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Compiled by **SAPNA CHAUHAN**

Based on The Hindu · Practice Zone with 2 Mains, 10 Prelims MCQs, Revision & Trap-setters

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TODAY'S SPINE

Energy security & sanctions · Biodiversity (Project Cheetah) · Welfare & skilling · Semiconductors & innovation · Deep-ocean governance.

EDITOR'S FOCUS

Two threads bind today's paper: the **limits of technological ambition** — from chips (SEMICON) and patents to deep-sea mining, where “can we?” must meet “should we?” — and the **reach of external pressure** on India's strategic autonomy, sharpest in the oil-import data. Read the oil and deep-sea pieces together as a study in strategic restraint versus strategic assertion.

India's oil buys fall after U.S. curbs, resume as pressure eases

Source — The Hindu · Page 1 · “Data suggest Indian oil buys fall after U.S. curbs”

India's crude sourcing from Venezuela, Iran and Russia has repeatedly bent to U.S. sanctions and tariff pressure and rebounded once that pressure eased — a pattern that reopens the debate on how far ‘strategic autonomy’ actually governs India's energy choices. The MEA has issued a strong statement asserting India buys energy from ‘diversified sources’ in the ‘national interest’, against a U.S. Bill proposing tariffs of up to 100% on India for importing Russian oil.

Page No.1 , GS 3

Data suggest Indian oil buys fall after U.S. curbs

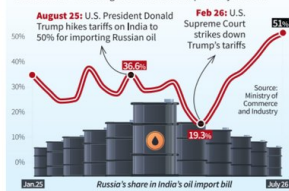
The government says energy sourcing is based on ‘national interest’, but India slashed imports from Venezuela, Iran, and Russia following U.S. pressure, and resumed sourcing after curbs eased

T.C.A. Sharad Raghavan
Kallol Bhattacharjee
NEW DELHI

Over the past decade, India has complied with U.S. pressure to reduce oil imports from countries it has sought to isolate, such as Venezuela, Iran, and Russia, even though they were important sources. Once the U.S. pressure eased, official data show that India immediately turned back to these sources of oil.

The External Affairs Ministry on Thursday issued a strong statement asserting India's strategic independence in sourcing energy against the backdrop of a U.S. Bill that proposes tariffs of up to 100% on India for importing Russian oil. The Ministry spokesperson said on Friday that

Pressure tactics | India began drastically cutting back on Russian oil following the 50% tariffs imposed by the U.S.



“energy sourcing is based on national interest” and that India continues “to buy energy from diversified sources”. “As stated, we have already conveyed, at senior levels of the U.S. administration, the implications that the legislation could have on India's energy security, for the international energy markets, and the overall bilateral partnership,” the spokesperson said. Earlier, the Ministry said that in its communications with the U.S., the Indian side “made clear its determination to take all mea-

sures to protect its trade and economic interests”.

Data show that protecting “trade and economic” interests has, in the past, coincided closely with the U.S. sanctions and tariff programme. Russia's share in India's oil imports was around 30%-40% between July 2024 and July 2025 but fell to 19.3% by February 2026 when the U.S. hiked tariffs to 50%. After the U.S. Supreme Court struck down the tariffs in February, India's oil imports from Russia increased, touching 51% this July. The share of Venezuelan crude fell from 6.7% in 2017-18 to zero by 2021-22, and that of Iranian oil plummeted from one-tenth to nil by 2020-21.

CONTINUED ON
» PAGE 10

MEA asserts India's energy sourcing is on ‘national interest’; import data track U.S. tariff pressure.

Key Facts & Data

- ◆ Russia's share in India's oil imports hovered at 30–40% (July 2024–July 2025), fell to 19.3% by February 2026 when the U.S. hiked tariffs to 50%, then rebounded to 51% by July 2026 after the U.S. Supreme Court struck the tariffs down in February.
- ◆ Venezuela's share fell from 6.7% (2017–18) to 6.4% (2018–19), 5.9% (2019–20), 1.1% (2020–21) and zero by 2021–22 — India imported no Venezuelan crude through 2022–23.
- ◆ Iran's share collapsed after Trump reimposed sanctions in Nov 2018 (to quell alleged nuclear ambitions): to ~1%, then nil by 2020–21; India imported no Iranian oil for six years (2020–26).
- ◆ Trigger events on the timeline: 25 Aug — U.S. hikes India tariff to 50% for Russian oil; 26 Feb — U.S. Supreme Court strikes down Trump's tariffs.

Why India's import basket is so sensitive

India imports ~85–88% of its crude requirement, so the source mix is a strategic variable, not just a commercial one. After Russia's invasion of Ukraine (Feb 2022), discounted Urals crude (trading below the Western \$60/barrel price cap) turned Russia into India's single-largest supplier — a windfall that also insulated global prices by keeping Russian barrels in the market. Washington's leverage runs through secondary sanctions (penalising third parties dealing with a sanctioned state), CAATSA-style measures, and now tariff threats — tools that raise the cost of a purchase without formally banning it.

Analysis — autonomy in rhetoric, adjustment in practice

- ▶ The data show a gap between the language of strategic autonomy and observed behaviour: shares fall under pressure and recover when it lifts. This is less capitulation than cost-benefit calculation — India optimises for price and supply security within the space U.S. measures leave open.
- ▶ ‘National interest’ sourcing is real but bounded: refiners (public and private) respond to discounts, insurance/shipping access, and the risk of being cut off from the U.S. financial system and export markets.
- ▶ The tariff route is novel: earlier isolation of Iran/Venezuela worked through sanctions on the seller; the 2026 Bill targets the buyer (India) — testing whether trade coercion can substitute for sanctions.

PRELIMS POINTERS

- India imports ~85%+ of its crude oil; top suppliers vary with discounts and sanctions.
- CAATSA (Countering America's Adversaries Through Sanctions Act, 2017) — U.S. law enabling secondary sanctions on entities dealing with Russia, Iran, North Korea.
- \$60/barrel price cap on Russian crude — imposed by G7/EU/Australia (Dec 2022) to curb Russia's revenue while keeping oil flowing.
- Strategic Petroleum Reserves (SPR): India's ISPR stores at Visakhapatnam, Mangaluru, Padur.

WAY FORWARD

Diversify beyond price-driven bets (Gulf, U.S., West Africa, Latin America), deepen SPR capacity, accelerate the energy transition (renewables, ethanol blending, EVs) to structurally shrink import dependence, and use plurilateral platforms to resist buyer-side coercion — the durable answer to sanction-driven volatility is lower demand, not a better supplier.

