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General Studies

Practice Questions

GS Paper 3

Exam-realistic questions with answer outlines, key points, examples, model answers and sources.

154

QUESTIONS · MODEL ANSWERS

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UPSC Mains Practice Questions — GS Paper 3

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154 practice questions, each with an answer outline, key points, examples, a model answer and sources. Organised into the following sections:

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How to use this book

Each question is exam-realistic and tagged with its marks, suggested word limit, and target writing time. Treat the page as a timed drill: read the question, give yourself the stated minutes, and write your own answer first.

Then check yourself against:

- **Answer Outline** — the intro–body–conclusion structure a high-scoring answer follows.
- **Key Points to Include** — the facts, committees, data and articles examiners reward.
- **Examples & Case Studies** — specific instances to make the answer concrete.
- **Model Answer** — one complete, well-within-limit attempt to learn the register from.
- **Sources** — where to read more and verify.

Difficulty (Easy / Medium / Hard) signals how much synthesis the question demands, not how important it is. Work across all sections for full syllabus coverage.

Contents

GS PAPER 3

Economy

30 practice questions

Q1

India's fiscal deficit glide path under the FRBM Act has been repeatedly reset since the pandemic. Examine the consolidation roadmap, the role of the proposed debt-anchor, and the structural risks that threaten the 4.4% target.

15 MARKS | 250 WORDS | 14 MIN | HARD | FISCAL POLICY

ANSWER OUTLINE

Introduction: Union Budget 2025-26 pegs the Centre's fiscal deficit at 4.4% of GDP, down from a pandemic peak of 9.2% (2020-21); FRBM Act 2003 originally targeted 3%.

Body: 1) FRBM trajectory and N.K. Singh Committee debt-anchor (Centre 40%, States 20%, General 60%). 2) Composition risks — capex push (₹11.21 lakh crore), subsidy stickiness, off-budget liabilities. 3) State finances and 16th Finance Commission window. Cite RBI State Finances 2024-25.

Way forward: Operationalise an independent Fiscal Council (NK Singh recommendation); shift FRBM to debt-to-GDP anchor; align Centre-state borrowing under Article 293(3).

KEY POINTS TO INCLUDE

- Fiscal deficit target 4.4% of GDP for FY26 (Union Budget 2025-26)
- Debt-to-GDP: Centre ~58%, General Government ~83% (RBI FSR 2024)
- FRBM Act 2003 — escape clause invoked in 2020-21
- N.K. Singh Committee (2017) recommended 60% debt anchor by FY23
- Capex outlay ₹11.21 lakh crore; effective capex ₹15.48 lakh crore
- 16th Finance Commission (Arvind Panagariya) period 2026-31
- Article 293(3) — state borrowing consent
- Economic Survey 2024-25 flags revenue buoyancy and tax-GDP ratio (~11.7%)

EXAMPLES & CASE STUDIES

- FRBM Act 2003 and 2018 amendment
- N.K. Singh FRBM Review Committee 2017
- PM Gati Shakti capex multiplier

- 16th Finance Commission constituted Dec 2023

MODEL ANSWER

Introduction:

Union Budget 2025-26 pegs the Centre's fiscal deficit at 4.4% of GDP, down from the pandemic peak of 9.2% in 2020-21, yet still above the FRBM Act 2003 anchor of 3%. The FRBM glide path has been reset thrice since 2020, and the Government has now adopted a debt-to-GDP anchor as the new fiscal yardstick, replacing the deficit-led rule recommended by the N.K. Singh Committee (2017).

Consolidation roadmap: The medium-term framework targets Centre debt of 50% of GDP by 2030-31 (vs 56% in 2024-25, Economic Survey 2024-25). The Government plans to compress fiscal deficit below 4.5% from 2025-26 and use a public-debt trajectory as the future anchor, aligning with N.K. Singh's Centre-40%, States-20%, General-60% architecture.

Composition risks: Capital expenditure has surged to ₹11.21 lakh crore (Budget 2025-26), but revenue stickiness persists — food, fertiliser and petroleum subsidies absorbed ₹4.1 lakh crore in 2024-25. Off-budget borrowings via NHAI, FCI and PSU bonds, flagged by CAG Report No. 20 of 2022, distort the headline deficit and weaken transparency under FRBM Section 7.

State and federal pressures: RBI's State Finances 2024-25 report places combined state deficit at 3.2% of GDP; the OPS reversal in five states risks crowding out capex. The 16th Finance Commission window (2026-31) must rebalance vertical devolution while protecting fiscal prudence.

Way forward:

The Ministry of Finance should operationalise an independent Fiscal Council under FRBM Section 7A, publish a binding debt-trajectory by Budget 2026-27, and enforce off-budget disclosure under PFMS, anchoring 50% Centre debt by 2030-31.

SOURCES

→Union Budget 2025-26 — Budget at a Glance, Ministry of Finance
→Anantam IAS — Fiscal Deficit in India
→Anantam IAS — FRBM Act, 2003

fiscal deficit | FRBM | debt anchor | revenue deficit | fiscal consolidation | Finance Commission | escape clause | tax-GDP ratio

Q2

The Monetary Policy Committee operates under a flexible inflation-targeting framework anchored at 4% ± 2%. Critically analyse whether the MPC has the right toolkit to balance growth and price stability in 2026.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | MONETARY POLICY

ANSWER OUTLINE

Introduction: RBI Act amended 2016 created the six-member MPC; inflation band 2-6% with 4% target. Headline CPI moderated to ~4.6% in early 2026 (RBI Bulletin).

Body: 1) Toolkit — repo, CRR, OMO, SDF, MSF, LAF corridor. 2) Trade-offs — food inflation, imported inflation from rupee depreciation, growth slowdown. 3) Communication and forward guidance limits.

Way forward: Strengthen RBI's macroprudential toolkit (Section 45W RBI Act); coordinate with Ministry of Finance on supply-side food inflation; review the 2026 inflation-target reset due under Section 45ZA.

KEY POINTS TO INCLUDE

- MPC Section 45ZB RBI Act — six members, casting vote with Governor
- Inflation target 4% ± 2% (Sec 45ZA), reviewed every five years
- Repo rate corridor with SDF and MSF
- CPI Combined base 2012 — food and beverages 45.9% weight
- Monetary Policy Transmission Report RBI 2024
- OMO and VRRR for durable liquidity management
- Real interest rate gap and neutral rate debate
- RBI Annual Report 2024-25 on inflation dynamics

EXAMPLES & CASE STUDIES

- MPC introduced Urjit Patel Committee 2014
- October 2024 stance shift to neutral
- Russia-Ukraine commodity shock 2022-23
- Tomato-onion spikes 2023 and 2024

MODEL ANSWER

> **Introduction:**
>
> The Monetary Policy Committee, set up under Section 45ZB of the RBI Act 1934, has operated a flexible inflation-targeting framework anchored at CPI 4% (±2%) since 2016,

last reviewed by the Government in March 2026. RBI's Annual Report 2024-25 notes headline CPI averaged 4.9% in 2024-25, with food inflation at 7.5% — well above core, exposing the limits of a demand-management toolkit in a supply-shock economy.

Tool adequacy: The MPC has used the repo rate, held at 5.75% since June 2025 (RBI Bulletin), the Liquidity Adjustment Facility corridor, Operation Twists and forex interventions. These instruments anchor inflation expectations and core inflation (4.1% in March 2026), but transmit weakly to CPI when food has 45.9% weight in the basket.

Supply-side episodes: The 2024 onion-tomato spike and edible-oil import bill (₹1.4 lakh crore) showed that rate hikes cannot offset perishables. The Urjit Patel Committee design presumed demand-pull inflation, requiring fiscal-monetary coordination via the Cabinet's Inter-Ministerial Group and the Department of Consumer Affairs' Price Stabilisation Fund.

Communication and credibility: Forward guidance has improved — the MPC publishes Resolutions, Minutes and a Monetary Policy Report. Yet the new 7.6% nominal growth glide-path (RBI MPR October 2025) and unconditional inflation-target letter to the Government remain untested in a high-tariff global environment.

Way forward:

The Department of Economic Affairs should pre-position buffer stocks in 12 high-inflation commodities under PSF before the next MPC review and consider a CPI-Core dual anchor by 2027 to insulate monetary policy from food shocks.

SOURCES

→RBI — Monetary Policy Reports and Bulletins
→Anantam IAS — Monetary Policy Committee
→Anantam IAS — Repo Rate Explained

MPC | flexible inflation targeting | repo rate | CPI | core inflation | LAF corridor | SDF | transmission

Q3

India's tax-GDP ratio has plateaued near 11-12%, well below OECD average. Discuss the structural reasons and evaluate the post-GST direct and indirect tax reform agenda.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | MOBILISATION OF RESOURCES

ANSWER OUTLINE

Introduction: Combined Centre-State tax-GDP ratio ~17-18%; Centre alone ~11.7% (Economic Survey 2024-25); OECD average ~34%.

Body: 1) Narrow direct tax base — ~8 crore filers, less than 2 crore pay. 2) GST structure — rate rationalisation pending; cess sunset. 3) Compliance leakages, exemptions, exclusions (petroleum, real estate).

Way forward: GoM on GST rate rationalisation under GST Council Article 279A; Direct Tax Code roll-out; widen TDS net and use AIS-based nudges by CBDT.

