MISSION X

INNOVATION IN LEARNING

MISSION X PRESENTS

X TECH

WEEKLY SCIENCE & TECHNOLOGY COMPILATION

17 – 24 July 2026

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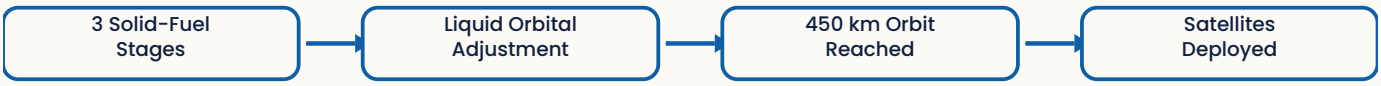
SECTION

Space Technology

01 Vikram-1 — India's First Private Orbital Launch

GS PAPER III · SPACE TECHNOLOGY · PRIVATE SPACE

Vikram-1 — India's First Private Orbital Launch



NEWS IN BRIEF

- Skyroot Aerospace's Vikram-1 lifted off from ISRO's First Launch Pad, Sriharikota, on 18 July 2026 at 12:05 pm IST, becoming the first privately developed Indian rocket to reach orbit, deploying payloads at a 450 km, 60° inclination orbit about 15 minutes after liftoff.
- Mission named 'Aagaman'; the launch made India the third country, after the United States and China, with private orbital launch capability.
- The 23-metre carbon-composite, four-stage rocket (three solid-fuel stages plus a liquid Orbital Adjustment Module) carried Skyroot's own SCOPE satellite alongside payloads from Grahaa Space, Cosmoserve and DCubed.
- ISRO provided motor casting, engine testing, integration and the launchpad, while IN-SPACe coordinated authorisation; Skyroot became India's first space-tech unicorn after raising about $60 million in May 2026.

CONCEPT SIMPLIFIED

A launch vehicle sheds mass in 'stages' as fuel burns off, so it isn't stuck accelerating dead weight. Vikram-1 uses three solid-fuel stages for its initial climb (simple, reliable, no moving parts) and finishes with a liquid-fuelled Orbital Adjustment Module for the precise 'last-mile' manoeuvring needed to place satellites in an exact target orbit.

23 m	4	350 kg to LEO
Height	Stages	Payload

STATIC CONNECT

Standard static on Indian space policy: revise the 2020 space-sector liberalisation, the role of IN-SPACe (single-window authoriser) versus NSIL (ISRO's commercial arm) versus ISRO (R&D), and India's private space ecosystem (Skyroot, Agnikul Cosmos, GalaxEye).

UNIQUE FACT

Vikram-1 also carried two purely symbolic payloads — an 18-karat gold rocket model and a lab-grown-diamond artwork called 'Cosmic Bloom' — alongside its technical payloads.

⚠ **EXAM TRAP —** Don't confuse Vikram-1 (India's first private rocket to reach ORBIT, July 2026) with Vikram-S (India's first private rocket to reach SPACE on a suborbital flight, November 2022) — a classic 'firsts' trap.

RELEVANCE

- Opens a commercial, on-demand launch market for small satellites (Earth observation, communication, IoT) instead of relying solely on ISRO's launch queue.
- Demonstrates a public-private model — ISRO infrastructure plus private engineering — that other Indian launch-vehicle companies can now follow.
- Strengthens India's position in the fast-growing global small-satellite launch market.

📌 PRELIMS MEMORY BANK

- Launch: 18 July 2026, Sriharikota, Mission 'Aagaman'
- Orbit achieved: 450 km, 60° inclination
- Vehicle: 4-stage, 23m carbon-composite rocket
- Milestone: India's first private orbital launch; 3rd country globally
- Company: Skyroot Aerospace (founded 2018)

PRACTICE MCQ · UPSC PRELIMS STYLE

Vikram-1 — India's First Private Orbital Launch

Consider the following statements regarding Vikram-1, recently in the news:

1. It is India's first privately developed rocket to reach orbit.
2. It was launched using ISRO's GSLV Mark III launch vehicle.
3. It employs a liquid-fuelled stage for final orbital adjustment after three solid-fuel stages.

Which of the statements given above is/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) 1 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

Vikram-1 is described throughout as Skyroot's own vehicle, not a payload riding on an ISRO rocket — a company achieving 'India's first private orbital launch' by using someone else's launch vehicle would be a contradiction in terms, so eliminate any GSLV linkage.

② THROUGH FACTUAL KNOWLEDGE

Reports confirm Vikram-1 lifted off on its own four-stage vehicle (three solid stages plus a liquid Orbital Adjustment Module) from ISRO's launchpad — ISRO provided ground infrastructure and testing support, not the rocket itself.

SECTION

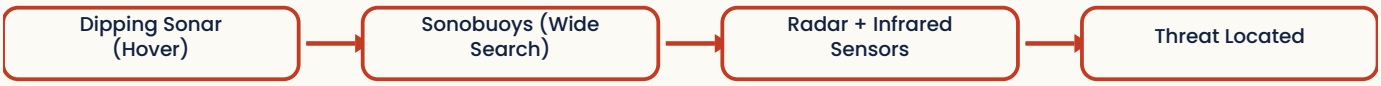
Defence Technology

02 MH-60R Seahawk — Fleet Nears Completion

03 Project Kusha — Maiden Flight Test

GS PAPER III · DEFENCE · NAVAL AVIATION

MH-60R Seahawk — Fleet Nears Completion



NEWS IN BRIEF

- The US Embassy in India confirmed on 17 July 2026 that another MH-60R Seahawk naval helicopter was delivered to the Indian Navy at Kochi, with two more arriving the same week, taking the delivered fleet to 21 of the 24 contracted helicopters.
- Part of a $2.6 billion Foreign Military Sales deal signed in February 2020 with Lockheed Martin; only three helicopters now remain to be delivered.
- The MH-60R is replacing the decades-old, British-origin Sea King Mk-42B helicopters, which were phased out of Indian Navy service in June 2026.
- Integrated with India's aircraft carrier INS Vikrant and equipped with multi-mode radar, dipping sonar, sonobuoys, torpedoes and air-to-surface missiles, the helicopters were used during Operation Sindoor.

CONCEPT SIMPLIFIED

The MH-60R is a maritime variant of the Black Hawk helicopter, purpose-built to hunt submarines. It 'dips' a sonar transducer into the water to listen for submarines while hovering, and drops sonobuoys (floating listening devices) over a wide search area — combining both methods with radar and infrared sensors to build a complete underwater and surface picture.

24	21	$2.6 bn
Contracted	Delivered	Deal Value

STATIC CONNECT

Static topic — Indian Naval Aviation: link to India's broader naval modernisation (Project 17A frigates, INS Vikrant) and India-US defence ties strengthened via agreements like the 2020 Foreign Military Sales framework.