GS 3 ENVIRONMENT · BIODIVERSITY · CONSERVATION

Indian-born cheetah litter at Kuno; Project Cheetah turns four

Source — The Hindu · Page 12 · “Indian-born cheetah gives birth to four cubs at Kuno”

An Indian-born cheetah has delivered four cubs at Madhya Pradesh's Kuno National Park — months after her previous litter was lost to a leopard attack — taking the total cheetah population to 56. The litter arrives a day after Project Cheetah, the world's first intercontinental wild-carnivore translocation, completed four years.

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Indian-born cheetah gives birth to four cubs at Kuno

An Indian-born cheetah has given birth to four cubs in Madhya Pradesh's Kuno National Park, months after her previous four cubs were killed in a leopard attack. The latest litter has taken the total population to 56. Union Minister for Environment, Forest and Climate Change Bhupendra Patel announced the latest litter, on X, which comes a day after India's Project Cheetah, the reintroduction programme for the big cat species, turned four. Speaking to *The Hindu*, Kuno Field Director and Project Cheetah Director Uttam Kumar Sharma said the four cubs appeared to be healthy and a team was keeping a watch without disturbing the mother the cubs.

An India-born cheetah's four new cubs take Kuno's population to 56.



The mother nursing her cubs at Kuno National Park, Madhya Pradesh.

Key Facts & Data

- ◆ Project Cheetah launched Sept 2022 to reintroduce the cheetah, declared extinct in India in 1952. It is the world's first intercontinental translocation of a wild carnivore.

- ◆ Founding cohorts: 8 cheetahs from Namibia (Sept 2022), 12 from South Africa (Feb 2023); a later batch of 9 arrived from Botswana. Botswana hosts ~24% of the global cheetah population (~7,100 individuals).
- ◆ Governance: NTCA is the implementing agency, with the MP Forest Department and the Wildlife Institute of India (WII); a Steering Committee (2023) oversees implementation.
- ◆ Habitats: Kuno National Park and Gandhi Sagar Wildlife Sanctuary (both MP) are primary; Nauradehi WLS is earmarked for future expansion.

African vs Asiatic cheetah — why Africa was the source

The reintroduced animals are African cheetahs (*Acinonyx jubatus*), sourced because the native Asiatic sub-species (*A. j. venaticus*) is Critically Endangered with only a tiny, non-viable population surviving in Iran — leaving no donor stock. The African cheetah is Vulnerable (IUCN), slightly larger and sturdier; the Asiatic is smaller, slender, buff-coloured with more fur on the underbelly. The project treats the African cheetah as an ecological analogue to restore a lost grassland predator niche.



African vs Asiatic cheetah — taxonomy, distribution and IUCN status.

Significance & the criticism

- Ecological restoration: the cheetah is a flagship for India's neglected open grassland/savanna ecosystems, which conservation policy has historically under-protected relative to forests.
- Successful in-situ breeding (Indian-born litters surviving) is the first real test of whether a self-sustaining wild population can establish — a milestone beyond mere survival of translocated adults.
- Concerns persist: high mortality among adults and cubs, questions over Kuno's carrying capacity and prey base, predator conflict (the earlier litter lost to a leopard), and debate on whether an African sub-species can substitute the extinct Asiatic one.

PRELIMS POINTERS

- Cheetah declared extinct in India: 1952. Reintroduction began: Sept 2022.
- Kuno & Gandhi Sagar — Madhya Pradesh; Nauradehi WLS — future site.
- Implementing agency: NTCA (under MoEFCC); scientific partner: WII, Dehradun.
- IUCN: African cheetah — Vulnerable; Asiatic cheetah — Critically Endangered.

- Note: NTCA is the statutory body under the Wild Life (Protection) Act, 1972, better known for Project Tiger.

WAY FORWARD

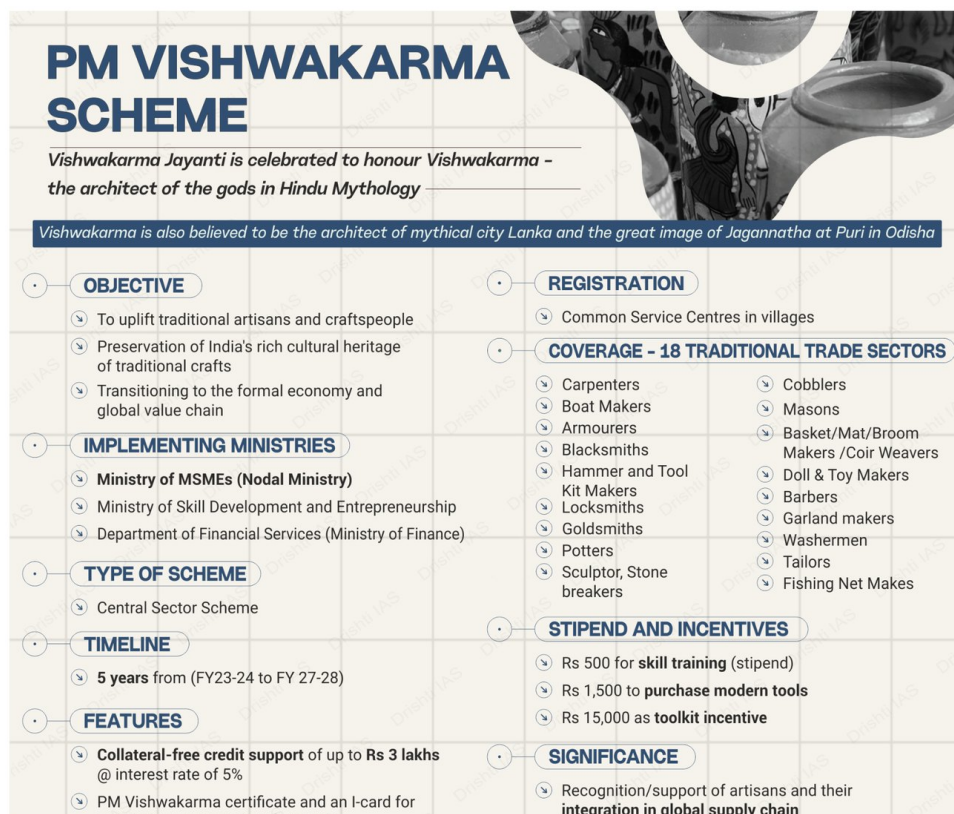
Establish a second and third free-ranging population (to spread risk), secure prey augmentation and grassland restoration, strengthen metapopulation management across sites, and pair the charismatic species push with legal protection for grassland habitats so the cheetah's return delivers ecosystem-wide gains, not just a headline count.

GS 2 · GS 3 GOVERNANCE · WELFARE · INFORMAL SECTOR

PM Vishwakarma completes two years

Source — Slide dossier · PM Vishwakarma Scheme (Central Sector Scheme)

L launched on 17 September 2023 (Vishwakarma Jayanti), PM Vishwakarma is an umbrella Central Sector Scheme with a ₹13,000-crore outlay (FY24–FY28) giving end-to-end, holistic support to informal self-employed artisans and craftspeople who work with their hands and traditional tools. Its progress featured prominently around Vishwakarma Diwas 2026.