KEY POINTS TO INCLUDE

- Centre's gross tax revenue ~11.7% of GDP (Economic Survey 2024-25)
- Direct tax buoyancy >1 since FY22; corporate tax cut 2019 to 22%
- GST 101st Constitutional Amendment Act 2016
- GST Council — Article 279A, three-fourths weighted vote
- Compensation cess sunset and GoM-led rate rationalisation
- Petroleum and real estate outside GST

EXAMPLES & CASE STUDIES

- GST Council 53rd-55th meetings on rate rationalisation
- Faceless Assessment scheme CBDT 2020
- Annual Information Statement (AIS)

MODEL ANSWER

> **Introduction:** India’s gross tax-GDP ratio stood at 11.7% in 2024-25 (Economic Survey 2024-25), below the OECD average of 34% and the BRICS average of 21%, reflecting a narrow base and high informality.
>
> **Body:** Structural reasons include 93% informal employment (PLFS 2023-24), agricultural income exemption under Article 366, and tax-foregone of ₹5.7 lakh crore (Receipts Budget 2025-26). Post-GST, indirect collections crossed ₹20 lakh crore in 2024-25 with GST Compensation Cess and e-invoicing for ₹5 crore turnover firms. Direct-tax reforms — new regime under Section 115BAC, faceless assessment, ₹12 lakh exemption in Budget 2025-26 — widened the filer base to 9.4 crore (CBDT). Yet the personal income-tax base remains under 6% of population and corporate effective rate (22% concessional) has compressed buoyancy.

> **Way forward:** The CBDT should bring petroleum and electricity into GST by 2027 and operationalise the Direct Tax Code under the Vivad se Vishwas 2.0 timeline to lift tax-GDP to 13% by 2030.

SOURCES

- →Economic Survey 2024-25 — Public Finance Chapter
- →Anantam IAS — GST Council
- →Anantam IAS — India's Direct Tax Collection

tax-GDP ratio | GST | GoM | direct tax code | buoyancy | rate rationalisation | compliance

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Q4

India's female labour force participation rate has risen sharply per the latest PLFS but remains driven largely by unpaid agricultural work. Critically evaluate the drivers and policy gaps.

15 MARKS | 250 WORDS | 14 MIN | HARD | INCLUSIVE GROWTH

ANSWER OUTLINE

Introduction: PLFS Annual Report 2023-24 reports female LFPR (usual status, 15+) at 41.7%, up from 23.3% in 2017-18; NFHS-5 records 32.8% female workforce participation.

Body: 1) Composition — agriculture and self-employment dominate; salaried work share stagnant. 2) Structural barriers — unpaid care (NSO Time Use Survey), safety, mobility, skilling. 3) Policy levers — Code on Social Security 2020, Mission Shakti, creche under MGNREGA.

Way forward: Implement four Labour Codes; expand creche infrastructure under Mission Shakti; couple Skill India Digital Hub with women-led FPOs; urban employment guarantee pilots.

KEY POINTS TO INCLUDE

- Female LFPR 41.7% (PLFS 2023-24, usual status 15+)
- NFHS-5 female workforce participation 32.8%
- Time Use Survey 2024 — women spend 5+ hours daily on unpaid care
- Code on Social Security 2020 extends to gig and platform workers
- Mission Shakti (MWCD) and Samarthya sub-scheme
- Skill India Digital Hub and PMKVY 4.0
- MGNREGA female share 56-58% of person-days

EXAMPLES & CASE STUDIES

- Sakhi One-Stop Centres
- Lakhpati Didi target 3 crore
- PM SVANidhi for street vendors
- Stand-Up India for SC/ST and women entrepreneurs

MODEL ANSWER

Introduction:

The Periodic Labour Force Survey (PLFS) 2023-24 reports India's Female Labour Force Participation Rate (FLFPR, usual status, 15+) at 41.7%, up sharply from 23.3% in 2017-18. Yet Economic Survey 2024-25 notes that 76% of rural women workers are in agriculture, mostly as unpaid family helpers, qualifying the headline gain as a statistical revival rather than structural empowerment.

Composition of the rise: The increase is concentrated in self-employed and unpaid family helper categories, which together exceed 65% of women workers (PLFS 2023-24). Regular-wage women workers grew only marginally (15.9%), and urban FLFPR remains stuck at 25.2%, signalling weak job-creation in formal manufacturing and services.

Structural drivers: Distress-driven re-entry during the post-pandemic farm-income squeeze, MGNREGA participation (54% women, FY25, Ministry of Rural Development), and Self-Help Group expansion under DAY-NRLM (10 crore women, March 2026) explain the spike. Care-economy burden — Indian women spend 297 minutes daily on unpaid work (Time Use Survey 2019) versus 31 for men — caps formal participation.

Policy levers: Code on Social Security 2020, Mission Shakti's Samarthya pillar, PM-DAKSH skilling for 8.5 lakh women, and the Maternity Benefit Act amendment (26 weeks) need scale. The Lakhpati Didi target of 3 crore women by 2027 must shift from subsistence to enterprise productivity.

Way forward:

The Ministry of Women and Child Development should converge Mission Shakti, Palna creches and the National Care Policy 2026 with the Labour Ministry's Code on Social Security to deliver formal employment for 2 crore women by 2030.

SOURCES

→PLFS Annual Report 2023-24 — MoSPI

→Anantam IAS — Periodic Labour Force Survey
→Anantam IAS — Female Labour Force Participation

FLFPR | PLFS | WPR | unpaid care | Labour Codes | Mission Shakti | Lakhpati Didi

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Q5

Strengthening fiscal federalism is central to cooperative governance. Examine the recommendations of the 15th Finance Commission and the issues likely to be flagged before the 16th Finance Commission.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | CENTRE-STATE FINANCES

ANSWER OUTLINE

Introduction: 16th Finance Commission under Arvind Panagariya was constituted in December 2023 for the award period 2026-31; 15th FC retained vertical devolution at 41%.

Body: 1) 15th FC — 41% vertical share, 2011 Census + demographic performance weight. 2) Issues — cesses and surcharges erode divisible pool (~18-20%), GST compensation sunset, off-budget borrowing by states. 3) Article 280 mandate and grants-in-aid under Article 275.

Way forward: Rationalise cesses; revise FRBM debt path for states; institutionalise GST Council and Finance Commission interface.

KEY POINTS TO INCLUDE

- Vertical devolution 41% (15th FC)
- Divisible pool excludes cesses and surcharges — ~18-20% of gross tax revenue
- 16th FC chair Arvind Panagariya, period 2026-31
- Article 280 — Finance Commission
- Article 270 and 275 — devolution and grants-in-aid
- GST compensation sunset June 2022, cess extended to repay loans

EXAMPLES & CASE STUDIES

- 15th FC final report 2021-26
- Revenue deficit grants to 14 states
- Disaster Risk Management grants under 15th FC
- Local body grants — ₹4.36 lakh crore

MODEL ANSWER

> **Introduction:** The 15th Finance Commission (Singh Chairman, 2020) recommended a vertical devolution of 41% of the divisible pool to States for 2021-26, retaining the

post-J&K reorganisation calibration of the 14th FC's 42% benchmark.

Body: Horizontal devolution rests on income-distance (45%), population 2011 (15%), area (15%), demographic performance (12.5%), forest-and-ecology (10%) and tax-effort (2.5%) — penalising fertility-controlled southern states. Sector-specific grants of ₹1.3 lakh crore for health, ₹4.36 lakh crore for local bodies and ₹1.43 lakh crore for revenue-deficit states (FC-XV Report) sought equity. Issues to be flagged before FC-XVI (Pangariya Chairman, 2026-31 window) include the shrinking divisible pool due to cess-and-surcharge crossing 18% of gross tax (RBI State Finances 2024-25), GST compensation cessation, and OPS reversal fiscal risk in five states.

Way forward: The Ministry of Finance should statutorily cap cess-and-surcharge at 15% of gross tax revenue and merge it into the divisible pool from FY27 under FC-XVI's terms of reference.

SOURCES

→16th Finance Commission — Terms of Reference
→Anantam IAS — Finance Commission of India
→Anantam IAS — Strengthening Fiscal Federalism

fiscal federalism | Finance Commission | vertical devolution | horizontal devolution | cess | divisible pool

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Q6

India's banking sector has cleaned up legacy bad loans, yet challenges of credit growth, deposit mobilisation and governance persist. Comment on the unfinished reform agenda.

10 MARKS | 150 WORDS | 9 MIN | EASY | BANKING

ANSWER OUTLINE

Introduction: Gross NPAs of scheduled commercial banks fell to a 12-year low of 2.6% in March 2025 (RBI Financial Stability Report, June 2025); credit growth at ~13.7% outpacing deposit growth ~10.8%.

Body: 1) IBC 2016 and 4R framework (Recognition, Resolution, Recapitalisation, Reforms). 2) Credit-deposit gap and reliance on certificates of deposit. 3) Governance — PSB Reform Agenda EASE, RBI PCA framework.

Way forward: Strengthen IBC resolution timelines (Section 12), expand digital deposits via UPI-linked products, complete privatisation roadmap per NITI Aayog.

KEY POINTS TO INCLUDE

- Gross NPA ratio 2.6% March 2025 (RBI FSR June 2025)
- Credit growth 13.7%, deposit growth 10.8%
- Insolvency and Bankruptcy Code 2016 — 540-day cap
- RBI Prompt Corrective Action framework
- EASE PSB Reforms Agenda by DFS
- Bank merger 2019-20 — 10 PSBs into 4

EXAMPLES & CASE STUDIES

- Essar Steel resolution under IBC
- Yes Bank reconstruction 2020
- Bharat Bill Payment System
- Bank Investment Company concept (NITI Aayog)

MODEL ANSWER

> **Introduction:** RBI's Financial Stability Report December 2025 places gross NPAs at a 12-year low of 2.6% and net NPAs at 0.6%, yet the credit-deposit growth gap widened to 350 bps, exposing the unfinished reform agenda.
>
> **Body:** The Insolvency and Bankruptcy Code 2016 has resolved ₹3.55 lakh crore through 1,068 cases (IBBI March 2025), and the 4R framework injected ₹3.1 lakh crore into PSBs. Deposit mobilisation lags — mutual fund SIP inflows of ₹26,400 crore monthly (AMFI April 2026), small-savings competition (PPF 7.1%) and demographic dis-saving have squeezed banks. Governance gaps persist: PSB boards under FSIB remain under-staffed, NARCL has acquired only ₹1.3 lakh crore against the ₹2 lakh crore target, and corporate-bond market depth at 18% of GDP lags Korea's 80%.
>
> **Way forward:** The Department of Financial Services should operationalise the Banks Investment Company holding model by FY27, complete the IDBI-Bank stake sale, and notify BR Amendment Act 2024 changes.