UNIQUE FACT

The MH-60R fleet's expansion directly coincided with the retirement of India's 40-year-old British-origin Sea King helicopters in June 2026, marking a complete generational shift in India's naval helicopter fleet within weeks.

⚠ **EXAM TRAP —** Don't confuse the MH-60R Seahawk (US-origin, anti-submarine focus) with India's indigenous ALH Dhruv or the Russian-origin Kamov Ka-31 (airborne early warning) — each serves a different naval aviation role.

RELEVANCE

- Extends India's anti-submarine warfare reach across the Indian Ocean Region, helping track foreign submarine activity near Indian waters.
- Doubles as a platform for search-and-rescue, medical evacuation and vertical replenishment at sea, useful well beyond combat scenarios.
- Operating from carriers like INS Vikrant, it extends the reach of India's carrier battle group against both underwater and surface threats.

📌 PRELIMS MEMORY BANK

- Delivered so far: 21 of 24 contracted MH-60Rs
- Deal: $2.6 billion FMS agreement, signed 2020
- Manufacturer: Lockheed Martin
- Roles: Anti-submarine warfare, anti-surface warfare, SAR, MEDEVAC
- Replacing: British-origin Sea King Mk-42B (retired June 2026)

PRACTICE MCQ · UPSC PRELIMS STYLE

MH-60R Seahawk — Fleet Nears Completion

With reference to the MH-60R Seahawk helicopter, consider the following statements:

1. It is a maritime variant of the Black Hawk helicopter.
2. It has completely replaced India's Sea King helicopters, which were retired in June 2026.
3. It can only be operated from Indian Navy shore bases and not from aircraft carriers.

Which of the statements given above is/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) 1 and 2 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

News reports explicitly describe the MH-60R fleet as integrated with INS Vikrant and undergoing carrier trials — a claim restricting it to shore bases directly contradicts this carrier-integration detail.

② THROUGH FACTUAL KNOWLEDGE

The MH-60R is confirmed as a maritime Black Hawk variant; Sea King Mk-42B helicopters were phased out of Indian Navy service in June 2026 as the MH-60R fleet expanded; and the MH-60R has undergone carrier trials aboard INS Vikrant.

GS PAPER III · DEFENCE TECHNOLOGY · DRDO

Project Kusha — Maiden Flight Test

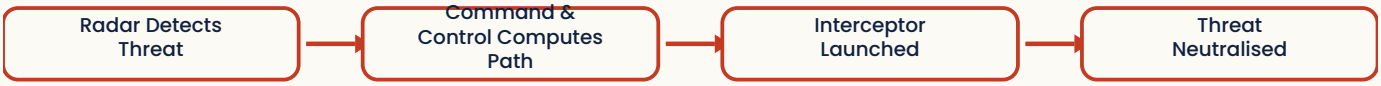
150 km	250 km	350–400 km
M1 Range	M2 Range	M3 Range

NEWS IN BRIEF

- DRDO successfully conducted the maiden flight test of the Long-Range Surface-to-Air Missile (LR-SAM) system 'Kusha' on 23 July 2026 from APJ Abdul Kalam Island off the Odisha coast.
- Project Kusha is designed to rival Russia's S-400, with three interceptor variants — M1 (~150 km), M2 (~250 km) and M3 (~350–400 km) — to counter fighter jets, cruise missiles, drones and select ballistic missile threats.
- Kusha is meant to operate alongside India's imported S-400 squadrons, not replace them, forming overlapping 'kill chains' within the Integrated Air Command and Control System; a naval variant based on the M2 is also being developed to counter anti-ship ballistic missiles.
- The system anchors India's 'Mission Sudarshan Chakra' — a plan for a multi-layered national missile defence umbrella targeted by 2035; phased induction is expected between 2028 and 2030.

CONCEPT SIMPLIFIED

A long-range Surface-to-Air Missile system works in layers: radar detects and tracks an incoming aerial threat, a command-and-control system calculates an intercept path, and an interceptor missile is launched to destroy the threat mid-air. Using multiple interceptor variants with different ranges, like Kusha's M1/M2/M3, lets one system handle threats at different distances instead of needing separate systems for each range band.



STATIC CONNECT

Static topic — Indigenous Missile Defence: link to India's Ballistic Missile Defence programme, Akash and Barak-8 (shorter-range systems), and compare with Russia's S-400 Triumf and the US Patriot system.

UNIQUE FACT

Kusha is deliberately designed to operate alongside the imported S-400, not replace it — creating overlapping, redundant 'kill chains' that make it harder for an adversary to plan a strike around any single system's gaps.

⚠ **EXAM TRAP —** Don't assume Kusha replaces the S-400 — reports explicitly describe it as operating alongside India's S-400 squadrons within the Integrated Air Command and Control System, not substituting for them.

RELEVANCE

- Reduces India's dependence on imported systems like Russia's S-400 for long-range air defence, insulating it from supply-chain and geopolitical risk.
- Once operational, it will protect critical infrastructure, cities and military installations from fighter jets, cruise missiles, drones and select ballistic missile threats.
- The naval variant extends this protection to warships, guarding against fast-moving anti-ship ballistic missiles.

📌 PRELIMS MEMORY BANK

- Maiden flight test: 23 July 2026, APJ Abdul Kalam Island, Odisha
- Interceptor variants: M1 (~150 km), M2 (~250 km), M3 (~350–400 km)
- Developer: DRDO, with Bharat Electronics as integration partner
- Compared to: Russia's S-400 Triumf
- Broader plan: Mission Sudarshan Chakra (missile defence umbrella by 2035)

PRACTICE MCQ · UPSC PRELIMS STYLE

Project Kusha — Maiden Flight Test

Consider the following statements about DRDO's Project Kusha:

1. It is designed to completely replace India's imported S-400 air defence squadrons.
2. It features three interceptor variants with different engagement ranges.
3. Its maiden flight test was conducted from APJ Abdul Kalam Island, Odisha.

Which of the statements given above is/are correct?

(a) 1 and 2 only

(b) 2 and 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (b) 2 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

Reports emphasise Kusha is 'engineered not to replace the S-400' but to operate alongside it — a statement claiming outright replacement contradicts this explicitly stated design philosophy.

② THROUGH FACTUAL KNOWLEDGE

DRDO confirms Kusha's three-tier interceptor architecture (M1, M2, M3) and that its maiden flight test occurred on 23 July 2026 from APJ Abdul Kalam Island off Odisha.