PM Vishwakarma — objectives, 18 trades, credit, toolkit and stipend at a glance.

Key Facts & Data

- ◆ 18 traditional trades covered — carpenters, boat makers, armourers, blacksmiths, locksmiths, goldsmiths, potters, sculptors, cobblers, masons, basket/mat/broom makers & coir weavers, doll & toy makers, barbers, garland makers, washermen, tailors, fishing-net makers, and hammer & tool-kit makers.
- ◆ Three pillars — Samman (recognition via PM Vishwakarma Certificate + digital ID), Samarthya (skilling, modern tooling, Udyam Assist Platform onboarding), and Samridhi (concessional credit, toolkits, digital-transaction cashback, market linkage).
- ◆ Benefits: collateral-free credit up to ₹3 lakh at 5% concessional interest; ₹500/day skill-training stipend; ₹15,000 toolkit incentive; monthly digital-transaction cashback.

- ◆ Progress: ~30 lakh beneficiaries registered (3-stage verification); 24.37–24.50 lakh completed 5–7 day Basic Skill Training (MSDE); 18.15 lakh toolkits (up to ₹15,000 each) delivered doorstep via India Post.

Where it sits in the scheme architecture

It is a Central Sector Scheme (100% Union-funded, distinct from Centrally Sponsored Schemes that need state cost-sharing). The nodal Ministry is MSME, working with MSDE (skilling) and the Department of Financial Services (credit). Registration is through Common Service Centres in villages. Vishwakarma is the divine architect of Hindu mythology — the branding ties recognition of artisan labour to cultural memory while trying to formalise it via the Udyam Assist Platform.

Significance

- ▶ Targets a segment welfare policy usually misses — the self-employed, guru-shishya-trained artisan outside both the salaried economy and formal MSME credit.
- ▶ Bundles recognition + skilling + credit + market access in one pipeline, rather than a single subsidy, aiming to move artisans up the value chain and into formal supply chains.
- ▶ Preserves intergenerational craft skills and cultural heritage while nudging beneficiaries toward digital payments and formal enterprise.

PRELIMS POINTERS

- Type: Central Sector Scheme; Nodal Ministry: MSME; launched 17 Sept 2023; outlay ₹13,000 cr (FY24–28).
- Credit: up to ₹3 lakh, collateral-free, @5%; toolkit incentive ₹15,000; stipend ₹500/day.
- 18 trades; registration via CSCs; skilling by MSDE.
- Distinguish from PM SVANidhi (street vendors) and PMEGP (micro-enterprises).

WAY FORWARD

Deepen genuine market linkage (GeM onboarding, exports, e-commerce) beyond registration numbers, ensure last-mile credit actually reaches artisans (not just sanction targets), track post-training income gains rather than enrolment, and integrate with ODOP/GI-tagging so traditional crafts capture premium value.

GS 3 SCIENCE & TECH · SEMICONDUCTORS · ECONOMY

SEMICON India 2026 — ‘Silicon to Systems’

Source — Slide dossier · SEMICON India 2026, Yashobhoomi, New Delhi

The Prime Minister inaugurated the 5th SEMICON India 2026 at Yashobhoomi (IICC), New Delhi, coinciding with Vishwakarma Diwas. It is India's flagship international semiconductor conference and exhibition — the premier meeting-point for fab operators, design start-ups, academia and policymakers across the global microelectronics supply chain.

SEMICON India



PM Modi at SEMICON India 2026, inaugurated on Vishwakarma Diwas at Yashobhoomi, New Delhi.

Key Facts & Data

- ◆ Organisers: India Semiconductor Mission (ISM), Ministry of Electronics & IT (MeitY), and SEMI (global industry association). Theme: 'Silicon to Systems: Building the Ecosystem'.
- ◆ Scale: 500+ companies from 20+ countries across silicon, chemicals, chip manufacturing, packaging and system integration – a full 'sand-to-systems' exhibition.
- ◆ Pavilions: country and state pavilions, a Workforce Development Pavilion, and a Startup Pavilion with 40+ deep-tech fabless start-ups.
- ◆ Skilling: 70,000+ engineering students trained in EDA (Electronic Design Automation) tools against a 100,000 target; chip-design promoted via universities and hackathons.

The India Semiconductor Mission and why chips matter

Semiconductors are the foundational input for computing, telecom, defence, autos and AI – and their supply is geographically concentrated (Taiwan, South Korea, the U.S.), making them a chokepoint in geopolitics. ISM (2021), a ₹76,000-crore programme under MeitY, offers fiscal support (up to 50% of project cost) for fabs, display fabs, compound-semiconductor/ATMP (assembly, testing, marking, packaging) and OSAT units, plus the Design-Linked Incentive (DLI) scheme. The 'silicon-to-systems' framing signals ambition to move up from assembly/packaging toward design IP and full system integration.

Significance & strategic stakes

- ▶ Supply-chain resilience: reduces dependence on a handful of foreign fabs amid U.S.–China tech decoupling and export controls; positions India as a 'trusted' manufacturing node.
- ▶ Value-chain climb: fostering domestic design IP and a fabless start-up base (not just ATMP/packaging) is where the higher margins and strategic depth lie.
- ▶ Talent is the binding constraint: the EDA-training push acknowledges that a fab is only as useful as the design and process engineers who feed it.

PRELIMS POINTERS

- ISM launched 2021 under MeitY; outlay ₹76,000 crore; fiscal support up to 50% of project cost.
- DLI (Design-Linked Incentive) supports domestic chip design; ATMP/OSAT = back-end assembly/packaging.
- Venue: Yashobhoomi (India International Convention & Expo Centre), Dwarka, New Delhi.
- First commercial 'Made-in-India' chips are being enabled via fabs in Gujarat (Dholera) and Assam (Morigaon/ATMP).

WAY FORWARD

Sustain multi-year fiscal certainty for capital-heavy fabs, secure inputs (ultra-pure water, chemicals, gases, rare materials), build the design-IP and EDA talent pipeline, deepen partnerships (U.S., Japan, EU, Taiwan) via frameworks like the iCET/Quad supply-chain initiatives, and anchor demand through electronics and EV manufacturing.

GS 3

SCIENCE & TECH · INNOVATION · IPR

A homegrown innovation ecosystem takes root

Source — The Hindu · Page 8 · Lead article (Chakrapani & Jain)

Technologies that once arrived through imports are increasingly being invented at home. Three institutional foundations of an innovation economy — public research, corporate R&D, and deep-tech entrepreneurship — are advancing together. The architecture is finally visible, even if the transformation is incomplete.