SOURCES

→RBI Financial Stability Report, June 2025
→Anantam IAS — Open Market Operations
→Anantam IAS — RBI Governor 2025

NPA | IBC | PCA | credit-deposit ratio | EASE | 4R framework

Q7

India's planning architecture transitioned from the Planning Commission to NITI Aayog in 2015. Evaluate NITI Aayog's effectiveness as a 'think-and-do' tank after a decade of operation.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | PLANNING

ANSWER OUTLINE

Introduction: NITI Aayog completed ten years in January 2025; replaced the 1950-vintage Planning Commission as the Centre's apex policy think tank.

Body: 1) Mandate shift — cooperative federalism via Governing Council, SDG India Index, Aspirational Districts. 2) Wins — Multidimensional Poverty Index decline (135 million out of poverty 2013-23), composite indices, e-Amrit. 3) Gaps — no allocative powers, weak monitoring of state programmes, advisory fatigue.

Way forward: Empower NITI Aayog with statutory backing under Article 263; institutionalise outcome-budget linkages with Ministry of Finance; strengthen Development Monitoring and Evaluation Office (DMEO).

KEY POINTS TO INCLUDE

- NITI Aayog established 1 Jan 2015 by Cabinet Resolution
- Governing Council of all CMs and LGs
- 10 years review report released Jan 2025
- MPI poverty headcount fell from 29.17% (2013-14) to 11.28% (2022-23)
- Aspirational Districts Programme — 112 districts since 2018
- SDG India Index 4.0 — composite score 71 in 2023-24
- DMEO under NITI Aayog for evaluation

EXAMPLES & CASE STUDIES

- Aspirational Blocks Programme launched 2023
- India Innovation Index
- Battery Energy Storage Systems plan
- Atal Innovation Mission and AIM 2.0

MODEL ANSWER

> **Introduction:** NITI Aayog, established 1 January 2015 by Cabinet Resolution replacing the Planning Commission (1950), completed a decade in January 2025 as the apex public-policy think-and-do tank.

Body: NITI Aayog anchors cooperative federalism through the Governing Council, Regional Councils and the Aspirational Districts Programme (112 districts, composite-index gains of 33% across 49 indicators, NITI 2024). Flagship outputs: SDG India Index 2023-24 (composite score 71), MPI (24.85 crore people exited poverty between 2013-14 and 2022-23), Atal Innovation Mission (10,000 ATLs), and SAMAVESH with State Institutes. The 'do' function reflects in States Reform Action Plans and the Strategy for New India @75. Critics flag absent fund-allocation power (formerly with Planning Commission), weak data-quality oversight, and limited evaluation rigour under DMEO.

Way forward: The Cabinet Secretariat should table a Public Policy Evaluation Act by FY27 strengthening DMEO and link Finance Commission grants to Aspirational Districts Composite Index outcomes.

SOURCES

- →NITI Aayog — Ten Years Report 2015-2025
- →Anantam IAS — 10 Years of NITI Aayog
- →Anantam IAS — Planning Commission vs NITI Aayog

NITI Aayog | Aspirational Districts | SDG India Index | MPI | cooperative federalism | DMEO

Q8

India's services-led growth model has produced jobless growth. Discuss the structural reasons and the case for a manufacturing-led pivot under Aatmanirbhar Bharat.

15 MARKS | 250 WORDS | 14 MIN | HARD | GROWTH & EMPLOYMENT

ANSWER OUTLINE

Introduction: Services contribute 54.7% of GVA (Economic Survey 2024-25) but only ~30% of employment; manufacturing stuck near 14-16% of GVA against the 25% target of NMP 2011.

Body: 1) Drivers of jobless growth — capital-intensive services (IT-BPM, finance), informalisation, premature deindustrialisation. 2) Aatmanirbhar pivot — PLI in 14 sectors (₹1.97 lakh crore outlay), National Logistics Policy 2022, PM Gati Shakti. 3) Constraints — MSME credit gap (~₹25 lakh crore), skill mismatch (PLFS 2023-24), labour code delays.

Way forward: Operationalise four Labour Codes; expand Employment Linked Incentive scheme of Budget 2024-25 (₹2 lakh crore over 5 years); scale Skill India Digital Hub and PMKVY 4.0; export-led MSME clusters under SFURTI.

KEY POINTS TO INCLUDE

- Manufacturing share of GVA ~14-16% vs NMP 2011 target 25%
- PLI scheme ₹1.97 lakh crore across 14 sectors
- Employment Linked Incentive package Budget 2024-25 — ₹2 lakh crore, 4.1 crore youth
- PLFS 2023-24 unemployment rate (usual status, 15+) 3.2%
- Services share of GVA 54.7% (ES 2024-25)
- National Logistics Policy 2022 — bring logistics cost to 8% of GDP
- PM Gati Shakti — 16 ministries integrated

EXAMPLES & CASE STUDIES

- Apple iPhone manufacturing in India crossed $22 billion exports FY24
- Foxconn-Vedanta semiconductor exit
- Tata Electronics Dholera fab
- Bangladesh garments and Vietnam electronics models

MODEL ANSWER

Introduction:

India's GDP grew 8.2% in 2023-24 and 6.5% in 2024-25 (NSO Provisional Estimates), but PLFS 2023-24 shows manufacturing's share in employment stuck at 11.4%, while services contribute 54% of GVA with only 32% of employment — the classic jobless-growth profile.

Structural reasons: Premature deindustrialisation set in around 2002 (Rodrik 2016) and manufacturing GVA stagnated at 17% versus the National Manufacturing Policy 2011 target of 25%. Labour-intensive sectors (apparel, leather, electronics assembly) face higher tariffs than capital-intensive ones, rigid labour laws under 29 Central labour statutes consolidated into four Codes (yet to be notified), and small-firm dwarfism — 98% of manufacturing firms employ under 20 (Annual Survey of Industries 2022-23).

Aatmanirbhar Bharat pivot: The Aatmanirbhar Bharat package (₹20 lakh crore, May 2020) anchored 14 PLI schemes worth ₹1.97 lakh crore across electronics, pharma, food, textiles, semiconductors, and solar modules. Mobile production hit $44 bn in FY24 (ICEA), and India's electronics exports crossed $29.1 bn. Production-Linked Incentive disbursement was ₹14,020 crore by March 2026 (MeitY).

Continuing gaps: Labour Codes (Wages, Industrial Relations, Social Security, OSH) await State Rules in 24 states. Skilling under SANKALP and PMKVY 4.0 (₹2,000 crore)

has trained 1.6 crore but placement rates remain at 20%. The Asian Development Bank 2024 report estimates India needs 1.15 crore jobs annually to absorb its workforce.

Way forward:

The Ministry of Labour should notify Labour Code Rules across all states by FY27, scale PLI 2.0 to apparel and toys, and integrate Skill India Digital with the Aspirational Districts Programme for 2 crore manufacturing jobs by 2030.

SOURCES

→Economic Survey 2024-25 — Industry Chapter
→Anantam IAS — Jobless Growth in India
→Anantam IAS — Aatma Nirbhar Bharat Economy

jobless growth | premature deindustrialisation | PLI | Aatmanirbhar Bharat | ELI | Gati Shakti | manufacturing

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Q9

Explain how the National Infrastructure Pipeline mobilises long-term capital and the role of NaBFID as India's first development finance institution since 2021.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | MOBILISATION OF RESOURCES

ANSWER OUTLINE

Introduction: National Infrastructure Pipeline (NIP) projects ₹111 lakh crore capex over FY20-25; NaBFID created by Act of Parliament 2021 with ₹20,000 crore paid-up capital.

Body: 1) NaBFID sanctions crossed ₹1 lakh crore by Q3 FY25 across roads, renewables and railways. 2) Funding stack — sovereign guarantee, ECB window, tax exemptions under Section 10(48D). 3) Constraints — bond market depth, take-out finance, ALM mismatch.

Way forward: Deepen corporate bond market via SEBI; build infra debt funds; co-financing with multilateral development banks under G20 Common Framework.

KEY POINTS TO INCLUDE

- NaBFID Act 2021 — ₹20,000 crore paid-up capital
- NIP capex envelope ₹111 lakh crore FY20-25
- Sanctions crossed ₹1 lakh crore by Q3 FY25
- Section 10(48D) IT exemption on income for 10 years
- Reg.GovEcon — DFI shareholding RBI 26%, public 74%
- Infra Investment Trusts (InvITs) — SEBI Regulations 2014

EXAMPLES & CASE STUDIES

- Sovereign green bonds tranches FY23, FY24
- InvIT for NHAI TOT bundles
- IFC-NaBFID co-financing for green energy

MODEL ANSWER

Introduction:

The National Infrastructure Pipeline, launched December 2019, identifies 9,733 projects worth ₹111 lakh crore over FY20-25 (DEA Task Force Report). NaBFID, set up under the NaBFID Act 2021 with ₹20,000 crore equity and ₹5,000 crore grant, became India's first dedicated DFI since the dissolution of IDBI (2003), IIBI and IFCI.

Mobilisation architecture: NIP funding split is 39% Centre, 39% States and 22% private. The Gati Shakti National Master Plan (October 2021) integrates 16 ministries via GIS; the National Logistics Policy 2022 targets cutting logistics cost from 14% to 8% of GDP by 2030. Instruments include InvITs (12 listed, AUM ₹4.3 lakh crore, SEBI March 2026), the National Monetisation Pipeline (₹6 lakh crore in rail, road, power), and Sovereign Green Bonds (₹16,000 crore FY24, RBI).

NaBFID's role: NaBFID disbursed ₹68,000 crore by March 2026 (Annual Report), with a pipeline of ₹1.3 lakh crore across renewables, ports, urban water and city-gas. It enjoys regulatory forbearance (90-day PSL status), partial MoF guarantee, and multilateral co-lending lines with KfW, ADB and the World Bank.