II

SECTION

Biotechnology & Health

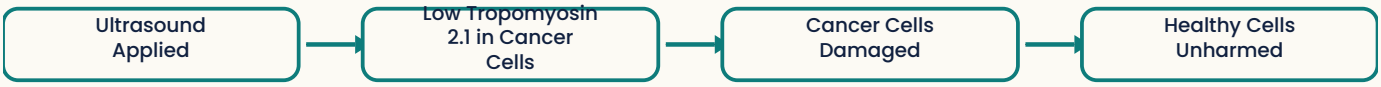
04 IISc — Ultrasound Selectively Kills Oral Cancer Cells

05 New Cholesterol Guidelines — ApoB and Lp(a)

06 National Anti-Doping Act Comes Into Force

GS PAPER III · BIOTECHNOLOGY · CANCER RESEARCH

IISc — Ultrasound Selectively Kills Oral Cancer Cells



NEWS IN BRIEF

- Researchers at IISc Bengaluru, working with clinicians at MS Ramaiah Medical College and Hospitals, found that low-frequency ultrasound mechanical stimulation can selectively kill oral cancer cells while largely sparing healthy tissue, using patient-derived oral tumour samples.
- Oral cancer cells were found to have reduced levels of Tropomyosin 2.1, a mechanosensory protein that normally helps cells withstand physical stress — making them unusually vulnerable to moderate mechanical forces from ultrasound.
- In a 3D tumour model, ultrasound also disrupted the dense protective barrier that cancer-associated cells form around a tumour — a barrier that normally blocks drugs and immune cells from reaching the tumour core.
- The response was consistent across patient samples from multiple cancer stages; researchers now want to test the approach in more physiologically realistic models and explore combining it with existing treatments.

CONCEPT SIMPLIFIED

Every cell has an internal 'skeleton' of structural proteins that let it sense and resist mechanical stress, much like a building's structural frame. The oral cancer cells here were found to have a weakened version of this frame (low Tropomyosin 2.1), so moderate mechanical 'shaking' from ultrasound damages them beyond repair, while healthy cells with a normal frame absorb the same stress and survive.

Tropomyosin 2.1	Cancer only	Pre-clinical
Target Protein	Cells Hit	Stage

STATIC CONNECT

Static connect — Human Cell Biology: revise the cytoskeleton and mechanosensing from NCERT Biology, and link this non-drug, mechanical-force approach to other cancer treatment classes (surgery, chemotherapy, radiotherapy, immunotherapy).

UNIQUE FACT

The same ultrasound treatment that destroys oral cancer cells left healthy oral cells largely unharmed — because it exploits a specific structural weakness (low Tropomyosin 2.1) that only the cancer cells share.

⚠ **EXAM TRAP —** This is a pre-clinical, lab-based finding using patient-derived cell samples — don't mistake it for an approved clinical treatment already available to patients.

RELEVANCE

- Could offer a non-invasive alternative to surgery, chemotherapy and radiotherapy, which often damage healthy tissue along with cancer cells.
- Particularly relevant for India, which carries a very high share of the world's oral cancer burden due to widespread tobacco and areca nut use.
- If combined with existing drug treatments, ultrasound-induced disruption of the tumour's protective barrier could improve how well drugs penetrate and work.

📌 PRELIMS MEMORY BANK

- Institution: IISc Bengaluru + MS Ramaiah Medical College
- Method: low-frequency ultrasound mechanical stimulation
- Key protein: Tropomyosin 2.1 (reduced in oral cancer cells)
- Stage: patient-derived samples, pre-clinical (not yet a clinical treatment)
- India relevance: high oral cancer burden linked to tobacco/areca nut use

PRACTICE MCQ · UPSC PRELIMS STYLE

IISc — Ultrasound Selectively Kills Oral Cancer Cells

With reference to the recent IISc study on ultrasound and oral cancer, consider the following statements:

1. Oral cancer cells were found to have elevated levels of the protein Tropomyosin 2.1 compared to healthy cells.
2. Ultrasound was found to selectively damage cancer cells while largely sparing healthy oral cells.
3. The therapy has already been approved for widespread clinical use in India.

Which of the statements given above is/are correct?

(a) 2 only

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

The mechanism described is a vulnerability caused by a deficiency, not an excess — a protein that helps cells withstand stress being REDUCED is what makes cancer cells fragile, so a statement claiming elevated levels reverses the actual finding. Since this is explicitly a lab study on patient-derived samples, a claim of clinical approval overstates its current stage.

② THROUGH FACTUAL KNOWLEDGE

The study found oral cancer cells have reduced, not elevated, Tropomyosin 2.1 levels; ultrasound selectively damaged cancer cells while healthy cells remained largely unaffected; and the approach remains a pre-clinical laboratory finding, not an approved treatment.

GS PAPER III · BIOTECHNOLOGY · PUBLIC HEALTH

New Cholesterol Guidelines — ApoB and Lp(a)

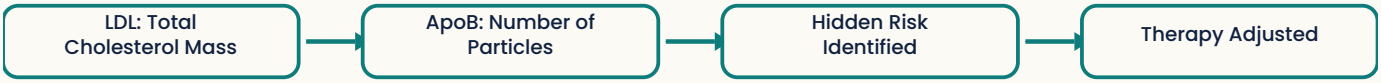
<55 mg/dL	<70 mg/dL	<90 mg/dL
High Risk	Moderate Risk	Standard

NEWS IN BRIEF

- The ACC and AHA, with nine other medical bodies, issued the first comprehensive update to US cardiovascular risk guidelines in eight years in March 2026, formally elevating Apolipoprotein B (ApoB) and Lipoprotein(a) [Lp(a)] alongside traditional LDL cholesterol.
- ApoB directly counts the number of artery-clogging (atherogenic) particles in the blood, rather than just measuring the cholesterol they carry — a more precise marker, especially for people with diabetes, high triglycerides, or who have already hit their LDL targets but remain at risk.
- The guidelines introduced numeric ApoB goals aligned with LDL targets (below 55, 70, or 90 mg/dL depending on risk category) and made one-time Lp(a) testing a near-universal recommendation.
- A new risk calculator called PREVENT replaces the older Pooled Cohort Equations, incorporates kidney function, and removes race as a direct input after the older equations were found to give different risk estimates by race.

CONCEPT SIMPLIFIED

Standard LDL cholesterol testing measures the total amount of cholesterol carried by particles in the blood — like measuring the total cargo weight on a fleet of trucks. ApoB instead counts the actual number of those particles (trucks), since it is the particles themselves that lodge in artery walls and cause plaque; a person can have 'normal' cholesterol cargo but still carry a dangerously high number of particles.



STATIC CONNECT

Static connect — Human Circulatory System: revise lipid transport and atherosclerosis (plaque formation in arteries) from NCERT Biology, and link to India's own rising cardiovascular disease burden.