Page No.8 , GS 3

A homegrown innovation ecosystem is taking root

Technologies that once arrived in India through imports are increasingly being invented at home through local research institutions, industry, and startups. Three institutional foundations of an innovation economy are now advancing together: public research, corporate research and development (R&D), and deep-tech entrepreneurship. The transformation is yet incomplete, but the architecture is finally visible. Gallium Nitride (GaN) semiconductor technologies, critical for advanced radar, space systems, and next-generation communications, are increasingly being developed domestically, helping close a strategic gap in a tightly regulated, export-controlled field. At the same time, affordable immunotherapies developed in India are expanding access to advanced cancer care and demonstrating the country's growing capacity for biomedical innovation.

Patent filings are often cited as a ready indicator of innovation. The filing numbers continue to show impressive growth. From just over 1,10,000 patent filings in 2024-25, the number grew to more than 1,43,000 in 2025-26, a 30.2% increase. Moreover, domestic applicants now account for almost seven in 10 filings.

However, the sheer volume of applications does not tell the complete story. Even a modest enquiry reveals an innovation story that begins to fray at the edges. The number of patents in force in India (just over 2,40,000 in 2025) is a fraction of those in China (5.7 million), the United States (5.5 million), and Japan (2.1 million); all these are 2024 data.

This suggests low grant rates, high abandonment rates, or a combination of both. Add to this meagre commercialisation, low R&D spending — India still spends just under 1% of GDP on research and development, against about 2.4% in China and 3.5% in the U.S. — and we see how far we are from a truly technology-driven, innovation-led economy.

The emerging pillars

However, there lies a resilient core, and shaping it are three strong and vital strands that promise to anchor India's future. Public institutions with government support have made vital breakthroughs in long-gestating innovation. Private R&D spending exceeded that of all levels of government combined for the first time in 2024. This is expected to climb and account for 5% through 2025-26. Domestic industrial houses are beginning to reap rewards from focused and committed R&D. A maturing startup ecosystem is finding its feet beyond low-hanging service platforms, actively showcasing deep-tech and complex manufacturing. That all three strands



Mohan Chakrapani

holds a PhD in science and a law degree and is an academic.



Gautam Jain

Founder of Innate Research and an intellectual property rights expert helping startups, academia, and innovators transform ideas into intellectual property.

are coming of age together bodes well for India. In March 2023, Defence Research and Development Organisation (DRDO) scientists at the Solid State Physics Laboratory (SSPL) in Delhi and the Gallium Arsenide Enabling Technology Centre (GAETEC) in Hyderabad announced a breakthrough in making gallium nitride (GaN) monolithic microwave integrated circuits (MMICs). The technical know-how to make these circuits, which are critical for military and defence applications, was, by widely reported accounts, referred to India under the other provisions of the Rafale fighter jet purchase from France. The DRDO is now actively transferring the technology for GaN High Electron Mobility Transistors (HEMTs) based MMICs to be used in 5G/6G wireless infrastructure, electric vehicles on-board chargers, and renewable energy inverter systems. India is now one of seven countries to have mastered this technology, alongside China, France, Germany, Russia, South Korea and the U.S. AGST Semiconductors, a spin-off from the Centre for Nano-Science and Engineering (CeNSE) at the Indian Institute of Science, Bengaluru is translating homegrown GaN technology to real-world commercial applications.

From implementer to innovator

While long gestation R&D at public institutions is starting to pay off, there is growing optimism from academia and domestic industry-led R&D as well. The Bharat 6G Alliance (B6GA) is making rapid progress in its stated aim of contributing 10% of the global 6G patents by 2030. According to a review meeting by Union Minister for Communication Jitendra Singh, B6GA members have made more than 7200 patent filings across 5G and 6G technologies, including over 4,000 foreign filings. That, these are applications, not yet grants or declared standard-essential patents, and their true impact remains to be seen. However, taken together with almost 1,000 technical contributions to 3GPP last year, a 15-fold increase from 2020, these figures point in the right direction. The World Intellectual Property Organization's 2023 Patent Cooperation Treaty rankings showed that Jio Platforms Limited had broken into the top 20 international patent filers for the first time, rising more than 300 places to be placed 19th overall.

While patent numbers are only a part of the story, participation in standards bodies and intellectual property ownership increasingly determine who captures value from future communication networks. India is securing ownership of critical digital infrastructure and is moving from being a standard implementer to a standard-setting innovator.

There is also a marked shift in India's startup ecosystem. buoyed by the government's commitment to Research, Development, and Innovation (RDI) and private capital reached by initiatives such as the more than \$2.5-billion in deep-tech commitments made by members of the India Deep Tech Alliance (IDTA). Indian startups are aiming further and higher than before. Picxel Space, founded by two IIT Bombay alumni, is carving a niche in hyperspectral imaging technology with its satellites in orbit and a full constellation of 18 to 24 planned. The Vikram Sarabhai Space Centre (VSSC) and the Vikram Sarabhai Space Centre (VSSC) are pushing towards fully reusable launch vehicles promise to strengthen India's role as a frugal space technology leader.

Startups such as ImmunoACT, incubated at IIT Bombay in partnership with the Tata Memorial Centre, are expanding access to advanced and affordable health care. NeoCARs, India's first indigenous CAR-T cell therapy, has delivered effective cancer treatment at a tenth of typical treatment costs. Leveraging the Biotechnology Industry Research Assistance Council (BIRAC) early-stage support, Bengaluru-based Remidio Innovative Solutions is at the forefront in the fight against preventable blindness, such as diabetic retinopathy and glaucoma, through smartphone-enabled retinal imaging systems and AI.

The direction is clear

These examples do not by themselves make India an innovation superpower but demonstrate that the three strands are coming together to weave an enduring innovation ecosystem. The GaN story illustrates the emerging innovation pipeline. Government laboratories developed the foundational capability, academic institutions nurtured the talent and research ecosystem, and startups such as AGST are now carrying the technology into commercial markets.

However, sustaining these three strands will demand more work, from standardising tech transfer terms for publicly funded IP and expanding examiner capacity at the patent office, to funding the translational gap between a granted patent and a first paying customer. Yet, as we look through the innovation lens, the direction is clear: India is gradually shedding its identity as a back-office service provider and strengthening the institutions that enable nations to generate their own technology, intellectual property, and industrial capabilities. The journey remains unfinished, but the contours of an innovation economy are beginning to form.

The views expressed are personal

India's innovation base — public research, corporate R&D and deep-tech start-ups — is finally visible.

