning alternative to gasoline and diesel engines.
3. Within the extraction industry, sweet gas denotes natural gas processing lines that are free from or contain very low concentrations of toxic, corrosive hydrogen sulfide, whereas sour gas contains significant amounts of it.

Which of the statements given above are correct?

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

Correct Answer: (d)

Explanation: All three statements are correct. Pure LPG and methane are naturally odorless; ethyl mercaptan is explicitly blended into commercial cylinders for safety. Sour gas requires industrial sweetening treatment plants to scrub out dangerous H₂S before it can be fed into commercial supply pipelines.

7. Based on industrial combustion data, which of the following sequences accurately lists the fuels in descending order based on their standard Calorific Value (from HIGHEST heat output per unit mass to the LOWEST)?

- (a) LPG -->Methane -->Petrol / Diesel / Kerosene -->Coal
- (b) Petrol -->LPG -->Methane -->Wood -->Cow Dung
- (c) Methane -->Coal -->Diesel -->Biogas -->Kerosene
- (d) Coal -->LPG -->Kerosene -->Biogas -->Wood

Correct Answer: (a)

Explanation: Calorific value indicates how much thermal energy a fuel yields when burned completely (kJ/kg). Evaluating the given datasets shows the accurate descending order in option (a):

- **LPG:** 55,000 kJ/kg
- **Methane:** 50,000kJ/kg
- **Petrol / Diesel / Kerosene:** 45,000kJ/kg
- **Biogas:** 40,000kJ/kg
- **Coal:** 33,000kJ/kg
- **Wood:** 22,000kJ/kg
- **Cow Dung:** 8,000kJ/kg

8. Consider the following statements regarding solar energy harvesting technologies:

1. Solar Photovoltaic (PV) panels generate electricity directly from solar radiation using semiconductor cells, making them suitable for residential and commercial electrical grids.
2. Solar thermal panels absorb sunlight to heat a working fluid, capturing thermal energy directly for applications such as space heating or domestic hot water systems rather than direct electrical conversion.

Which of the statements given above is/are correct?

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

Correct Answer: (c)

Explanation: Both statements are correct. The core distinction lies in the form of energy harvested: Solar PV utilizes quantum interactions within silicon layers to output electrons (electricity), while solar thermal configurations use mirrors or collectors to absorb infrared heat waves directly into water or glycol loops.

9. Consider the following statements regarding solar-powered water pumping systems:

1. A solar water pumping system integrates an electric pump with a solar photovoltaic (PV) array that harvests sunlight to generate the necessary driving power.
2. These solar-powered arrays can run a variety of pump configurations, including surface pumps, deep-well submersible units, Direct Current (DC) motor systems, Alternating Current (AC) induction motors, centrifugal setups, and positive-displacement piston pumps.

Which of the statements given above is/are correct?

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

Correct Answer: (c)

Explanation: Both statements are correct. Solar water pumping networks are versatile and scalable. Depending on the depth of the water table and agricultural needs, the electricity from the solar array can power either DC motors directly (without an inverter) or AC systems, using either centrifugal force or mechanical piston configurations.

10. Consider the following statements regarding the strategic objectives highlighted in the National Geothermal Energy Policy:

1. The policy targets unlocking an estimated 10,600 MW potential of clean geothermal energy to provide dependable, continuous base-load power to the national grid.
2. To encourage exploration, the policy allows up to 100% Foreign Direct Investment (FDI) via automatic routes alongside fiscal incentives like tax holidays, green bonds, and viability gap funding (VGF).
3. To protect long-term capital investments, supported geothermal extraction projects are granted an absolute maximum commercial lease tenure of 5 years, with zero extensions allowed.

Which of the statements given above are correct?

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

Correct Answer: (a)

Explanation:

• **Statements 1 and 2 are correct:** Geothermal power serves as an excellent base-load alternative because it operates continuously, independent of shifting weather patterns. The policy introduces fiscal incentives and opens up FDI options to de-risk high up-front drilling costs.

• **Statement 3 is incorrect:** Geothermal infrastructure requires long operation windows to amortize capital costs. The policy supports projects for an initial duration of 30 years, providing options to extend agreements based on resource availability, not limiting them to a strict 5-year maximum.

Conventional and Alternative Energy

1. Consider the following statements regarding gas hydrates:

1. They are crystalline, ice-like mineral compounds where gas molecules are chemically bonded to water molecules rather than physically trapped.
2. Gas hydrates occur exclusively in tropical terrestrial ecosystems under conditions of high ambient temperature and fluctuating low atmospheric pressures.
3. Methane hydrates serve as a major focus for global energy exploration, representing a vast, untapped potential reservoir of natural gas.

Which of the statements given above is/are correct?

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

Correct Answer: (b)

Explanation:

- **Statement 1 is incorrect:** Gas hydrates are clathrate compounds where gas molecules (primarily methane) are physically trapped inside a cage-like structure of water molecules, rather than chemically bonded.
- **Statement 2 is incorrect:** They form under specific conditions of low temperature and high pressure. Consequently, they are found in deep-sea continental margins and arctic permafrost regions, not tropical terrestrial ecosystems.
- **Statement 3 is correct:** Methane hydrates are highly abundant, and extraction technologies are being researched globally as they hold massive reserves of cleaner-burning natural gas.