UNIQUE FACT

The new PREVENT risk calculator deliberately removes race as a direct input, after the older equations were found to systematically give different cardiovascular risk estimates purely based on race.

⚠ **EXAM TRAP —** Don't treat ApoB as a replacement for LDL testing — the guidelines keep LDL central and add ApoB/Lp(a) as additional risk-refining markers, particularly for patients who've already hit their LDL targets but remain at risk.

RELEVANCE

- Helps identify 'hidden risk' in patients who look fine on a standard cholesterol panel but are still building arterial plaque, especially those with diabetes or metabolic syndrome.
- Guides doctors on when to intensify cholesterol-lowering therapy beyond standard LDL targets.
- The near-universal Lp(a) recommendation means many more people will now learn about a largely genetic risk factor they previously had no reason to test for.

📌 PRELIMS MEMORY BANK

- New guideline: 2026 ACC/AHA Dyslipidemia Guideline (March 2026)
- ApoB: counts atherogenic particles directly, not just cholesterol mass
- ApoB targets: <55 / <70 / <90 mg/dL by risk category
- New calculator: PREVENT (replaces Pooled Cohort Equations)
- Lp(a): now a near-universal one-time test recommendation

PRACTICE MCQ · UPSC PRELIMS STYLE

New Cholesterol Guidelines — ApoB and Lp(a)

With reference to the 2026 ACC/AHA cholesterol guidelines, consider the following statements:

1. ApoB measures the total mass of cholesterol carried in the blood.
2. The new PREVENT risk calculator removes race as a direct input.
3. Lipoprotein(a) testing has been made a near-universal one-time recommendation.

Which of the statements given above is/are correct?

(a) 1 and 2 only

(b) 2 and 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (b) 2 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

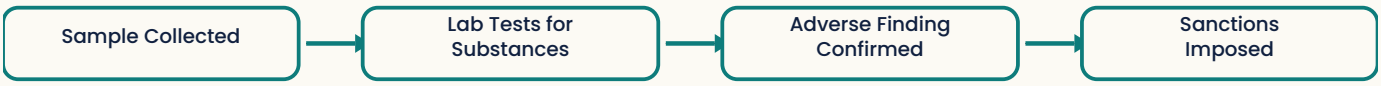
ApoB's entire clinical value proposition, repeated across every report, is that it counts particle NUMBER rather than cholesterol mass — a statement describing it as a mass measurement is describing standard LDL testing instead, so it can be eliminated.

② THROUGH FACTUAL KNOWLEDGE

ApoB directly quantifies the number of atherogenic particles; the PREVENT calculator explicitly removes race as an input; and the 2026 guideline makes one-time Lp(a) testing a near-universal recommendation.

GS PAPER II/III · SPORTS GOVERNANCE · PUBLIC HEALTH

National Anti-Doping Act Comes Into Force



NEWS IN BRIEF

- India's National Anti-Doping Act, 2022 formally came into force on 15 July 2026, giving statutory legal backing to India's anti-doping framework for the first time; the National Anti-Doping (Amendment) Act, 2025 followed a day later on 16 July.
- The Act establishes a National Board for Anti-Doping in Sports and gives statutory recognition to specified provisions of the World Anti-Doping Code, which now carry the force of law in India; NADA becomes a statutory body responsible for testing, investigations and results management.
- Sports Minister Mansukh Mandaviya told the Lok Sabha that India recorded 78 Adverse Analytical Findings up to 13 July 2026, part of 682 total findings since 2023; Uttar Pradesh and Punjab reported the most cases.
- Days later, at the 2026 Commonwealth Games in Glasgow, doping violations disrupted India's campaign — judoka Arun Kumar was provisionally suspended by NADA, and India's weightlifting squad lost five qualification places after multiple adverse findings.

CONCEPT SIMPLIFIED

Anti-doping systems work on the principle of 'strict liability' — an athlete is responsible for any prohibited substance found in their body, regardless of how it got there. Testing, in and out of competition, checks urine or blood for banned substances or methods; a positive 'Adverse Analytical Finding' triggers a results-management process, and if confirmed, leads to sanctions like disqualification and periods of ineligibility.

78	682	UP & Punjab
2026 AAFs (to 13 Jul)	Since 2023 (Total)	Top States

STATIC CONNECT

Static connect — Sports Governance: link to WADA's global role, India's National Sports Governance framework, and the broader theme of statutory versus administrative backing for regulatory bodies.

UNIQUE FACT

The National Anti-Doping Act, 2022 took over three years to actually come into force after being passed — it was only operationalised on 15 July 2026, just as India's Commonwealth Games doping controversy was unfolding.

⚠ **EXAM TRAP —** Don't confuse the National Anti-Doping Rules, 2021 (administrative rules NADA already followed) with the National Anti-Doping Act, 2022 (the law that only came into legal force on 15 July 2026) — the Act gives statutory teeth to what were previously administrative rules.

RELEVANCE

- Statutory backing under the new Act gives NADA stronger legal powers for investigation and enforcement, rather than relying only on administrative rules.
- Real-time consequences are visible at events like the 2026 Commonwealth Games, where violations directly cost India competitive slots and medal chances.
- Strengthens India's credibility as it prepares to host the 2030 Commonwealth Games and pursues a 2036 Olympic bid, where a strong anti-doping record matters for hosting bids.

📌 PRELIMS MEMORY BANK

- Act in force: 15 July 2026 (National Anti-Doping Act, 2022)
- Amendment Act in force: 16 July 2026
- New body: National Board for Anti-Doping in Sports
- 2026 AAFs so far: 78 (as of 13 July); 682 total since 2023
- CWG 2026 impact: judoka suspended, weightlifting squad cut by 5 places

PRACTICE MCQ · UPSC PRELIMS STYLE

National Anti-Doping Act Comes Into Force

Consider the following statements regarding India's anti-doping framework:

1. The National Anti-Doping Act, 2022 came into force in 2022, the same year it was passed.
2. NADA now functions as a statutory body under the National Anti-Doping Act, 2022.
3. India's Adverse Analytical Findings have shown a continuously rising trend every year since 2023.

Which of the statements given above is/are correct?

(a) 2 only

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

A three-year gap between an Act being passed and actually being 'brought into force' is common for Indian legislation requiring rules and institutional setup — the news specifically flags 2026 as the enforcement date, so assuming immediate 2022 enforcement is a trap. Since AAFs rose then fell (213→260→131) before ticking up again in 2026, a claim of continuous rise is factually reversed.