Key Facts & Data

- ◆ Patent filings rose from ~1,10,000 in 2024-25 to 1,43,000+ in 2025-26 (a 30.2% jump); domestic applicants now account for ~7 in 10 filings.
- ◆ But patents in force in India (~2,40,000 in 2025) trail China (5.7 mn), the U.S. (3.5 mn) and Japan (2.1 mn) — pointing to low grant rates, high abandonment and weak commercialisation.
- ◆ R&D spend: India spends just under 1% of GDP, vs ~2.4% (China) and ~3.5% (U.S.). Private R&D exceeded all levels of government spend for the first time in 2024.
- ◆ WIPO 2025 PCT rankings: Jio Platforms broke into the global top 20 filers for the first time, rising 300+ places to 19th.
- ◆ Frontier examples: domestic Gallium Nitride (GaN) semiconductors (radar, space, 5G/6G) via DRDO-SSPL-GAETEC and CeNSE; affordable CAR-T immunotherapy (ImmunoACT/IIT-B-Tata Memorial); Bharat 6G Alliance targeting 10% of global 6G patents by 2030.

From implementer to innovator

India's story is shifting from being a 'standard-implementer' (using technologies set abroad) to a 'standard-setter' (owning IP and shaping global standards). The three strands reinforce one another: government labs build foundational capability, academia nurtures talent and research, and start-ups carry the technology to commercial markets — the GaN and CAR-T cases illustrate the full pipeline. But sustaining it needs standardised tech-transfer terms for publicly funded IP, more patent-office capacity, and a bridge across the 'translational gap' from a granted patent to a first paying customer.

Analysis

- ▶ Rising filings are necessary but not sufficient: what matters is the grant-to-commercialisation conversion, where India lags sharply.
- ▶ The 1%-of-GDP R&D intensity is the structural ceiling — well below innovation-led economies; the shift of private R&D above government spend (2024) is a hopeful inflection.
- ▶ IP ownership in standards bodies (5G/6G, SEPs — Standard Essential Patents) increasingly decides who captures value from future networks; India moving from implementer to owner is a strategic gain.

PRELIMS POINTERS

- GaN (Gallium Nitride): wide-bandgap semiconductor for radar, EVs, 5G/6G, space; export-controlled field.
- PCT (Patent Cooperation Treaty): WIPO-administered route for international patent filing.
- CAR-T therapy: engineered T-cell cancer immunotherapy; India's ImmunoACT (NexCAR19) delivers it at a fraction of global cost.
- Bharat 6G Alliance (B6GA): targets 10% of global 6G patents by 2030.
- India's R&D spend $\approx$ <1% of GDP (Anusandhan National Research Foundation set up to raise this).

WAY FORWARD

Raise gross R&D expenditure decisively above 1% of GDP, operationalise the Anusandhan NRF, fix patent-office throughput and grant rates, standardise IP tech-transfer from public labs, and fund the translational gap (proof-of-concept to first customer) so filings convert into products and standards.

GS 3 ENVIRONMENT · OCEAN GOVERNANCE · SCI-TECH

Deep-sea mining vs deep-sea responsibility

Source — The Hindu · Page 8 · "Deep-sea discovery, environmental responsibility" (P. Ragavan)

India stands at the threshold of a deep-sea frontier. As it builds capability to access the least-understood parts of the planet, the fundamental question is not how deep it can go or how much wealth lies beneath the ocean floor — but whether everything that can be technologically exploited should be. The author argues strategic importance cannot automatically become ecological permission.

Deep-sea discovery, environmental responsibility

India is standing at the threshold of a new frontier. But the most important question is not how deep we can go, how much we can mine, or how much wealth lies beneath the ocean floor. It is more fundamental: Should everything that can be technologically exploited necessarily be exploited? The question is particularly important as India strengthens its position in deep-sea exploration and develops its scientific and technological capabilities to access one of the least understood parts of the planet.

A growing deep-sea footprint

India is not new to seabed mineral exploration and holds three International Seabed Authority (ISA) exploration contracts covering approximately 95,000 square kilometres across the Central Indian Ocean Basin, Central Indian Ridge and Carlsberg Ridge in the international seabed area. Its exploration has identified an estimated 366 million tonnes of polymetallic nodules containing nickel, copper, cobalt and manganese, alongside extensive environmental and biodiversity studies.

Under the Deep Ocean Mission, India is developing deep-sea mining technology, underwater robotics and the MATSYA-6000 human submersible, while the National Institute of Ocean Technology has tested a mining machine at depths of about 5,270 metres. At the same time, biodiversity surveys across 19 seamounts have studied around 1,300 deep-sea organisms, including nearly 23 species reported as new to science. These achievements also impose a profound responsibility to decide whether technological ability should ultimately lead to exploitation.

Technological progress can create a dangerous assumption: if we can exploit something, we should. But the deep ocean challenges this logic. It is a complex and poorly understood ecosystem, and India's own biodiversity research continues to reveal previously unknown organisms. We cannot confidently predict the consequences of



P. Ragavan
Marine biologist with over a decade of professional experience in the conservation and management of coastal and marine environments

India has an opportunity to become a global leader not only in deep-sea technology but also in deep-sea ecological governance

large-scale seabed disturbance while our understanding of these ecosystems remains incomplete. This is not an argument against science, but for more science before potentially irreversible intervention. Deep-sea minerals may have legitimate strategic importance for India's renewable-energy, electric-mobility and advanced-manufacturing ambitions. However, strategic importance cannot automatically become ecological permission. Before considering extraction, India should ask whether the minerals are genuinely necessary at the proposed scale, whether alternatives exist, and whether demand can be reduced through recycling, efficiency, substitution and a circular economy. Necessity must be demonstrated, not presumed.

India's investment in deep-ocean science need not imply a commitment to commercial mining. Exploration can advance knowledge, biodiversity assessment, environmental baselines and technology without leading to exploitation. Mining, however, would physically disturb the seabed. Therefore, adaptive management alone cannot guarantee ecological protection. India has an opportunity to adopt a stronger principle before exploitation begins: the question should not be "How can we mine with minimum damage?" but "Do we need to mine at all?" Since India's ISA activities remain at the exploration stage, this is the right time to establish a high ecological threshold for any future decision to exploit.

Science must also teach us to say 'no'

The deep ocean is now emerging as the next frontier for economic growth. Yet, we expect the ocean to regulate climate and support biodiversity while extending industrial activity into its least understood ecosystems. The ocean should not become a place where the environmental costs of human consumption are simply relocated. Scientific progress should not mean making more of nature exploitable and

then calling it sustainable. True sustainable development must reduce dependence on extraction through lower demand, resource efficiency, recycling, substitution and circular consumption – principles reflected in India's Mission LIFE. Science must therefore help us use resources responsibly and, equally importantly, determine when we do not need to use them at all. This calls for a broader understanding of scientific progress. Science should not merely open new frontiers for exploitation; it should also reveal which frontiers are best left untouched. The ability to say "we do not need to go there" may itself represent a higher level of scientific and civilisational maturity than simply proving that we can

India can lead a different model

India has an opportunity to become a global leader in deep-sea ecological governance. India could take the bold step of recognising the deep ocean not merely as a mineral reserve, but as a precious ecological asset whose value may exceed that of its mineral wealth. It could use the knowledge gained through the Deep Ocean Mission to conclude that some poorly understood and potentially irreversible ecosystems are better left undisturbed. Progress is not how much nature we can convert into resources, but how much we can preserve while meeting human needs. This would reaffirm India's long-standing civilisational tradition of living in harmony with nature.