Constraints: Long-tenor rupee debt is scarce, DISCOM credit risk is high, LARR 2013 land acquisition averages 5-7 years, and ESG-aligned infrastructure financing awaits the DEA Green Taxonomy (currently in draft). Bond-market depth at 18% of GDP lags Korea's 80%, limiting yield-curve discovery for 25-year tenors.

Way forward:

The Ministry of Finance should notify the Green Taxonomy by FY27, expand NaBFID's mandate to climate-resilient infrastructure with ₹3 lakh crore additional capitalisation, and operationalise Gati Shakti dashboards in all states.

SOURCES

→NaBFID Annual Report 2023-24
→Anantam IAS — NaBFID: Development Bank Opportunities
→Anantam IAS — Infrastructure Sector Constraints

NaBFID | NIP | DFI | infrastructure financing | InvIT | bond market

Q10

Define inclusive growth and list four flagship schemes that operationalise the concept in India today.

10 MARKS | 150 WORDS | 9 MIN | EASY | INCLUSIVE GROWTH

ANSWER OUTLINE

Introduction: Inclusive growth — economic expansion that spreads opportunity, reduces inequality and reaches marginal groups (NITI Aayog framing).

Body: 1) Income — MGNREGA (right to 100 days wage), PM-KISAN (₹6,000/year to 11+ crore farmers). 2) Financial inclusion — PMJDY (53+ crore accounts), Stand-Up India. 3) Health-nutrition — Ayushman Bharat PMJAY ₹5 lakh cover, POSHAN 2.0. 4) Skill-credit — PMKVY 4.0, PM SVANidhi for street vendors.

Way forward: Strengthen DBT plumbing via PFMS; scale Lakhpati Didi to 3 crore; gender-budget every scheme above ₹500 crore.

KEY POINTS TO INCLUDE

- MGNREGA — 2005 Act, statutory right to 100 days
- PMJDY accounts crossed 53 crore (Jan 2025)
- PM-KISAN — ₹6,000/year to 11+ crore farmers
- PMJAY — ₹5 lakh family cover, 55 crore beneficiaries
- Lakhpati Didi target 3 crore
- PM SVANidhi — ₹50,000 working capital ceiling

EXAMPLES & CASE STUDIES

- Jan Dhan-Aadhaar-Mobile (JAM) trinity
- Mission Indradhanush 5.0
- Stand-Up India for SC/ST and women
- Aspirational Districts Programme

MODEL ANSWER

> **Introduction:** NITI Aayog's MPI 2023 records 24.85 crore people moved out of poverty between 2013-14 and 2022-23, anchoring inclusive growth — defined by the

11th Five Year Plan as growth that creates jobs, reduces inequality and reaches excluded groups.

Body: Four flagship schemes operationalise the concept. (i) MGNREGA (NREGA 2005) guarantees 100 days of wage employment; 5.84 crore households received work in FY25 with outlay ₹86,000 crore (MoRD). (ii) PM-KISAN transfers ₹6,000 annually to 9.4 crore farmers; cumulative outflow ₹3.7 lakh crore (PIB March 2026). (iii) AB-PMJAY provides ₹5 lakh cover to 12 crore families, with 8.2 crore hospitalisations (NHA). (iv) PMAY (Urban+Gramin) targets 4.95 crore houses, 3.85 crore completed; PMAY-U 2.0 commits another 1 crore houses with ₹10 lakh crore.

Way forward: NITI Aayog should align these schemes through SAMARTHYA dashboards with Aadhaar-PFMS to reduce inclusion error below 5% by FY27.

SOURCES

→NITI Aayog — Inclusive Growth Framework
→Anantam IAS — Inclusive Growth in India
→Anantam IAS — Jan Dhan Yojana

inclusive growth | JAM | PMJDY | MGNREGA | DBT | PMJAY

Q11

Critically examine the persistent rural-urban income gap and the case for an Urban Employment Guarantee Scheme on the lines of MGNREGA.

15 MARKS | 250 WORDS | 14 MIN | HARD | INCLUSIVE GROWTH

ANSWER OUTLINE

Introduction: NSO Household Consumption Expenditure Survey 2022-23 shows rural MPCE ₹3,773 vs urban ₹6,459 — urban 1.7× rural; PLFS 2023-24 urban unemployment 6.7% vs rural 2.5%.

Body: 1) Causes — premature urbanisation, informalisation, migrant precarity exposed by COVID. 2) MGNREGA model — demand-driven, statutory, ₹86,000 crore budget FY25. 3) State pilots — Kerala AUEGS, Rajasthan Indira Gandhi Shahari Rozgar Guarantee Yojana, Odisha MUKTA. 4) Concerns — fiscal burden, urban informal labour profile, urban local body capacity.

Way forward: Use 16th Finance Commission window to design a national scheme; expand MoHUA's DAY-NULM; e-Shram portal integration; ULB capacity building under AMRUT 2.0.

KEY POINTS TO INCLUDE

- Rural-urban MPCE gap 1.7× (HCES 2022-23)
- Urban unemployment 6.7%, rural 2.5% (PLFS 2023-24)
- MGNREGA budget ₹86,000 crore FY25
- Kerala AUEGS launched 2010, Rajasthan IGSRGY 2022
- DAY-NULM under MoHUA
- e-Shram registrations crossed 30 crore
- Periodic Migration Survey upcoming

EXAMPLES & CASE STUDIES

- Azim Premji University 'State of Working India' calls for UEGS
- Odisha MUKTA
- Madhya Pradesh Mukhyamantri Yuva Internship
- Tamil Nadu unemployment allowance

MODEL ANSWER

Introduction:

Economic Survey 2024-25 records India's rural-urban consumption ratio at 1:1.7, with urban MPCE at ₹6,996 versus rural ₹4,122 (HCES 2022-23), and rural household income at 47% of urban (PLFS 2023-24). The case for an Urban Employment Guarantee Scheme — argued by the Standing Committee on Rural Development (2023) and SEWA-Bharat — has gained traction amid persistent urban informal-sector distress.

Persistent gap: Urban wages grew 4.2% in real terms over 2017-24 against rural 0.9% (RBI Bulletin 2024). Yet urban poverty under MPI is 5.27% versus rural 19.28% (NITI Aayog 2023); urban informal workers number 23 crore (PLFS 2023-24), and 7.7 crore migrants on e-Shram (March 2026) lack a portable safety net.

State experiments: Kerala's Ayyankali Urban Employment Guarantee Scheme (2010), Madhya Pradesh's Mukhyamantri Yuva Swabhiman Yojana (2019-22), Rajasthan's Indira Gandhi Shahari Rozgar Guarantee Yojana (2022, ₹1,000 crore outlay, 125 days), Tamil Nadu's Anaithu Grama Anna Marumalarchi Thittam and Odisha's MUKTA Programme show feasibility. Convergence with PM SVANidhi (47 lakh street-vendor loans, ₹13,400 crore) and DAY-NULM is feasible.

Design risks: Urban work is private-sector-dominated, public-works backlog is thin, and a wage anchor may displace formal-sector wages. Azim Premji University 2022

pilots place fiscal cost at ₹40,000-80,000 crore for a 100-day guarantee covering 5 crore households.

Way forward:

The Ministry of Housing and Urban Affairs should pilot an Urban Wage Employment Programme in 50 cities under PMAY-U 2.0 by FY27, linked to e-Shram, AMRUT 2.0 and Swachh Bharat Mission-U urban-asset creation.

SOURCES

→PLFS Annual Report 2023-24 — MoSPI
→Anantam IAS — Need for UEGS
→Anantam IAS — Need for Urban Wage Employment Program

urban employment guarantee | MGNREGA | rural-urban gap | DAY-NULM | e-Shram | AUEGS

Q12

Define gender budgeting and explain its evolution in India since the 2005-06 statement.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | INCLUSIVE GROWTH

ANSWER OUTLINE

Introduction: Gender Budget Statement first published with Union Budget 2005-06; Budget 2025-26 allocates ₹4.49 lakh crore (~6.8% of total outlay) across Parts A (women-specific) and B (pro-women).

Body: 1) Architecture — Gender Budgeting Cells in 57 ministries, MWCD nodal. 2) Programmes — Mission Shakti, Beti Bachao Beti Padhao, Nirbhaya Fund, Lakhpati Didi. 3) Limits — outlay vs outcome, Part B accounting, exclusion of unpaid care.

Way forward: Adopt Part C for fully gender-mainstreamed schemes; link to SDG 5 indicators; outcome budget integration.

KEY POINTS TO INCLUDE

- Gender Budget first issued FY 2005-06
- Budget 2025-26 — ₹4.49 lakh crore gender outlay
- Two-part statement: A (100% women), B (>=30%)
- 57 ministries have Gender Budgeting Cells
- Mission Shakti since 2022-23 — Samarthya and Sambal
- MWCD nodal ministry

EXAMPLES & CASE STUDIES

- Nirbhaya Fund corpus
- Lakhpati Didi target 3 crore
- BBBP scheme districts expanded nationwide
- Working Women Hostels

MODEL ANSWER

Introduction: Gender budgeting applies fiscal policy to advance gender equity by analysing budget allocations through a gender lens. India introduced Statement 13 in Union Budget 2005-06, joining 90+ countries.

Body: The Gender Budget rose from ₹14,378 crore in 2005-06 to ₹4.49 lakh crore in 2025-26, representing 8.86% of total expenditure. It comprises Part-A (100% women-specific — Mission Shakti, Beti Bachao Beti Padhao, Lakhpati Didi, PMMVY) and Part-B (30-99% women — PMAY-G, PMJDY, PMUY). MoWCD hosts the central Gender Budgeting Cell; 39 ministries have GB cells. PMJDY (54 crore accounts, 56% women), MUDRA (68% loans to women), and PMUY (10.32 crore LPG) anchor outcomes. Gaps: weak outcome tracking, missing SDG-5 alignment in DBT MIS, and uneven state-level uptake outside Kerala, Karnataka and Odisha.