② THROUGH FACTUAL KNOWLEDGE

The Act was passed in 2022 but only brought into force on 15 July 2026; NADA is now explicitly a statutory body under this Act; and AAFs rose from 213 (2023) to 260 (2024), fell to 131 (2025), before 78 were recorded by mid-July 2026 — not a continuous rise.



SECTION

ICT & Emerging Tech

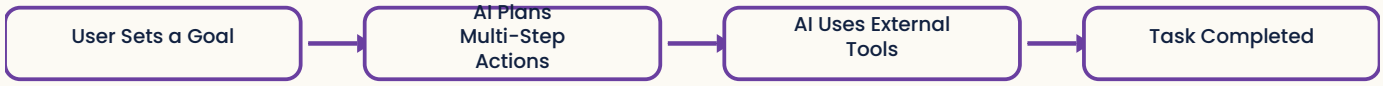
07 Agentic AI — India's Push to Lead

08 India Semiconductor Mission 2.0 Approved

09 On-Device AI — Regulation Catches Up

GS PAPER III · EMERGING TECH · AI GOVERNANCE

Agentic AI — India's Push to Lead



NEWS IN BRIEF

- India's IndiaAI Mission and government officials have positioned India to become 'a leading global service provider for Agentic AI', as highlighted at pre-summit conferences ahead of the India-AI Impact Summit 2026.
- NITI Aayog projects AI could contribute nearly $1.7 trillion to India's economy by 2035, but also flags risks of overdependence on foreign AI platforms, driving a push toward 'Sovereign AI' built on domestic compute, data and models.
- India's AI Governance Guidelines, released around the AI Impact Summit 2026, are anchored in seven guiding 'sutras' and establish new institutions — an AI Governance Group, a Technology & Policy Expert Committee, and an AI Safety Institute — to oversee AI, including autonomous 'agentic' systems.
- Globally, agentic AI is shifting 'from test mode into paid work' through 2026, with autonomous agents increasingly handling real business tasks such as scheduling, data analysis and customer service, rather than just answering chat queries.

CONCEPT SIMPLIFIED

Traditional generative AI mainly responds to a single prompt and stops. Agentic AI goes further: it can independently plan a sequence of steps, use external tools such as calendars, databases or software, and take actions toward a goal with limited human oversight at each step — more like an assistant completing a multi-step task than a chatbot answering one question.

$1.7 tn by 2035	7	3
Economic Potential	Governance Sutras	New Bodies

STATIC CONNECT

Static connect — Emerging Technology Governance: link to India's IT Act/Digital India framework, NITI Aayog's National Strategy for AI, and the global debate on AI regulation (EU AI Act, US approach) as a comparative governance theme.

UNIQUE FACT

Because agentic AI systems can independently trigger real actions rather than just generate text, a growing 'back office' industry has emerged just to audit, bill and govern what these AI agents actually do — treating them almost like autonomous employees.

RELEVANCE

- Businesses are using agentic AI to automate multi-step workflows — coordinating specialist agents for data cleaning, scheduling and quality checks — cutting manual work.
- Raises new security and governance challenges, since autonomous agents acting across cloud services and business apps can turn access weaknesses into major security incidents if not carefully governed.
- India's push to become an agentic AI 'service provider' could create new IT-services opportunities built specifically around deploying and managing AI agents for global clients.

PRELIMS MEMORY BANK

- India ambition: global service provider for Agentic AI (IndiaAI Mission)
- Economic projection: ~$1.7 trillion AI contribution to India by 2035
- New institutions: AI Governance Group, Tech & Policy Expert Committee, AI Safety Institute
- Governance framework: 7 guiding 'sutras' (India AI Governance Guidelines)
- 2026 shift: agentic AI moving from pilot testing into paid, real-world work

PRACTICE MCQ · UPSC PRELIMS STYLE

Agentic AI — India's Push to Lead

With reference to 'Agentic AI', consider the following statements:

1. It refers to AI systems that can only respond to a single prompt and cannot take further independent action.
2. It can independently plan multi-step tasks and use external tools to achieve a goal.
3. India's AI Governance Guidelines establish new institutions including an AI Safety Institute.

Which of the statements given above is/are correct?

(a) 1 and 2 only

(b) 2 and 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (b) 2 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

The defining feature separating 'agentic' AI from ordinary generative AI, repeated in every description, is exactly the ability to act beyond a single response — a statement describing it as limited to single-prompt responses describes conventional generative AI instead, so it can be eliminated.

② THROUGH FACTUAL KNOWLEDGE

Agentic AI is defined by its capacity to autonomously plan and execute multi-step actions using external tools; and India's AI Governance Guidelines explicitly establish new institutions including an AI Governance Group, a Technology & Policy Expert Committee, and an AI Safety Institute.

GS PAPER III · ICT · INDUSTRIAL POLICY

India Semiconductor Mission 2.0 Approved

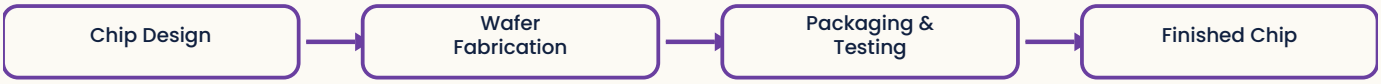
₹76,000 cr	₹1.27 lakh cr	12 approved
ISM 1.0	ISM 2.0	Projects

NEWS IN BRIEF

- The Union Cabinet approved India Semiconductor Mission (ISM) 2.0 on 15 July 2026 with an outlay of ₹1.27 lakh crore (about $13 billion) — more than 60% higher than ISM 1.0's ₹76,000 crore.
- The Cabinet simultaneously cleared Phase 2 of the Mobile Phone Manufacturing Scheme (₹62,500 crore); together, the government says the entire electronics value chain is now covered.
- Under ISM 1.0, 12 semiconductor manufacturing and packaging projects worth over ₹1.6 lakh crore have been approved, including India's first chip fabrication project (Tata-PSMC) and a chip assembly/testing unit by Micron; three projects had started commercial production by mid-July 2026.
- ISM 2.0 aims to strengthen the entire chip value chain — equipment, materials, design, manufacturing and packaging — with a long-term roadmap toward advanced 3nm (by 2032) and 2nm (by 2035) fabrication.

CONCEPT SIMPLIFIED

A semiconductor is a material, usually silicon, that conducts electricity under some conditions but not others, making it the base material for the microchips that power nearly all electronics. Chip manufacturing has three broad stages — design (the blueprint), fabrication (etching that design onto silicon wafers in a 'fab'), and packaging/testing (protecting and connecting the finished chip) — and different government schemes target different stages of this chain.



STATIC CONNECT

Static connect — Industrial Policy & PLI Schemes: link to India's broader Production-Linked Incentive scheme family and the Design Linked Incentive Scheme supporting chip-design startups, as part of India's Atmanirbhar Bharat manufacturing push.