The defining environmental approaches of this century – Nature-based Solutions, the SDGs, the Circular Economy and Mission LIFE – share a common principle: nature is the capital on which development depends. They call for conserving ecosystems, reducing resource consumption and ensuring responsible development. Science and technology must therefore tell us not only how far we can go but also where we must stop. Our future depends on preserving the natural capital that sustains development.

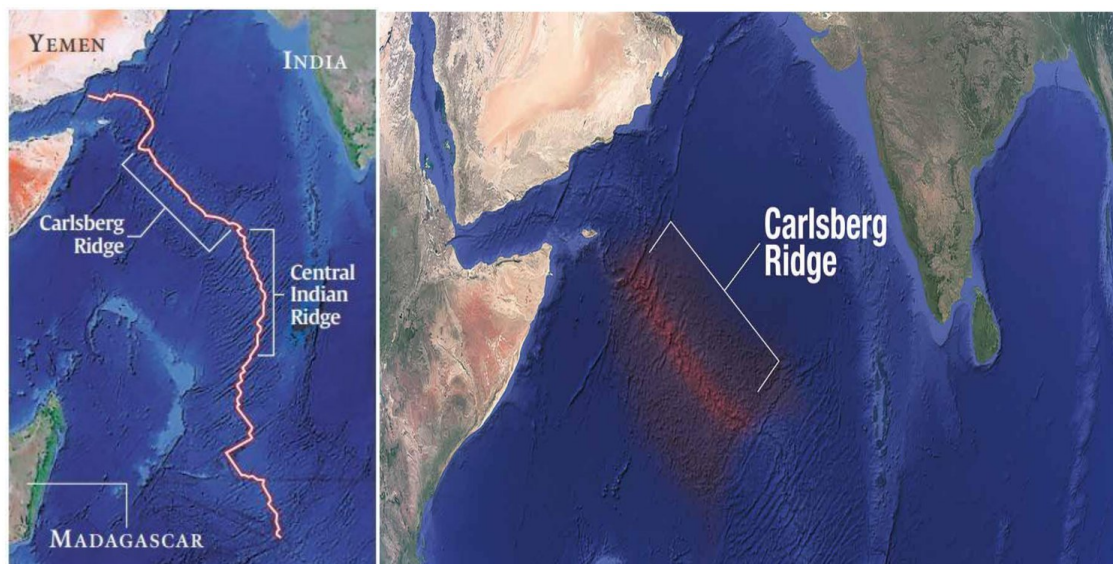
The debate: should everything technologically exploitable on the seabed necessarily be exploited?

Key Facts & Data

- ◆ India holds three ISA exploration contracts covering ~95,000 sq km across the Central Indian Ocean Basin, Central Indian Ridge and Carlsberg Ridge in the international seabed area.
- ◆ Exploration has identified ~366 million tonnes of polymetallic nodules containing nickel, copper, cobalt and manganese.
- ◆ Under the Deep Ocean Mission, India is developing the MATSYA-6000 human submersible (Samudrayaan) and deep-sea mining tech; NIOT tested a mining machine at ~5,270 m depth.
- ◆ Biodiversity surveys across 19 seamounts studied ~1,300 deep-sea organisms, ~23 reported as new to science.

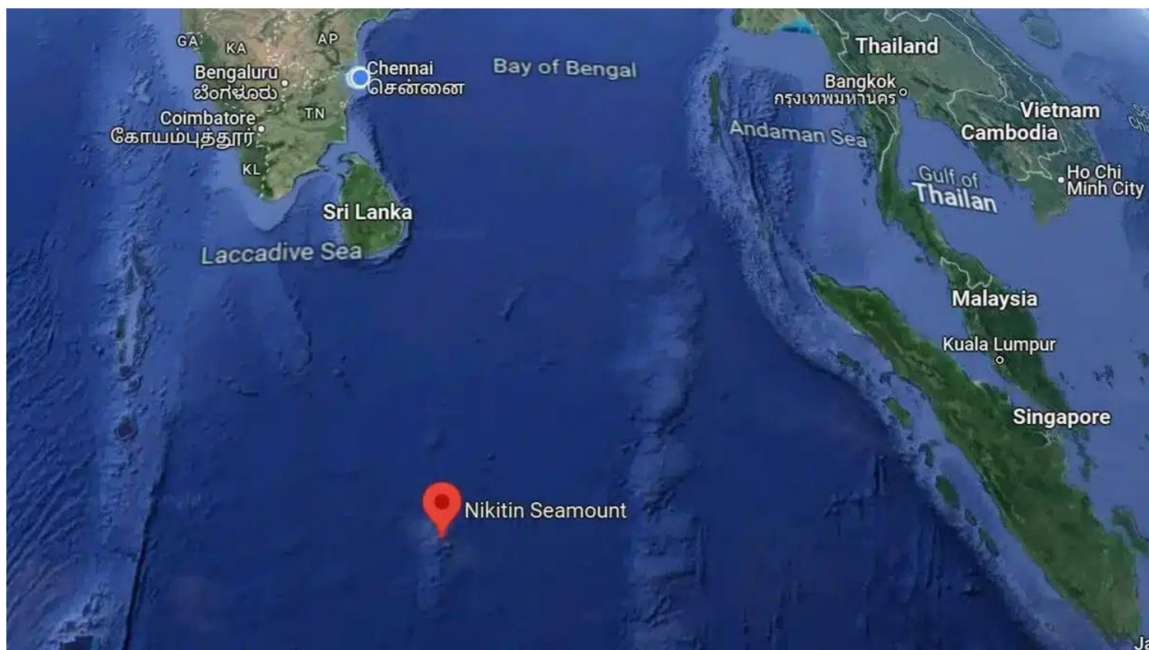
ISA and the 'Area'

The International Seabed Authority (ISA) is an autonomous body established under UNCLOS 1982 and the 1994 Part-XI Agreement, headquartered in Kingston, Jamaica, with 168 member states plus the EU. It governs the 'Area' – the seabed beyond national jurisdiction, ~54% of the world's oceans – declared the 'common heritage of mankind'. ISA both regulates exploration/exploitation of deep-sea minerals and is mandated to protect the marine environment. Polymetallic nodules are potato-sized mineral concretions rich in the critical minerals needed for batteries, EVs and renewables – which is exactly why the pressure to mine is rising.