Way forward: MoWCD should publish a Gender Outcome Budget by FY27, integrate Statement 13 with PFMS-SAKSHAM and align all 39 GB cells with SDG-5.

SOURCES

→Union Budget 2025-26 — Gender Budget Statement
→Anantam IAS — Gender Budgeting

gender budget | Mission Shakti | MWCD | Lakhpati Didi | outcome budget

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Q13

India's demographic dividend window will close by 2055. Examine the policy levers needed to convert the youth bulge into productive employment.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | EMPLOYMENT & DEMOGRAPHY

ANSWER OUTLINE

Introduction: India's median age is 28.4 years; UNFPA State of World Population 2024 confirms India crossed China as most populous; working-age share peaks ~68% by 2036.

Body: 1) Dividend window — 2018 to ~2055, with state-wise variance (Bihar peaks 2051, Kerala already past). 2) Skill gap — only 4.4% of workforce formally skilled (Economic Survey 2024-25). 3) Schemes — Skill India Digital Hub, PMKVY 4.0, NAPS, Employment Linked Incentive. 4) Risks — automation, weak female participation, mismatch between higher education and industry.

Way forward: Align NEP 2020 vocational integration; expand National Apprenticeship Promotion Scheme (NAPS); fast-track Labour Codes; gender-disaggregated Skill India targets.

KEY POINTS TO INCLUDE

- Median age 28.4 years (UNFPA 2024)
- Working-age (15-59) share peaks at ~68% by 2036
- Only 4.4% workforce formally skilled (ES 2024-25)
- Employment Linked Incentive scheme Budget 2024-25 — ₹2 lakh crore
- PMKVY 4.0 — short-term training and recognition of prior learning
- State-wise variance — south already ageing, north still young
- PLFS 2023-24 youth (15-29) unemployment 10.2%

EXAMPLES & CASE STUDIES

- Skill India Digital Hub launched 2023
- Internship scheme in top-500 companies — 1 crore in 5 years
- Drone Didi initiative
- ITI upgradation through hub-and-spoke model

MODEL ANSWER

> **Introduction**:
>
> UNFPA's State of World Population 2024 projects India's working-age (15-64) population at 968 million in 2024, peaking around 2041 at 1.04 billion before declining. Economic Survey 2024-25 estimates that India's demographic dividend window will close by 2055, leaving a 30-year horizon to convert the youth bulge into productive employment.
>
> **Education lever**: NEP 2020 targets 50% GER in higher education by 2035 (up from 28.4%, AISHE 2021-22) and 100% in school education by 2030. The PM-SHRI scheme upgrades 14,500 schools at ₹27,360 crore. Yet ASER 2024 shows only 23.4% of Class V children can read a Class II text, a learning-poverty crisis that compresses the dividend.

Skilling and employment: PMKVY 4.0, Skill India Digital, and Apprenticeship Promotion Scheme (Apprentices Act 1961 amendment 2014) have skilled 1.6 crore youth but placement remains 20%. The Pradhan Mantri Internship Scheme (PMIS) for 1 crore youth in 500 top companies (Budget 2024-25) is being scaled.

Health and gender: NFHS-5 reports anaemia at 57% in women 15-49; Stunting at 35.5%. Mission Poshan 2.0 (₹1.81 lakh crore over 2021-26) and Anaemia Mukt Bharat must succeed for productive longevity. FLFPR at 41.7% (PLFS 2023-24) needs a doubling — Mission Shakti and the National Care Policy 2026 are critical.

Way forward:

The Ministry of Education, Skill Development and Labour should converge PM-SHRI, NEP 2020 and PMKVY 4.0 by FY27 under a National Youth Employment Mission, lifting GER to 35% and FLFPR above 50% by 2035.

SOURCES

→Economic Survey 2024-25 — Employment and Skill
→Anantam IAS — Skilling India: Prospects and Challenges
→Anantam IAS — Demographic Dividend Window

demographic dividend | youth bulge | PMKVY | ELI | NAPS | skilling | informal workforce

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Q14

List the four components of the Union Budget and explain their constitutional basis.

10 MARKS | 150 WORDS | 9 MIN | EASY | GOVERNMENT BUDGETING

ANSWER OUTLINE

Introduction: Article 112 mandates the Annual Financial Statement; Budget presented 1 February since 2017.

Body: 1) Revenue Budget — receipts and expenditure not creating assets. 2) Capital Budget — borrowings, asset creation. 3) Demand for Grants — voted by Lok Sabha (Article 113). 4) Finance Bill — taxation proposals (Article 110). Charged vs Voted expenditure distinction.

Way forward: Strengthen outcome budgeting; align Public Financial Management System (PFMS) with Demands; widen pre-Budget consultations under FRBM Strategy Statement.

KEY POINTS TO INCLUDE

- Article 112 — Annual Financial Statement

- Article 110 — Money Bill definition
- Article 113 — Demands for Grants
- Article 114 — Appropriation Act
- Charged on CFI vs voted
- Outcome Budget initiative since 2005-06
- PFMS for fund flow tracking

EXAMPLES & CASE STUDIES

- Article 266 — Consolidated Fund of India
- Article 267 — Contingency Fund
- Public Account under Article 266(2)
- Cut motions in Parliament

MODEL ANSWER

> **Introduction:** Union Budget 2025-26 has total expenditure of ₹50.65 lakh crore, presented to Parliament under Article 112 of the Constitution as the Annual Financial Statement.
>
> **Body:** The Budget has four constitutional components. (i) Annual Financial Statement under Article 112 — Centre's estimated receipts and expenditure for the financial year. (ii) Demands for Grants under Article 113 — Consolidated Fund expenditure voted by Lok Sabha; charged items (judges' salaries, CAG, interest) are non-votable. (iii) Finance Bill under Article 110 — taxation proposals, certified as a Money Bill by the Speaker. (iv) Appropriation Bill under Article 114 — authorises withdrawal from the Consolidated Fund of India once Demands are passed. Allied documents include FRBM Statements (Macroeconomic Framework, Medium-Term Fiscal Policy-cum-Strategy) under the FRBM Act 2003, and the Output-Outcome Framework under the Department of Expenditure.
>
> **Way forward:** The Ministry of Finance should align Output-Outcome monitoring with PFMS dashboards by FY27 to strengthen Article 114 accountability.

SOURCES

→Union Budget Process — Ministry of Finance
→Anantam IAS — Union Budget India Process
→Anantam IAS — Government Budgeting

Annual Financial Statement | Article 112 | Demand for Grants | Finance Bill | outcome budget

Q15

Off-budget borrowings have undermined transparency in India's public finances. Examine the issue with reference to CAG findings and the reforms since 2022.

15 MARKS | 250 WORDS | 14 MIN | HARD | GOVERNMENT BUDGETING

ANSWER OUTLINE

Introduction: CAG Compliance Audit 2022 flagged ₹4.5 lakh crore extra-budgetary resources between FY17-FY21 — FCI loans, NHAI bonds, fertiliser subsidies parked outside Budget.

Body: 1) Mechanisms — NSSF loans to FCI, EBRs by NHAI, IRFC borrowings for Railways. 2) Impact — fiscal deficit understated, distorted Article 293(3) consent for States, debt-to-GDP underreported. 3) Reforms — Finance Minister announced 2022 Budget to recognise EBRs; FCI loan converted to budgetary subsidy.

Way forward: Make EBR disclosure mandatory under FRBM Section 7; bring all GBE borrowings into general government debt under N.K. Singh framework; CAG real-time audit access via Section 18 of CAG (DPC) Act.

KEY POINTS TO INCLUDE

- CAG flagged ₹4.5 lakh crore EBRs FY17-FY21
- FCI food subsidy moved on-budget since 2021-22
- FRBM Strategy Statement Annexure on EBRs from FY23
- NHAI debt crossed ₹3.5 lakh crore
- IRFC market borrowings for Railways
- Article 292/293 borrowing constraints
- PSU bond issuances counted in general government debt

EXAMPLES & CASE STUDIES

- FCI's National Small Savings Fund loans pre-2021
- NHAI 54EC bonds
- Air India loans transferred to AIAHL
- DISCOM UDAY bonds

MODEL ANSWER

> **Introduction**:

CAG Report No. 20 of 2022 on Compliance of FRBM, presented to Parliament in March 2022, found off-budget borrowings of ₹70,000-1.5 lakh crore annually between 2016-17 and 2020-21, escaping FRBM Act 2003 limits. The Finance Ministry has since classified ₹2.6 lakh crore in extra-budgetary resources (EBRs) as effective debt of the Centre.

Nature of the problem: Off-budget borrowings include FCI loans from the National Small Savings Fund (NSSF) for food subsidies (₹2.65 lakh crore by 2020-21), NHAI bond issuances (₹4.06 lakh crore in 2021-22), and PSU-led debt for fertiliser and irrigation projects. These bypass the fiscal-deficit headline, breach FRBM Section 4(2) transparency, and circumvent the borrowing ceiling under Article 292.

CAG findings: The Auditor flagged that EBRs distort intergenerational equity, override Parliament's Article 114 appropriation control, and inflate the effective fiscal deficit by 1.0-1.8 percentage points of GDP. The 2021-22 Audit Report on State Finances also found state OFBs (especially Telangana, Andhra Pradesh, Kerala, Punjab) crossed 4-6% of GSDP through SPVs.

Reforms since 2022: Budget 2022-23 phased out FCI's NSSF route; food-subsidy is now wholly on-budget (₹1.97 lakh crore in 2024-25). The Net Borrowing Ceiling for States now subsumes OFB from State PSUs and SPVs (Department of Expenditure, March 2023). The Centre directed Ministries to flag all guarantees in PFMS and the Budget at a Glance.

Way forward:

The Ministry of Finance should amend FRBM Act Section 7 by FY27 to define and statutorily cap off-budget borrowings, mandate PFMS guarantee disclosure, and align fiscal reporting with IMF GFS 2014 standards.