UNIQUE FACT

ISM 2.0's approved outlay of ₹1.27 lakh crore is more than 60% larger than the entire original ISM 1.0 scheme — one of the sharpest funding jumps between phases of any Indian industrial mission.

⚠ **EXAM TRAP —** Don't confuse the India Semiconductor Mission (chip manufacturing incentives) with the separate Mobile Phone Manufacturing Scheme (device assembly incentives) — both were cleared the same Cabinet day but are distinct schemes.

RELEVANCE

- Reduces India's near-total dependence on imported chips for mobile phones, cars, appliances, telecom and defence equipment.
- Commercial production already starting at ISM-backed plants means 'Made in India' chips are beginning to reach the market, not just remaining a policy ambition.
- The long-term advanced-node roadmap (3nm/2nm) aims to eventually let India compete with global leaders like Taiwan and South Korea, not just do lower-end assembly and packaging.

📌 PRELIMS MEMORY BANK

- ISM 2.0 outlay: ₹1.27 lakh crore (~$13 billion), approved 15 July 2026
- ISM 1.0 outlay: ₹76,000 crore (for comparison)
- Projects approved so far: 12, worth over ₹1.6 lakh crore
- First fab project: Tata-PSMC joint venture; first ATMP: Micron, Sanand
- Long-term goal: 3nm by 2032, 2nm by 2035

PRACTICE MCQ · UPSC PRELIMS STYLE

India Semiconductor Mission 2.0 Approved

With reference to India Semiconductor Mission (ISM) 2.0, consider the following statements:

1. It was approved by the Union Cabinet with an outlay smaller than that of ISM 1.0.
2. It aims to strengthen the entire semiconductor value chain, including design, fabrication and packaging.
3. As of mid-2026, no semiconductor project approved under the mission had begun commercial production.

Which of the statements given above is/are correct?

(a) 2 only

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

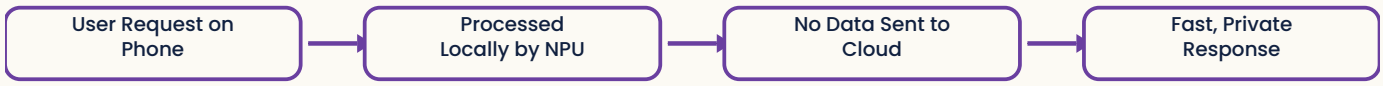
A 'Mission 2.0' launched with a SMALLER budget than its first phase would be an unusual policy signal — the reported figures (₹1.27 lakh crore vs ₹76,000 crore) show a major increase, so a statement claiming a decrease can be eliminated on that basis alone.

② THROUGH FACTUAL KNOWLEDGE

ISM 2.0's ₹1.27 lakh crore outlay is substantially larger than ISM 1.0's ₹76,000 crore; the mission explicitly covers the full value chain from design to packaging; and by mid-July 2026 three ISM-backed projects had already started commercial production.

GS PAPER III · ICT · DIGITAL GOVERNANCE

On-Device AI — Regulation Catches Up



NEWS IN BRIEF

- China's Cyberspace Administration published its first batch of regulatory approvals for on-device generative AI on smartphones on 15 July 2026, covering Apple, Huawei, Xiaomi, OPPO, vivo, Samsung and Nubia.
- Separately, the European Commission on 20 July 2026 ordered Google to open Android to rival AI assistants and share portions of its search data with competing AI developers, under the Digital Markets Act.
- On-device AI runs inference directly on a device's own chip, typically a Neural Processing Unit (NPU), rather than sending data to cloud servers, enabling faster responses, offline capability and stronger privacy.
- By 2026, NPUs have become standard even in sub-$300 smartphones, and the 'on-device vs cloud' split is increasingly hybrid, with some AI features processed locally and others still requiring an internet connection.

CONCEPT SIMPLIFIED

Cloud-based AI sends your request over the internet to a remote data centre, processes it there, and sends back a response — powerful, but slower and dependent on connectivity. On-device AI instead runs a smaller, compressed version of the model directly on the phone's own NPU chip, so requests never leave the device, cutting delay and keeping sensitive data physically local.

7 firms	20 Jul 2026	Sub-$300 phones
China Approvals	EU Ruling	NPU Floor

STATIC CONNECT

Static connect — Digital Governance & Competition Law: link to India's Digital Competition Bill discussions and the Competition Commission of India's approach to Big Tech, alongside the EU's Digital Markets Act as a comparative model.

UNIQUE FACT

China's regulatory approval process meant Apple Intelligence needed roughly two years to clear the hurdles required to operate legally on iPhones sold in the Chinese market.

⚠ **EXAM TRAP —** Don't assume all AI features on a modern smartphone run on-device — many 'AI phones' still use a hybrid approach, sending heavier tasks to the cloud while handling lighter ones locally.

RELEVANCE

- Enables features like live translation, real-time photo/video enhancement, and voice assistants that keep working without an internet connection.
- Improves privacy for sensitive tasks, since data doesn't need to be uploaded to a company's servers to be processed.
- Regulatory moves like the EU's Android ruling show governments increasingly treating control over on-device AI assistants as a competition issue, not just a technology one.

📌 PRELIMS MEMORY BANK

- China approval: 15 July 2026, 7 companies (Apple, Huawei, Xiaomi, OPPO, vivo, Samsung, Nubia)
- EU ruling: 20 July 2026, forces Google to open Android to rival AI assistants
- Core hardware: Neural Processing Unit (NPU)
- Key benefits: speed, offline use, privacy (data stays on-device)
- 2026 trend: NPUs now standard even in sub-$300 smartphones

PRACTICE MCQ · UPSC PRELIMS STYLE

On-Device AI — Regulation Catches Up

With reference to on-device AI, consider the following statements:

1. It requires an active internet connection to process every AI request.
2. It relies on a dedicated chip commonly known as a Neural Processing Unit (NPU).
3. In July 2026, the European Commission ordered Google to open Android to rival AI assistants.

Which of the statements given above is/are correct?

(a) 2 and 3 only

(b) 1 and 2 only

(c) 1 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

The entire point of 'on-device' processing, as opposed to cloud AI, is that it does NOT require sending data over the internet — a statement claiming it needs an active connection for every request describes cloud AI, the opposite concept, so it can be eliminated.

② THROUGH FACTUAL KNOWLEDGE

On-device AI processes requests locally via an NPU without needing constant connectivity; and the European Commission's Digital Markets Act ruling on 20 July 2026 ordered Google to open Android to rival AI assistants and share search data.