2. Consider the following statements:

1. Biomass Cogeneration refers to the simultaneous, thermodynamic production of usable electricity and heat from organic matter, commonly utilized in sugar milling industries.
2. Biomass Gasification is a thermochemical process that converts solid biomass into a gaseous fuel mixture (syngas), using feedstocks such as coconut shells, groundnut shells, and rice husks.
3. Incineration involves the biological decomposition of urban waste materials under freezing temperatures to convert the entire raw volume into liquid methane with zero ash residues.

Which of the statements given above are correct?

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

Correct Answer: (a)

Explanation:

- **Statements 1 and 2 are correct:** Cogeneration improves energy efficiency in sugar mills by using sugarcane bagasse to generate both process heat and power. Gasification safely processes agricultural residues like rice husks and shells into synthesis gas (carbon monoxide and hydrogen).
- **Statement 3 is incorrect:** Incineration is a high-temperature thermal combustion process used to burn waste and reduce its volume. It produces ash, flue gas, and heat (used for waste-to-energy generation), not a freezing biological reaction that yields liquid methane.

3. Consider the following statements regarding Polycrack technology:

1. It utilizes a heterogeneous catalytic process to convert multiple types of waste feedstocks simultaneously into hydrocarbon liquid fuels, gas, carbon, and water.
2. The entire chemical process requires high-level segregation of raw waste and mandatory pre-drying of municipal solid waste before feeding it into the reactor.

Which of the statements given above is/are correct?

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

Correct Answer: (a)

Explanation:

- **Statement 1 is correct:** Polycrack is an innovative thermo-catalytic conversion process that processes diverse waste matrixes (plastics, organic waste, electronic waste) into useful petroleum-grade liquid fuels and gases.
- **Statement 2 is incorrect:** A key industrial advantage of Polycrack technology is its ability to process unsegregated and wet waste directly. It does not require intensive sorting or pre-drying of waste, making it highly efficient.

4. Consider the following table regarding different generations of biofuels:

	Biofuel Generation	Key Feedstock and Production Characteristics
1.	First Generation	Derived from consumable food crops like starch, sugar, and vegetable oil; known as conventional biofuels.
2.	Second Generation	Derived from sustainable non-food feedstocks, forest residues, and wood; known as cellulosic-ethanol.
3.	Third Generation	Extracted from high-yielding algae cultures; also known as algae fuel or oilage.
4.	Fourth Generation	Produced using advanced genetically engineered organisms like modified algae and cyanobacteria to maximize carbon capture.

How many of the rows presented above are correctly matched?

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

Correct Answer: (d)

Explanation:

All four rows are matched correctly. Biofuel generations trace an evolutionary path designed to minimize conflicts with food security. First-generation fuels compete directly with agriculture. Second-generation fuels

utilize non-edible organic waste. Third-generation fuels introduce high-yield marine algae, and fourth-generation fuels use synthetic biology and genetic engineering to convert solar energy and carbon dioxide directly into fuel.

5. Consider the following statements regarding the integration of Methanol in petrol:

1. Methanol, historically termed wood alcohol, can be clean-synthesized from diverse resources including natural gas, coal gasification, or industrial biomass.
2. The commercial designations M5 and M15 denote automotive fuel mixtures containing 5% and 15% volume of pure methanol blended into gasoline, respectively.
3. Methanol blending lowers the fuel octane rating, which causes engine knocking and reduces overall thermal efficiency compared to unblended petrol.

Which of the statements given above are correct?

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

Correct Answer: (a)

Explanation:

- **Statements 1 and 2 are correct:** Methanol is a versatile liquid fuel that can be produced from domestic resources like coal and biomass. Blends like M15 are being systematically introduced to reduce oil import costs and carbon emissions.
- **Statement 3 is incorrect:** Methanol blending actually increases the octane rating of the fuel. A higher octane rating improves anti-knock properties and engine performance, though adjustments are needed to counter its corrosive effects on standard rubber gaskets and fuel lines.

6. Consider the following statements regarding Ethanol blending in India:

1. Fuel-grade ethanol is an alcohol compound primarily produced through the industrial fermentation of simple sugars present in crops like sugarcane, corn, and sugar beet.
2. The deployment of high-concentration ethanol fuel blends can be run seamlessly in any conventional petrol engine without requiring structural modifications to fuel lines or injection blocks.
3. Increasing the volume of food crops used for ethanol production has sparked global debate over food security versus fuel diversification.

Which of the statements given above are correct?

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

Correct Answer: (c)

Explanation:

- **Statements 1 and 3 are correct:** Ethanol burns cleaner than raw gasoline, helping to lower greenhouse gas emissions. However, scaling up first-generation ethanol relies heavily on diverting food crops, creating a policy trade-off between energy production and agricultural food security.
- **Statement 2 is incorrect:** High ethanol blends like E85 cannot be used in standard conventional engines. They require dedicated modifications to the fuel infrastructure and engine components because ethanol is highly corrosive to standard plastics and metals, and has a different air-fuel ratio requirement.