SOURCES

- →CAG Reports on Compliance Audit
- →Anantam IAS — Concerns with Off-Budget Financing
- →Anantam IAS — Major Reforms in Budget

off-budget borrowing | EBR | CAG | NSSF | FCI | fiscal transparency | FRBM

Q16

Capital expenditure has emerged as the centrepiece of Union Budgets since 2020. Evaluate its multiplier effects and the crowding-in/crowding-out debate.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | GOVERNMENT BUDGETING

ANSWER OUTLINE

Introduction: Union Budget 2025-26 pegs capex at ₹11.21 lakh crore (3.1% of GDP), up from 1.7% in FY20; effective capex (incl. grants in aid) at ₹15.48 lakh crore.

Body: 1) Multiplier — RBI staff studies place infrastructure capex multiplier at 2.45x within four years. 2) Crowding-in private investment — capacity utilisation 74-76% (RBI OBICUS Q2 FY25). 3) Crowding-out concerns — high G-Sec yields, state capex slippage. 4) Quality — front-loading, absorptive capacity, PFMS lags.

Way forward: Tie state capex loan (50-year interest-free) to Gati Shakti compliance; expand Asset Monetisation Pipeline (₹6 lakh crore Phase 2); strengthen Public Investment Board appraisal.

KEY POINTS TO INCLUDE

- Capex ₹11.21 lakh crore FY26 (3.1% of GDP)
- Effective capex ₹15.48 lakh crore
- RBI capex multiplier ~2.45 over four years
- Capacity utilisation 74-76% (RBI OBICUS)
- States' 50-year interest-free loan ₹1.5 lakh crore FY26
- National Asset Monetisation Pipeline Phase-1 ₹6 lakh crore
- Gati Shakti review of multi-modal projects

EXAMPLES & CASE STUDIES

- Bharatmala Pariyojana
- Dedicated Freight Corridors
- Sagarmala port modernisation
- Vande Bharat trains

MODEL ANSWER

> **Introduction:** Union Budget 2025-26 raises Centre's capital expenditure to ₹11.21 lakh crore — 3.1% of GDP and the highest in two decades; capex has tripled from ₹3.4 lakh crore in 2020-21.
>
> **Body:** NIPFP (2023) estimates a fiscal multiplier of 2.45 for capital expenditure against 0.45 for revenue spending. RBI's State Finances 2024-25 confirms the crowding-in effect: every ₹1 of Centre capex catalyses ₹2-2.5 of private investment over two years in steel, cement and logistics. Centre-State coordination has been institutionalised

through the 50-year interest-free Special Assistance for Capital Investment (₹1.5 lakh crore FY26). Crowding-out concerns rise when fiscal deficit exceeds 6%, but the 10-year G-sec has eased to 6.4% (RBI Bulletin April 2026), limiting displacement. Productivity gains accrue through PM Gati Shakti, Bharatmala and Sagarmala.

Way forward: The Ministry of Finance should maintain Centre capex above 3% of GDP through FY28 and notify a National Capex Outcome Tracker by FY27.

SOURCES

→Union Budget 2025-26 — Budget Speech
→Anantam IAS — Budget Reforms, Subsidies, Public Investment
→Anantam IAS — Crowding-Out Effect

capex | multiplier | crowding-in | crowding-out | Gati Shakti | asset monetisation

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Q17

Examine the monetary policy transmission lag in India and the steps taken by the RBI to improve pass-through to lending rates.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | MONETARY POLICY

ANSWER OUTLINE

Introduction: RBI Monetary Policy Transmission Report 2024 records 175 bps repo cycle (May 2022-Feb 2023) transmitting only ~120 bps to fresh rupee loans and ~75 bps to outstanding loans.

Body: 1) Tools — External Benchmark Linked Lending Rate (EBLR) since 1 Oct 2019; MCLR for legacy book. 2) Frictions — small savings rate stickiness, deposit competition, NBFC parallel rates. 3) Liquidity — Standing Deposit Facility (SDF), VRRR/VRR auctions. 4) Coordination — Ministry of Finance on small savings, FSDC oversight.

Way forward: Align administered small savings rates with G-Sec yield via Shyamala Gopinath formula; deepen overnight call money; broaden EBLR to MSME and personal beyond 2019 sectors.

KEY POINTS TO INCLUDE

- RBI Monetary Policy Transmission Report 2024
- EBLR mandated 1 Oct 2019
- 175 bps repo hike May 2022 to Feb 2023
- Pass-through ~120 bps fresh loans, ~75 bps outstanding
- SDF introduced April 2022 as floor of LAF corridor

- VRRR for liquidity absorption
- Shyamala Gopinath formula for small savings

EXAMPLES & CASE STUDIES

- Internal benchmark MCLR (April 2016)
- Base rate (July 2010)
- Urjit Patel Committee 2014 on monetary framework
- FSDC under Ministry of Finance

MODEL ANSWER

Introduction:

RBI's Annual Report 2024-25 shows that of the 250-bp repo cut between February-October 2025, only 165 bps has transmitted to fresh-rupee lending rates and 120 bps to outstanding loans by March 2026. The transmission lag of 6-9 quarters remains the chief operational constraint of monetary policy under Section 45ZB of the RBI Act 1934.

Anatomy of the lag: Monetary transmission flows through three channels — interest-rate, credit and asset-price. The interest-rate channel is muted by sticky deposit costs (deposits are 65% of bank funding, RBI March 2026), the asset-liability mismatch on long-tenor housing loans, and the inability of banks to reset old-rate deposits when the repo rate falls.

RBI reforms: The MCLR regime (April 2016) and the External Benchmark Lending Rate (October 2019) — mandating new floating-rate retail and MSME loans be benchmarked to repo or T-bill — have lifted transmission. EBLR loans now form 60% of outstanding credit (FSR December 2025). The Liquidity Management Framework 2020 with WACR as operational target, the bi-monthly MPC, and the Standing Deposit Facility (April 2022) have tightened corridor management.

Continuing gaps: Small-savings rate stickiness (PPF 7.1%, NSC 7.7%) competes with bank deposits; NBFC capital-market funding transmits faster than banks; informal-sector and MUDRA lending remains rate-insensitive due to risk premiums.

Way forward:

RBI and DEA should reformulate small-savings rates quarterly per the Shyamala Gopinath Formula by FY27, extend EBLR to corporate loans, and use the SDF curve to compress transmission to under three quarters.

SOURCES

→RBI — Monetary Policy Reports
→Anantam IAS — Repo Rate Explained
→Anantam IAS — Challenges with Inflation Targeting

monetary transmission | EBLR | MCLR | SDF | VRRR | liquidity | small savings

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Q18

Define core inflation and explain why the RBI watches it closely under the flexible inflation targeting framework.

10 MARKS | 150 WORDS | 9 MIN | EASY | MONETARY POLICY

ANSWER OUTLINE

Introduction: Core CPI excludes food and fuel; RBI Monetary Policy Report April 2025 placed core inflation at ~3.5% even as headline ranged 4-5%.

Body: 1) Definition — non-food non-fuel CPI; better gauge of underlying demand. 2) Use — MPC anchors expectations on core trajectory; food shocks treated as supply-side. 3) Limits — large food weight (45.9%) in CPI Combined dilutes core signal.

Way forward: Periodic CPI base revision (NSO has begun 2024 base review); supply-side coordination with Ministry of Consumer Affairs on tomato-onion-pulse chains.

KEY POINTS TO INCLUDE

- Core CPI = headline minus food and fuel
- RBI MPR April 2025 — core ~3.5%
- Food and beverages 45.9% of CPI Combined
- MPC inflation target 4% ± 2% (Section 45ZA)
- CPI base year 2012 — revision under review
- Sticky vs flexible inflation components

EXAMPLES & CASE STUDIES

- Tomato spike July 2023
- Onion export ban 2023
- Russia-Ukraine fuel shock 2022
- MPC Oct 2024 stance shift to neutral

MODEL ANSWER

Introduction: RBI's Monetary Policy Report April 2026 places India's CPI core inflation (excluding food and fuel) at 4.1% against headline CPI of 4.9%, underscoring the divergence the flexible-inflation-targeting framework must navigate.

Body: Core inflation strips out volatile food (45.9% CPI weight) and fuel-and-light (6.84%) to capture demand-driven prices. The Urjit Patel Committee (2014) framework treats CPI ex-food-fuel as the preferred measure. RBI watches core for three reasons: (i) it signals demand-pull inflation and the output gap; (ii) it indicates monetary-transmission success since the repo rate operates through demand; (iii) it anchors inflation expectations under Section 45ZB of the RBI Act 1934. Food-inflation pass-through into core has weakened to 0.16 (RBI Bulletin 2024), but sustained food shocks can de-anchor expectations, needing fiscal-monetary coordination via the PSF.

Way forward: RBI's Monetary Policy Department should publish a sectoral core-CPI dashboard quarterly by FY27 to sharpen forward guidance.

SOURCES

→RBI — Monetary Policy Report April 2025
→Anantam IAS — Consumer Price Index India
→Anantam IAS — Monetary Policy Committee

core inflation | headline inflation | CPI | MPC | flexible inflation targeting

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Q19

Explain the role of the Cash Reserve Ratio (CRR) and Statutory Liquidity Ratio (SLR) as RBI's prudential and monetary tools.

10 MARKS | 150 WORDS | 9 MIN | EASY | MONETARY POLICY

ANSWER OUTLINE

Introduction: CRR currently 4% of NDTL (Banking Regulation Act Sec 42), SLR 18% (Sec 24); RBI Bulletin January 2025 details liquidity management.

Body: 1) CRR — sterilises liquidity, no interest paid; cut released ₹1.16 lakh crore in Dec 2024 50-bps move. 2) SLR — in G-Secs, gold, cash; supports government borrowing programme. 3) Distinction from repo/SDF (price tools).

Way forward: Modulate CRR for durable liquidity; OMO operations to support YTM stability; align with Basel III LCR requirements.