SECTION

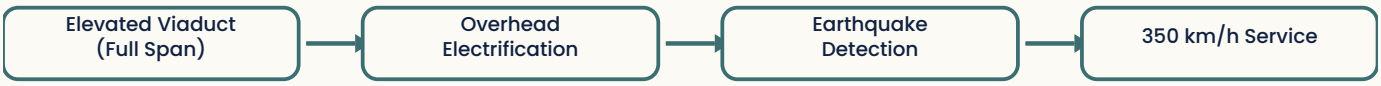
Infrastructure & Transport

10 Mumbai-Ahmedabad Bullet Train — First Service Dated

11 Hyperloop — From Pilot to Commercial Cargo

GS PAPER III · INFRASTRUCTURE · HIGH-SPEED RAIL

Mumbai-Ahmedabad Bullet Train — First Service Dated



NEWS IN BRIEF

- Railway Minister Ashwini Vaishnaw announced on 17 July 2026 that India's first bullet train service will begin operations from 15 August 2027, starting with the Surat-Bilimora stretch of the 508 km Mumbai-Ahmedabad High-Speed Rail corridor, extending in phases to Vapi, Ahmedabad, Thane and finally the full route.
- India and Japan agreed to fast-track the corridor by starting operations with an indigenously developed Indian high-speed train, ahead of Japan's next-generation E10 Series Shinkansen, expected only in the early 2030s.
- Nearly 80% of the project is complete; as of early 2026, about 334 km of viaduct, 415 km of pier work, 17 river bridges and around 4,800 overhead electrification masts had been installed.
- The corridor will use an Early Earthquake Detection System with 28 seismometers that can trigger automatic power shutdown and emergency braking; it is being built with a ₹88,087 crore JICA loan at just 0.1% interest.

CONCEPT SIMPLIFIED

High-speed rail achieves its speed mainly through dedicated, fully elevated or grade-separated tracks with no level crossings, gentle curves designed for high speed, and Shinkansen-style rolling stock. The MAHSR corridor is about 90% elevated, built using the Full Span Launching Method, which lifts and places entire pre-cast concrete spans in one piece rather than assembling track bed-by-bed.

508 km	~80%	Aug 2027
Corridor Length	Completion	First Service

STATIC CONNECT

Static connect — Infrastructure Financing: link to India-Japan bilateral cooperation via JICA's ultra-low-interest financing model, compared with financing structures for other major infrastructure projects.

UNIQUE FACT

India decided to begin bullet train operations using an indigenously developed Indian high-speed train, deliberately choosing not to wait for Japan's next-generation E10 Shinkansen, which won't be ready until the early 2030s.

⚠ **EXAM TRAP —** Don't confuse the first OPERATIONAL stretch (Surat-Bilimora, targeted August 2027) with full corridor completion (Mumbai-Ahmedabad, targeted around 2029) — these are different milestones on different timelines.

RELEVANCE

- Will cut Mumbai-Ahmedabad travel time from 6–7 hours to roughly 2 hours once fully operational, transforming a key economic corridor.
- The India-Japan technical partnership model — a JICA soft loan plus domestic execution — is now a template for the 7 additional high-speed corridors proposed in the Union Budget 2026-27.
- Employment generation, industrial growth and tourism benefits are expected along the corridor, especially in Gujarat, where construction is furthest along.

📌 PRELIMS MEMORY BANK

- First service: 15 August 2027, Surat-Bilimora stretch
- Full corridor: 508 km, Mumbai-Ahmedabad, 12 stations
- Progress: ~80% complete (as of July 2026)
- Design speed: 350 km/h; travel time target: ~2 hours
- Financing: ₹88,087 crore JICA loan at 0.1% interest

PRACTICE MCQ · UPSC PRELIMS STYLE

Mumbai-Ahmedabad Bullet Train — First Service Dated

Consider the following statements regarding the Mumbai-Ahmedabad High-Speed Rail corridor:

1. The first operational stretch will run between Surat and Bilimora.
2. India will begin operations using Japan's next-generation E10 Shinkansen trains.
3. The corridor is being financed partly through a low-interest loan from Japan.

Which of the statements given above is/are correct?

(a) 1 and 3 only

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 1 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

Reports explicitly state India and Japan agreed to START operations with an INDIGENOUS Indian train specifically because the E10 Shinkansen won't be ready until the early 2030s — a statement claiming the E10 will be used from day one reverses this sequencing.

② THROUGH FACTUAL KNOWLEDGE

The first operational stretch is confirmed as Surat-Bilimora from August 2027; India will begin service with an Indian-developed train, not the E10; and the project is financed via a ₹88,087 crore JICA loan at 0.1% interest.

GS PAPER III · INFRASTRUCTURE · FUTURISTIC TRANSPORT

Hyperloop — From Pilot to Commercial Cargo

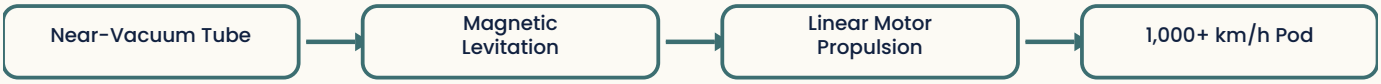
422 m	1,000+ km/h	Jan 2026
Test Track	Target Speed	World First

NEWS IN BRIEF

- Titagarh Rail Systems signed a collaboration agreement with TuTr Hyperloop, an IIT Madras-incubated startup, on 6 July 2026 to develop hyperloop-enabled freight mobility solutions.
- This builds on India's earlier milestone in January 2026, when it placed the world's first live commercial order for hyperloop-based cargo logistics, moving the technology from pilot testing into real-world deployment.
- India's hyperloop programme centres on a 422-metre near-vacuum test track at IIT Madras's Discovery Campus, completed December 2024 and Asia's longest, where pods use magnetic levitation and linear induction motors to travel with minimal friction.
- The Ministry of Railways has cleared a proposal for a 40–50 km hyperloop test track, with location still being finalised, as part of India's 'fifth mode of transportation' push.

CONCEPT SIMPLIFIED

Hyperloop pods travel through sealed, near-vacuum tubes to minimise air resistance, while magnetic levitation uses electromagnets to lift the pod off the track entirely, eliminating rolling friction. Together, minimal air resistance and zero surface friction are what theoretically allow hyperloop pods to reach speeds exceeding 1,000 km/h — far beyond what wheeled trains can achieve.



STATIC CONNECT

Static connect — Futuristic Transport Systems: link to Japan's operational maglev bullet trains for comparison, and India's own MAHSR bullet train project as a different point on the same high-speed-transport spectrum.

UNIQUE FACT

India became the first country in the world to place a live commercial order for hyperloop-based cargo logistics, in January 2026 — moving hyperloop from a research showcase into a paid logistics deployment before any other nation.