7. Consider the following table regarding different types of biofuels:

Row	Biofuel Type	Technical Composition	Production Method & Core Operational Advantage
1.	Bioethanol	Primarily Ethanol	Fermentation of starch/sugars; features higher energy density per unit volume than pure petrol.
2.	Biodiesel	Fatty Acid Methyl Esters (FAME)	Transesterification of oils/fats; yields fewer particulate emissions than petroleum diesel.
3.	Biobutanol	Butanol	Fermentation of starches; offers the highest energy content among standard gasoline alternatives.
4.	Biohydrogen	Elemental Hydrogen	Pyrolysis, gasification, or biological fermentation; acts as a zero-carbon emission alternative.

How many of the rows presented above are correctly matched?

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

Correct Answer: (c)

Explanation:

- **Rows 2, 3, and 4 are correctly matched:** Biodiesel is produced via transesterification and burns cleaner than fossil diesel. Biobutanol has a long four-carbon chain that provides a high energy density close to gasoline, and biohydrogen offers a clean, zero-emission fuel source.
- **Row 1 is incorrectly matched:** While its composition and fermentation method are correct, Bioethanol has a **lower energy content (around 33% less) than pure petrol**, not higher. More ethanol is needed to match the driving range of standard gasoline.

8. Consider the following statements regarding Flex-Fuel Vehicles (FFVs):

1. FFVs are engineered with advanced engine management and fuel systems that dynamically detect the exact ratio of the fuel blend and automatically adjust the internal combustion parameters.
2. These vehicles are designed to operate flexibly across varying combinations of gasoline and biofuels, and can run entirely on 100% unblended petrol when biofuels are unavailable.
3. The structural design incorporates corrosion-resistant alloys and specialized polymers to prevent structural degradation caused by the corrosive nature of high-concentration ethanol or methanol blends.

Which of the statements given above is/are correct?

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

Correct Answer: (d)

Explanation: All three statements are correct. Flex-Fuel Vehicles look similar to standard vehicles but feature updated power management software, optimized fuel sensors, and durable, corrosion-resistant fuel lines. This allows them to switch seamlessly between standard gasoline and high-biofuel blends (like E85 or M85).

9. Consider the following statements regarding the production of hydrogen:

1. Grey Hydrogen is synthesized via Steam Methane Reforming (SMR) at temperatures between 700°C and 1000°C, releasing all generated carbon dioxide directly into the atmosphere.
2. Blue Hydrogen utilizes an identical SMR thermochemical reaction using fossil fuel inputs, but it integrates Carbon Capture and Storage (CCS) technologies to isolate and store the carbon emissions.
3. Green Hydrogen is produced by passing electricity through a water-splitting cell (electrolysis), and it must rely exclusively on nuclear fission power grids to ensure a zero-carbon footprint.

Which of the statements given above are correct?

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

Correct Answer: (a)

Explanation:

- **Statements 1 and 2 are correct:** Grey and Blue hydrogen both rely on fossil fuels (methane) for production. The key difference is that Blue hydrogen incorporates carbon capture systems to prevent carbon dioxide from entering the atmosphere.
- **Statement 3 is incorrect:** Green hydrogen is produced through water electrolysis powered by renewable energy sources like solar, wind, or hydropower, rather than nuclear power grids.

10. Consider the following statements regarding the regulatory waivers announced under India's National Green Hydrogen Mission:

1. Standalone production plants manufacturing green hydrogen or green ammonia via water electrolysis are required to undergo a full, mandatory Environmental Impact Assessment (EIA) clearance under the Notification 2006 framework before starting operations.
2. Renewable energy generation plants configured to supply electricity to green hydrogen production units must wait a minimum of 25 years after commissioning to apply for waivers on Inter-State Transmission System (ISTS) charges.
3. The Approved List of Models & Manufacturers (ALMM) for solar modules applies strictly to all renewable installations built inside Special Economic Zones (SEZs) or Export Oriented Units (EOUs), even if they supply power exclusively to adjacent green hydrogen plants.

Which of the statements given above is/are correct?

- (a) 1 and 2 only
- (b) 3 only
- (c) 1 and 3 only
- (d) None of the statements

Correct Answer: (d)

Explanation: All statements are incorrect.

- **Statement 1 is incorrect:** Standalone green hydrogen and ammonia plants using water electrolysis are completely exempt from the prior environmental clearance requirements of the EIA Notification 2006 to speed up project development.

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- **Statement 2 is incorrect:** Projects commissioned on or before December 31, 2030, receive an immediate, full 25-year waiver on Inter-State Transmission System (ISTS) charges from day one, rather than having to wait 25 years.
- **Statement 3 is incorrect:** The ALMM for solar modules and RLMM for wind turbines do not apply to renewable energy plants located inside an SEZ or EOU that supply power exclusively to co-located green hydrogen units. This allows developers to source components flexibly and reduce production costs.