The core argument — science must also teach us to say 'no'

- ▶ Strategic ≠ permissible: before extraction, India should ask whether the minerals are genuinely necessary at scale, whether alternatives exist, and whether demand can be cut via recycling, efficiency, substitution and a circular economy (echoing Mission LiFE).
- ▶ The deep sea is a complex, poorly understood and potentially irreversible ecosystem; adaptive management alone cannot guarantee ecological protection, so a stronger precautionary principle should precede mining.
- ▶ India could lead a different model — recognising the deep ocean as a precious ecological asset whose value may exceed its mineral wealth, and championing deep-sea ecological governance rather than a race to extract.



Nikitin Seamount in the Central Indian Ocean, south of the Bay of Bengal.

PRELIMS POINTERS

- ISA: under UNCLOS 1982 + 1994 Agreement; HQ Kingston, Jamaica; 168 members + EU; governs 'the Area' (~54% of oceans).
- 'Common heritage of mankind' principle applies to the Area's resources.
- Deep Ocean Mission (2021, MoES); MATSYA-6000 = crewed submersible under Samudrayaan; NIOT is the nodal tech body.
- Polymetallic nodules: Ni, Cu, Co, Mn — critical minerals for batteries/EVs.
- Sites in news: Carlsberg Ridge, Central Indian Ridge, Central Indian Ocean Basin, Nikitin Seamount.

WAY FORWARD

Adopt a precautionary, science-first stance: exploration and biodiversity baselining need not commit India to commercial mining; press for robust ISA exploitation rules, invest in mineral recycling and substitution, and position India as a leader in deep-sea ecological governance — proving that the maturity to say 'we do not need to go there' can itself be a scientific achievement.

STATIC ↔ CURRENT LINKAGES

- ◆ **Energy & IR** Oil-import data ↔ Strategic autonomy, CAATSA, \$60 price cap, ISPR/SPR, OPEC+, energy transition (GS2/GS3).
- ◆ **Biodiversity** Project Cheetah ↔ Wild Life (Protection) Act 1972, NTCA, IUCN Red List, grassland ecosystems, in-situ conservation (GS3).
- ◆ **Welfare & Skilling** PM Vishwakarma ↔ Central Sector vs Centrally Sponsored schemes, informal sector, MSME, Udyam, ODOP/GI tags (GS2).
- ◆ **Sci-Tech** SEMICON/ISM & innovation ↔ Global value chains, IPR/PCT, Standard Essential Patents, Anusandhan NRF, iCET (GS3).
- ◆ **Ocean Governance** Deep Ocean Mission ↔ UNCLOS 1982, ISA & 'the Area', common heritage of mankind, critical minerals, Mission LiFE (GS2/GS3).

SECTION II

Practice Zone

Answer-writing & Prelims drill – built from today's topics

Mains / Answer Writing

Q1.

India's crude oil sourcing repeatedly contracts under U.S. sanctions and tariff pressure and rebounds once that pressure eases. In this light, critically examine the claim that India's energy policy is guided by 'strategic autonomy'. Suggest a durable path to insulate energy security from external coercion. (250 words)

अमेरिकी प्रतिबंधों एवं टैरिफ दबाव के अंतर्गत भारत का कच्चे तेल का स्रोत बार-बार सिकुड़ता है और दबाव घटते ही पुनः बढ़ जाता है। इस संदर्भ में इस दावे का समालोचनात्मक परीक्षण कीजिए कि भारत की ऊर्जा नीति 'सामरिक स्वायत्तता' से संचालित है। ऊर्जा सुरक्षा को बाह्य दबाव से बचाने का एक स्थायी मार्ग सुझाइए। (250 शब्द)

APPROACH — Intro: India's ~85% import dependence makes source-mix a strategic variable. Body: (a) Evidence of adjustment — Russia 40%→19.3%→51%, Iran/Venezuela to nil under sanctions; (b) the autonomy case — diversified sourcing, discounted Urals, keeping global prices stable; (c) the limits — secondary sanctions, CAATSA, dollar/financial-system exposure, buyer-side tariffs (2026 Bill). Way forward: SPR expansion, supplier diversification, and the structural fix — energy transition to cut demand. Conclude: autonomy is real but bounded; lower dependence, not a better supplier, is the durable answer.

Q2.

"Technological ability to exploit a resource does not create an ethical obligation to exploit it." Discuss this proposition with reference to India's Deep Ocean Mission and the governance of deep-sea mineral resources. (250 words)

"किसी संसाधन के दोहन की तकनीकी क्षमता, उसके दोहन का नैतिक दायित्व उत्पन्न नहीं करती।" भारत के गहन महासागर मिशन एवं गहन-समुद्री खनिज संसाधनों के अभिशासन के संदर्भ में इस कथन की विवेचना कीजिए। (250 शब्द)

APPROACH — Intro: India holds 3 ISA contracts (~95,000 sq km); 366 MT of polymetallic nodules identified. Body: (a) the strategic case for mining — critical minerals (Ni, Cu, Co, Mn) for EVs/renewables; (b) the ecological case for restraint — irreversible, poorly understood ecosystems, precautionary principle, ISA's dual mandate, common heritage of mankind; (c) alternatives — recycling, substitution, circular economy, Mission LiFE. Way forward: exploration ≠ commitment to exploit; India as a leader in deep-sea ecological governance. Conclude: science must also teach us where to stop.

Prelims / 10 MCQs

1. With reference to the International Seabed Authority (ISA), consider the following statements:

1. It was established under the UN Convention on the Law of the Sea and the 1994 Part-XI Agreement.

2. It is headquartered in Geneva, Switzerland.

3. It governs the seabed and ocean floor beyond the limits of national jurisdiction, known as 'the Area'.

How many of the statements are correct?

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

2. Consider the following pairs of minerals found in polymetallic nodules:

1. Nickel

2. Cobalt

3. Manganese

4. Lithium

Which of the above are principal metals associated with the polymetallic nodules of the Central Indian Ocean Basin?

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

3. 'MATSYA-6000', seen in the news, is associated with which of the following?

- (a) An indigenous anti-submarine torpedo (b) A crewed deep-sea submersible under the Deep Ocean Mission (c) A satellite for ocean-colour monitoring (d) A desalination plant technology

4. With reference to Project Cheetah, consider the following statements:

1. The cheetah was declared extinct in India in 1952.

2. The cheetahs reintroduced belong to the Asiatic sub-species.

3. The National Tiger Conservation Authority is the implementing agency.

Which of the statements are correct?

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

5. The primary designated habitats for translocated cheetahs in India are located in which State?

- (a) Rajasthan (b) Madhya Pradesh (c) Gujarat (d) Maharashtra

6. With reference to the PM Vishwakarma scheme, consider the following statements:

1. It is a Centrally Sponsored Scheme requiring cost-sharing by States.

2. The Ministry of Micro, Small and Medium Enterprises is the nodal ministry.

3. It provides collateral-free credit up to ₹3 lakh at a concessional interest rate.

Which of the statements are correct?