⚠ **EXAM TRAP —** Don't confuse Hyperloop (near-vacuum tube plus maglev, still mostly at testing/pilot cargo stage in India) with the Mumbai-Ahmedabad bullet train (conventional Shinkansen-style high-speed rail, already under active construction) — different technologies at very different stages.

RELEVANCE

- The Titagarh-TuTr partnership targets freight first — faster, more energy-efficient cargo transport could reduce logistics costs and delivery times for Indian industry.
- India becoming the first country to place a live commercial hyperloop cargo order shifts the technology from an experimental showcase into a real, revenue-generating logistics tool.
- Zero direct emissions and solar-powered operation align hyperloop development with India's broader sustainable mobility and Net Zero goals.

📌 PRELIMS MEMORY BANK

- Test track: 422 m, IIT Madras (completed December 2024, Asia's longest)
- World first: commercial hyperloop cargo order, January 2026 (India)
- New tie-up: Titagarh Rail + TuTr Hyperloop, 6 July 2026 (freight focus)
- Planned track: 40–50 km test track cleared by Railways
- Core tech: magnetic levitation + near-vacuum tube

PRACTICE MCQ · UPSC PRELIMS STYLE

Hyperloop — From Pilot to Commercial Cargo

With reference to India's Hyperloop programme, consider the following statements:

1. India's Hyperloop test track is located at IIT Madras and uses magnetic levitation technology.
2. India was the first country to place a live commercial order for hyperloop-based cargo logistics.
3. Hyperloop pods achieve high speed primarily by increasing air resistance inside the tube.

Which of the statements given above is/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) 1 and 2 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

Hyperloop's core design principle, repeated everywhere it is described, is REDUCING air resistance via a near-vacuum tube — a statement claiming it increases air resistance inverts the basic physics the technology depends on, so it can be eliminated.

② THROUGH FACTUAL KNOWLEDGE

India's Hyperloop test track is confirmed at IIT Madras using magnetic levitation and linear induction motors; and India placed the world's first live commercial hyperloop cargo order in January 2026.



SECTION

Energy & Environment

12 Long Duration Energy Storage Goes Commercial

GS PAPER III · ENERGY · GRID STORAGE

Long Duration Energy Storage Goes Commercial

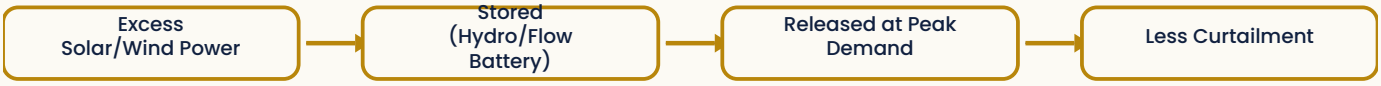
1,344 MW	100 MWh	270.8 GW
Pumped Hydro	Flow Battery	Peak Demand

NEWS IN BRIEF

- India's grid-storage agency SECI awarded 1,344 MW of pumped hydro energy storage contracts to Greenko, Torrent Power and Tata Power on 20–21 July 2026, at tariffs of roughly $112,000–114,000 per MW per year.
- The same week, Delectrik Systems won India's first utility-scale vanadium redox flow battery contract — a 100 MWh system, to be deployed with infrastructure partner Bondada Engineering.
- India's Long Duration Energy Storage push aims to support the country's 500 GW non-fossil energy capacity target by 2030; since April 2025, solar curtailment has cost Indian power producers over $26 million in lost revenue.
- India's peak power demand hit a record 270.8 GW in May 2026, underlining the urgency of storage technologies that can discharge electricity for many hours, not just the few hours lithium-ion batteries typically manage.

CONCEPT SIMPLIFIED

Solar and wind power are intermittent — they don't generate electricity when the sun isn't shining or the wind isn't blowing. Long Duration Energy Storage technologies such as pumped hydro, flow batteries, compressed air and thermal storage can store electricity for many hours to days, smoothing out this mismatch — unlike standard lithium-ion batteries, which are efficient for short bursts of a few hours but not for storing large amounts of energy over longer stretches.



STATIC CONNECT

Static connect — Renewable Energy Integration: link to India's National Electricity Plan, the 500 GW non-fossil capacity target by 2030, and the Net Zero by 2070 commitment as the broader policy context for storage investment.

UNIQUE FACT

India's first utility-scale vanadium flow battery contract (100 MWh) was awarded in the very same week as its largest-ever pumped hydro storage contracts (1,344 MW) — two very different LDES technologies both crossing from pilot to commercial scale simultaneously.

⚠ **EXAM TRAP —** Don't confuse standard lithium-ion battery storage, efficient for short, few-hour discharge, with Long Duration Energy Storage technologies like pumped hydro and flow batteries, designed for many hours to days of discharge — they solve different parts of the grid-storage problem.

RELEVANCE

- Reduces 'solar curtailment' — the costly practice of intentionally wasting available clean power because the grid can't absorb or store it all at once.
- Pumped hydro storage (elevated reservoirs storing energy as gravitational potential) and vanadium flow batteries (liquid electrolyte tanks) are both now moving from pilot projects into full commercial contracts in India.
- Helps replace fossil-fuel 'peaking plants', which run only during high-demand periods, with clean, dispatchable storage, supporting grid stability during record demand spikes.

📌 PRELIMS MEMORY BANK

- Pumped hydro awarded: 1,344 MW (Greenko, Torrent, Tata Power), 20–21 July 2026
- First utility-scale flow battery: 100 MWh, Delectrik Systems
- Target: 500 GW non-fossil capacity by 2030
- Peak demand record: 270.8 GW (May 2026)
- Curtailment cost: $26+ million lost since April 2025

PRACTICE MCQ · UPSC PRELIMS STYLE

Long Duration Energy Storage Goes Commercial

With reference to Long Duration Energy Storage (LDES) in India, consider the following statements:

1. Lithium-ion batteries are generally the preferred technology for storing energy over many hours to days.
2. Pumped hydro energy storage and vanadium flow batteries are examples of LDES technologies.
3. India's grid-storage agency awarded its first utility-scale flow battery contract in July 2026.

Which of the statements given above is/are correct?

(a) 2 and 3 only

(b) 1 and 2 only

(c) 1 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

LDES technologies are explicitly defined as filling the gap that lithium-ion batteries DON'T cover — short-duration efficiency is lithium-ion's strength, not its role in long-duration storage, so a statement favouring lithium-ion for multi-day storage misattributes the technology best suited for that job.

② THROUGH FACTUAL KNOWLEDGE

Pumped hydro and vanadium flow batteries are confirmed LDES technologies; and Delectrik Systems won India's first utility-scale flow battery contract in July 2026.