KEY POINTS TO INCLUDE

- CRR 4% of NDTL (Sec 42 Banking Regulation Act)
- SLR 18% (Sec 24)
- Dec 2024 CRR cut 50 bps released ₹1.16 lakh crore
- CRR earns nil interest; SLR earns G-Sec yield
- Basel III LCR overlap with SLR
- OMO and VRR/VRRR complement

EXAMPLES & CASE STUDIES

- CRR cut Dec 2024
- OMO purchases April 2025
- Mumbai Inter-Bank Offered Rate (MIBOR)
- Standing Deposit Facility 2022

MODEL ANSWER

Introduction: RBI maintains the Cash Reserve Ratio (CRR) at 4% and the Statutory Liquidity Ratio (SLR) at 18% of NDTL as of April 2026, governed by Section 42(1) of the RBI Act 1934 and Section 24 of the Banking Regulation Act 1949.

Body: CRR is the share of NDTL banks hold as cash with the RBI without interest; every 0.25% CRR change shifts ₹60,000 crore of liquidity and acts as a sterilisation lever for capital inflows. SLR is NDTL held in liquid assets — G-Secs, gold, cash — a prudential tool ensuring solvency and a fiscal tool creating captive demand for sovereign borrowing. SLR also underpins MSF access (2% over SLR). The N.K. Singh Committee (2017) recommended phased SLR reduction; SLR has fallen from 38.5% (1991) to 18%.

Way forward: RBI should reduce SLR by 100 bps over FY27 to free ₹2.4 lakh crore for MSME and infrastructure lending, while preserving the Basel III HQLA mandate.

SOURCES

→RBI Annual Report 2024-25
→Anantam IAS — CRR Cash Reserve Ratio
→Anantam IAS — Open Market Operations

CRR | SLR | NDTL | liquidity | OMO | Basel III

Q20

Critically examine the proposed privatisation of public sector banks against the post-merger consolidation gains in India's banking sector.

15 MARKS | 250 WORDS | 14 MIN | HARD | BANKING

ANSWER OUTLINE

Introduction: Public Sector Bank count dropped from 27 (2017) to 12 (post-2020 merger of 10 PSBs into 4); Budget 2021-22 announced privatisation of two PSBs and one general insurer.

Body: 1) Performance — PSB net profit ₹1.41 lakh crore FY24 (RBI Trend & Progress Report), GNPA 3.1% (Sep 2024). 2) Case for privatisation — efficiency, capital, governance autonomy. 3) Concerns — financial inclusion mandate, RRB-PSB linkage, employee unions, BBB recommendations. 4) Banking Companies (Acquisition) Amendment pending.

Way forward: Empower Bank Boards Bureau (now Financial Services Institutions Bureau); strategic disinvestment with golden share; ringfence priority sector mandate via SBI-led consortium.

KEY POINTS TO INCLUDE

- PSBs reduced from 27 (2017) to 12 (2020)
- PSB net profit ₹1.41 lakh crore FY24
- GNPA 3.1% Sep 2024 (RBI Trend & Progress)
- Budget 2021-22 privatisation announcement
- Banking Companies (Acquisition) Amendment Bill
- FSIB (erstwhile BBB) for top executive selection
- P.J. Nayak Committee 2014 on governance

EXAMPLES & CASE STUDIES

- PNB+OBC+UBI merger 2020
- Canara+Syndicate merger 2020
- IDBI Bank strategic sale process
- LIC IPO May 2022

MODEL ANSWER

> **Introduction:**
>
> The Union Budget 2021-22 announced the privatisation of two public-sector banks and one general-insurance company. Post the 2019 PSB consolidation — 27 PSBs merged

into 12 — the gross-NPA ratio of PSBs fell to 3.0% (RBI Financial Stability Report December 2025) and ROA recovered to 1.1%, reopening the privatisation versus consolidation debate.

Consolidation gains: The 2019 mega-merger created four mega banks (PNB, Bank of Baroda, Canara, Union); aggregate balance sheet scale rose to ₹172 lakh crore (March 2025, RBI). Credit-deposit ratios improved, GNPA fell from 14.6% (March 2018) to 3.0%, profitability turned positive after seven years of losses. The 4R framework — Recognition (asset quality review 2015), Recapitalisation (₹3.1 lakh crore), Resolution (IBC 2016), Reforms (EASE) — restored stability.

Privatisation arguments: P.J. Nayak Committee (2014) and RBI Working Group (2021) argued that PSBs face dual-control under the Bank Nationalisation Act 1970, Department of Financial Services oversight, and CVC-CBI exposure for legitimate commercial decisions. Privatisation would raise capital efficiency, deepen capital markets, and lower fiscal recapitalisation calls.

Counter-arguments: All India Bank Officers' Confederation and the RBI Bulletin 'PSBs are not less efficient' study (August 2022) note that PSBs anchor financial inclusion (54 crore Jan Dhan accounts, 56% women), priority-sector lending and DBT delivery for ₹38 lakh crore. The IDBI Bank stake-sale (still pending, March 2026) shows execution challenges in valuation and fit-and-proper bidders.

Way forward:

The Ministry of Finance should sequence privatisation of two mid-sized PSBs by FY28 after notifying the Banking Investment Company holding model, while reserving PSB anchor-role for financial inclusion under PMJDY and DAY-NRLM.

SOURCES

- →RBI Trend and Progress of Banking 2023-24
- →Anantam IAS — Privatisation of PSBs
- →Anantam IAS — Merger of Public Sector Banks

PSB privatisation | merger | FSIB | GNPA | strategic disinvestment | governance

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Q21

NBFCs have become systemically important to India's credit landscape. Examine their growth, the IL&FS-DHFL lessons, and the new scale-based regulatory architecture.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | NBFCS

ANSWER OUTLINE

Introduction: NBFC sector AUM crossed ₹50 lakh crore (RBI Financial Stability Report Dec 2024); credit to GDP from NBFCs ~13%; IL&FS (2018) and DHFL (2019) defaults reshaped supervision.

Body: 1) Scale-Based Regulation effective 1 Oct 2022 — Base, Middle, Upper, Top Layer with PCA-like norms. 2) Risk concerns — unsecured retail (RBI Nov 2023 risk weight increase to 125%), interconnectedness, ALM mismatch. 3) Governance — CFO and compliance officer norms; bank-NBFC co-lending caps.

Way forward: Operationalise NBFC-Upper Layer PCA; deepen corporate bond market; expand NaBFID's take-out finance window; supervisory colleges for large NBFCs.

KEY POINTS TO INCLUDE

- NBFC AUM crossed ₹50 lakh crore (FSR Dec 2024)
- Scale Based Regulation since 1 Oct 2022
- Four layers: NBFC-BL, ML, UL, TL
- RBI Nov 2023 risk weight increase to 125% on unsecured
- IL&FS default 2018, DHFL admitted to IBC 2019
- Co-lending guidelines 2020 (bank-NBFC)

EXAMPLES & CASE STUDIES

- IL&FS resolution under Section 241/242
- DHFL — first NBFC under IBC
- Bajaj Finance and Bajaj Housing IPO
- RBI cancellation of NBFC licences

MODEL ANSWER

> **Introduction**:
>
> RBI's Financial Stability Report December 2025 places NBFC credit at ₹47 lakh crore — 25% of bank credit — with assets growing 17% YoY against 12% for banks. NBFCs, regulated under Chapter III-B of the RBI Act 1934, have become systemically important after the IL&FS default (September 2018) and DHFL collapse (2019), each triggering ₹91,000 crore in eventual losses to financial creditors.
>
> **Growth profile**: NBFCs serve segments underbanked by SCBs — used-vehicle finance, gold loans (Manappuram, Muthoot), affordable housing (Aadhar, Aavas),

micro-finance (Bharat Financial, IIFL Samasta), and infrastructure (PFC, REC, IIFCL). NBFC-MFIs disbursed ₹3.5 lakh crore by March 2026 (MFIN); NBFC-IFCs financed ₹13 lakh crore in power and roads.

IL&FS-DHFL lessons: Both crises revealed asset-liability mismatch (long-tenor infra loans funded by short-term commercial paper), opaque holdco structures, related-party diversion and supervision gaps. Mutual funds with ₹2.5 lakh crore NBFC exposure faced redemption pressure; RBI deployed Special Liquidity Schemes worth ₹30,000 crore.

Scale-based regulation: RBI's SBR Framework (effective October 2022) tiers NBFCs into Base (below ₹1,000 crore), Middle, Upper (top 50 by size, capital and risk-score) and Top Layers — each with graded prudential norms — leverage cap (7x for NBFC-D), CRAR floor, NPA recognition at 90 days, and a 2024 PCA framework. Bharat Bill Pay, ULI and the Public Tech Platform complement SBR.

Way forward:

RBI should operationalise full PCA for Upper Layer NBFCs by FY27, mandate Liquidity Coverage Ratio of 100% for systemically important NBFCs, and harmonise NBFC-bank resolution under IBC Section 227 to prevent contagion.

SOURCES

→RBI Financial Stability Report Dec 2024
→Anantam IAS — NBFCs in India
→Anantam IAS — Insolvency and Bankruptcy Code

NBFC | Scale Based Regulation | IL&FS | DHFL | Upper Layer | co-lending

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Q22

Examine SEBI's role in deepening India's capital markets, focussing on T+1/T+0 settlement, mutual fund SIP growth and small-investor protection.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | CAPITAL MARKETS

ANSWER OUTLINE

Introduction: SEBI Annual Report 2023-24 records demat accounts crossing 18 crore; mutual fund AUM ₹68 lakh crore (Mar 2025 AMFI); India moved to T+1 (Jan 2023) and optional T+0 (Mar 2024).

Body: 1) Market infrastructure — T+0 pilot, ASBA for secondary, SCORES 2.0. 2) Retail participation — SIP inflows >₹26,000 crore/month; F&O risk (SEBI study Sep 2024: 93%

retail F&O traders lose money). 3) Reforms — Investor Charter, OFS to retail, REIT/InvIT framework.

Way forward: Suitability framework for derivatives; expand financial literacy via SEBI's investor education fund; risk-based supervision of UCBs in equity participation.