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

7. 'Silicon to Systems: Building the Ecosystem' was the theme of which of the following events held in 2026?

- (a) India Mobile Congress (b) SEMICON India (c) Startup Mahakumbh (d) World Economic Forum India Summit

8. The India Semiconductor Mission (ISM) functions under which ministry/department?

- (a) Ministry of Heavy Industries (b) Ministry of Electronics and Information Technology (c) Department of Science and Technology (d) Ministry of Commerce and Industry

9. With reference to India's innovation indicators, consider the following statements:

1. India's gross expenditure on R&D is roughly 2.4% of GDP.

2. Domestic applicants account for about seven in ten patent filings in India.

3. Jio Platforms entered the global top 20 PCT patent filers in WIPO's 2025 rankings.

Which of the statements are correct?

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

10. Consider the following statements regarding CAATSA:

1. It is a law of the United States enabling sanctions on entities transacting with certain adversary nations.

2. Russia is among the countries covered under it.

Which of the statements is/are correct?

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

ANSWER KEY & RATIONALE

1. (b) — ISA is under UNCLOS 1982 + 1994 Agreement (1 correct) and governs 'the Area' beyond national jurisdiction (3 correct). It is headquartered in Kingston, Jamaica, not Geneva (2 wrong). Hence two are correct.
2. (a) — Polymetallic (manganese) nodules chiefly contain nickel, copper, cobalt and manganese. Lithium is not a principal constituent. Hence 1, 2 and 3.
3. (b) — MATSYA-6000 is the crewed deep-sea submersible being developed under the Samudrayaan project of the Deep Ocean Mission, designed to carry humans to ~6,000 m depth.
4. (b) — Cheetah extinct in India by 1952 (1 correct); NTCA is the implementing agency with WII (3 correct). The reintroduced animals are African cheetahs (*A. jubatus*), not the Asiatic sub-species (2 wrong).
5. (b) — Kuno National Park and Gandhi Sagar Wildlife Sanctuary — both in Madhya Pradesh — are the primary habitats; Nauradehi WLS (also MP) is earmarked for expansion.
6. (b) — PM Vishwakarma is a Central Sector Scheme (100% Union-funded), not Centrally Sponsored (1 wrong). MSME is the nodal ministry (2 correct); it offers collateral-free credit up to ₹3 lakh at 5% (3 correct).
7. (b) — It was the theme of the 5th SEMICON India 2026, held at Yashobhoomi, New Delhi, organised by the India Semiconductor Mission, MeitY and SEMI.
8. (b) — ISM operates under the Ministry of Electronics and Information Technology (MeitY), offering fiscal support for fabs, ATMP/OSAT units and chip design (DLI).
9. (b) — India's R&D spend is just under 1% of GDP, not 2.4% (that is roughly China's) — 1 wrong. Domestic applicants are ~70% of filings (2 correct); Jio Platforms broke into the top 20 PCT filers, ranking 19th (3 correct).
10. (c) — CAATSA (Countering America's Adversaries Through Sanctions Act, 2017) is a U.S. law that empowers secondary sanctions on entities dealing with Russia, Iran and North Korea — both statements are correct.

QUICK REVISION RECAP

- ▶ Russia's share in India's oil imports: ~40% → 19.3% (Feb 2026, 50% U.S. tariff) → 51% (July 2026, after SC struck tariffs). Iran & Venezuela: fell to nil under sanctions.
- ▶ Project Cheetah — world's first intercontinental wild-carnivore translocation (Sept 2022); cheetah extinct in India 1952; population now 56; NTCA + WII; Kuno & Gandhi Sagar (MP).
- ▶ African cheetah — Vulnerable; Asiatic cheetah (*A. j. venaticus*) — Critically Endangered, survives only in Iran.
- ▶ PM Vishwakarma — Central Sector Scheme, 17 Sept 2023, ₹13,000 cr, MSME nodal; 18 trades; ₹3 lakh credit @5%; ₹15,000 toolkit; ₹500/day stipend.
- ▶ SEMICON India 2026 — 'Silicon to Systems'; ISM (MeitY) + SEMI; Yashobhoomi, New Delhi; ISM outlay ₹76,000 cr.
- ▶ Innovation — patent filings up 30.2% (1.43 lakh, 2025-26); R&D <1% of GDP; Jio Platforms 19th in WIPO PCT 2025; GaN, CAR-T, Bharat 6G Alliance.
- ▶ Deep Ocean Mission — ISA (Kingston; 168+EU; governs 'the Area', ~54% of oceans); 3 India contracts, ~95,000 sq km; 366 MT polymetallic nodules; MATSYA-6000.

PRELIMS TRAP-SETTERS

- ⚠ ISA HQ is Kingston, Jamaica — NOT Geneva or New York. The 'Area' ≈ 54% of the world's oceans.
- ⚠ PM Vishwakarma is a CENTRAL SECTOR scheme (100% Union-funded) — do not confuse with Centrally Sponsored.
- ⚠ Reintroduced cheetahs are AFRICAN (*A. jubatus*), not Asiatic. Extinction year 1952; project began 2022.
- ⚠ India's R&D spend is <1% of GDP (China ~2.4%, U.S. ~3.5%) — a common swap-trap in statement MCQs.
- ⚠ NDB HQ is Shanghai; ISM is under MeitY (not DST); DOM is under Ministry of Earth Sciences (MoES).
- ⚠ Polymetallic nodules contain Ni, Cu, Co, Mn — NOT lithium.

Persons & Places in News

PERSONS

Bhupender Yadav — Union Minister for Environment, Forest & Climate Change — announced the new Kuno cheetah litter.

Uttam Kumar Sharma — Kuno Field Director & Project Cheetah Director.

Jyotiraditya Scindia — Union Minister for Communications — linked to Bharat 6G Alliance's patent target.

P. Ragavan — Marine biologist; author of the deep-sea governance article.

PLACES

Kuno National Park — Madhya Pradesh — primary cheetah reintroduction site; population now 56.

Gandhi Sagar WLS / Nauradehi WLS — Madhya Pradesh — cheetah habitat (current / future expansion).

Carlsberg Ridge & Central Indian Ridge — Mid-ocean ridges in India's ISA exploration area.

Nikitin Seamount — Undersea mountain in the Central Indian Ocean, south of the Bay of Bengal.

Yashobhoomi (IICC) — Dwarka, New Delhi — venue of SEMICON India 2026.

— End of Analysis · The Hindu, Saturday, 19 September 2026 · Compiled by Sapna Chauhan for Vedanta Coaching Academy & Library —