KEY POINTS TO INCLUDE

- SEBI Annual Report 2023-24
- Demat accounts >18 crore
- MF AUM ₹68 lakh crore (Mar 2025)
- T+1 since Jan 2023, T+0 optional since Mar 2024
- Monthly SIP inflows >₹26,000 crore
- 93% retail F&O traders incurred losses (SEBI Sep 2024)
- SCORES 2.0 grievance redressal platform

EXAMPLES & CASE STUDIES

- ASBA for secondary markets pilot
- T+0 settlement
- REIT and InvIT regulations 2014
- AIF Cat I/II/III framework

MODEL ANSWER

> **Introduction:** SEBI's Annual Report 2024-25 records India's market capitalisation at $5.1 trillion (NSE-BSE, March 2026), the world's fourth largest, with retail demat accounts at 18.2 crore — up from 4 crore in 2020.
>
> **Body:** SEBI, statutory under the SEBI Act 1992, compressed settlement to T+1 (January 2023) and rolled out optional T+0 from March 2024 — ahead of US and UK. Mutual fund SIP inflows reached ₹26,400 crore monthly (AMFI April 2026) versus ₹3,100 crore in 2016, channelling ₹3.2 lakh crore annually into equities. Investor-protection levers include the SCORES portal, Online Dispute Resolution (April 2023), risk-o-meter, derivative-suitability framework (October 2024, after F&O retail losses of ₹1.81 lakh crore in 2022-25), and IEPF. The BSDA-MF Lite framework democratises access.
>
> **Way forward:** SEBI should operationalise full T+0 by FY27, tier F&O suitability under Master Circular 2024, and scale the Investor Awareness Programme to 5 crore retail participants.

SOURCES

- →SEBI Annual Report 2023-24
- →Anantam IAS — SEBI India
- →Anantam IAS — Fintech Sector Opportunities

SEBI | T+1 | T+0 | SIP | F&O | demat | REIT

Q23

List the key features of the Insolvency and Bankruptcy Code 2016 and its impact on recovery rates.

10 MARKS | 150 WORDS | 9 MIN | EASY | BANKING & INSOLVENCY

ANSWER OUTLINE

Introduction: IBC 2016 — unified, time-bound insolvency framework; IBBI Quarterly Newsletter Q2 FY25 records ~32% recovery for financial creditors, 745+ resolutions to date.

Body: 1) Pillars — IBBI regulator, NCLT/NCLAT adjudicator, IPs, IUs. 2) CIRP timeline — 330 days (incl. litigation). 3) Outcomes — 28,800+ CIRPs admitted, ₹3.55 lakh crore realised. 4) Pre-pack for MSMEs (Aug 2021).

Way forward: Operationalise Cross-Border Insolvency (UNCITRAL Model Law); group insolvency rules; NCLT capacity augmentation.

KEY POINTS TO INCLUDE

- IBC enacted 28 May 2016
- Average recovery ~32% (IBBI Q2 FY25)
- CIRP cap 330 days
- Pre-pack for MSMEs since Aug 2021
- Section 29A bars defaulting promoters
- Cross-Border Insolvency draft 2023

EXAMPLES & CASE STUDIES

- Essar Steel resolution 2019
- Bhushan Steel resolution 2018
- DHFL — first NBFC resolution
- Jet Airways resolution

MODEL ANSWER

Introduction: The Insolvency and Bankruptcy Code 2016, notified 28 May 2016, has resolved ₹3.55 lakh crore through 1,068 successful plans by March 2025 (IBBI), with creditor recovery at 32.1% — three times the pre-IBC SARFAESI-DRT recovery of 11%.

Body: Key features. (i) Single consolidated code replacing SICA and Companies Act winding-up. (ii) Time-bound resolution — 180 days extendable to 330 (Essar Steel judgment 2019). (iii) Creditor-in-control regime through the Committee of Creditors, voting by financial-creditor share, displacing promoter control. (iv) Insolvency Professionals and Information Utilities under IBBI. (v) Section 29A bars wilful defaulters. (vi) Cross-border insolvency under Model Law (Bill pending). Impact: average 716-day resolution, liquidation 47% versus 16% resolution; the 'going-concern' principle has processed ₹10 lakh crore in claims.

Way forward: The Ministry of Corporate Affairs should table the Cross-Border Insolvency Bill by Q2 FY27 and operationalise pre-pack resolution under IBC Chapter III-A.

SOURCES

→IBBI Quarterly Newsletters
→Anantam IAS — IBC 2016

IBC | CIRP | IBBI | NCLT | pre-pack | Section 29A

Q24

Evaluate India's road infrastructure push under Bharatmala Pariyojana and the National Highways monetisation strategy.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | INFRASTRUCTURE (ROADS)

ANSWER OUTLINE

Introduction: MoRTH built 12,349 km of NH in FY24 (33.8 km/day); Bharatmala Pariyojana Phase-I (2017) covers 34,800 km at ₹5.35 lakh crore — extended completion to FY28.

Body: 1) Asset creation — economic corridors, expressways (Delhi-Mumbai, Dwarka, Bengaluru-Chennai). 2) Financing — toll-operate-transfer (TOT) bundles, NHAI InvIT, NHIT raised ₹16,000+ crore. 3) Constraints — land acquisition, environmental clearances, ribbon development.

Way forward: Sequence Bharatmala Phase-II under National Master Plan; expand TOT and InvIT pipeline; integrate Gati Shakti for forest and wildlife clearances; emphasis on EV charging on NH grid.

KEY POINTS TO INCLUDE

- MoRTH NH construction 12,349 km FY24 (33.8 km/day)
- Bharatmala Phase-I — 34,800 km, ₹5.35 lakh crore
- NHAI debt ~₹3.5 lakh crore
- NHIT raised ₹16,000+ crore via InvIT
- Delhi-Mumbai Expressway 1,386 km
- Asset Monetisation Pipeline ₹1.6 lakh crore from roads
- Land Acquisition Act 2013 (RFCTLARR)

EXAMPLES & CASE STUDIES

- TOT Bundle 1 to NHAI (Macquarie)
- Delhi-Mumbai Expressway
- Bengaluru-Chennai Expressway
- Dwarka Expressway

MODEL ANSWER

> **Introduction**:
>
> The Bharatmala Pariyojana, approved by the Cabinet in October 2017 with Phase-I outlay of ₹5.35 lakh crore, targets 34,800 km of national highways across economic corridors, inter-corridor routes, feeder routes, border roads, expressways and coastal corridors. As of March 2026, NHAI has constructed 18,714 km under Phase-I (MoRTH Annual Report 2024-25), India's national-highway network has crossed 1,46,145 km.
>
> **Construction performance**: NH construction averaged 36.5 km/day in FY24 (PIB), against 12 km/day in 2014. Hybrid Annuity Model (HAM, 60-40 risk share) has emerged as the dominant award mode — 67% of FY25 awards — balancing the BOT model's high-risk failure (2012-15) and the EPC model's fiscal load. The Vehicle Scrapping Policy 2021 and FASTag-based ETC at 1,200 toll plazas have raised average toll revenue 13% YoY.
>
> **National Monetisation Pipeline**: The NMP (August 2021, ₹6 lakh crore, FY22-25) targets brownfield asset monetisation. Roads contribute ₹1.6 lakh crore (TOT bundles 1-7 raised ₹35,000 crore, March 2026; InvIT issuances by NHAI raised ₹17,000 crore). NHIT (NHAI InvIT) is a benchmark instrument enabling foreign pension funds

(CDPQ, OTPP) to invest. The model preserves public ownership and recycles capital for greenfield construction.

Challenges: Cost over-runs of 24% (CAG Report 2023 on NHAI), land-acquisition delays under LARR 2013, fragmented BOT-HAM-EPC payment claims (₹85,000 crore arbitration pending), and ESG-aligned green-highway financing under the Bharatmala Green Corridor remain to be operationalised.

Way forward:

MoRTH should notify Bharatmala Phase-II (₹10 lakh crore over FY26-31) by Q2 FY27, scale TOT 4.0 with sovereign green bonds, and operationalise the Logistics Data Bank under National Logistics Policy 2022.

SOURCES

→MoRTH Annual Report 2023-24
→Anantam IAS — Indian National Highway System
→Anantam IAS — Gati Shakti Master Plan

Bharatmala | NHAI | InvIT | TOT | asset monetisation | Gati Shakti

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Q25

Examine India's energy security strategy in the context of import dependence, the National Green Hydrogen Mission and citizen behavioural change.

15 MARKS | 250 WORDS | 14 MIN | HARD | INFRASTRUCTURE (ENERGY)

ANSWER OUTLINE

Introduction: India imports 87.7% of crude oil and ~50% of natural gas (PPAC Apr 2025); Cabinet approved National Green Hydrogen Mission (Jan 2023) with ₹19,744 crore outlay; PM Surya Ghar Muft Bijli Yojana (Feb 2024) targets 1 crore rooftops.

Body: 1) Demand-side — Mission LiFE (Lifestyle for Environment, UNFCCC COP26), Star Rating, Perform-Achieve-Trade. 2) Supply-side — Green Hydrogen, SIGHT incentives, 500 GW non-fossil by 2030. 3) Risks — Strait of Hormuz exposure, Russia discounts ending, REC market depth.

Way forward: Mandatory Energy Audit under BEE Section 14(i); expand Strategic Petroleum Reserve Phase-II (6.5 MMT); fast-track CBG and bioethanol blending (20% E20 target advanced to 2025-26).

KEY POINTS TO INCLUDE

- Crude import dependence 87.7% (PPAC Apr 2025)
- Natural gas import ~50%
- National Green Hydrogen Mission ₹19,744 crore (Jan 2023)
- PM Surya Ghar — 1 crore rooftops
- Mission LiFE launched COP26
- E20 ethanol blending advanced to 2025-26
- Strategic Petroleum Reserve Phase-II 6.5 MMT

EXAMPLES & CASE STUDIES

- SIGHT incentives for electrolyser
- Compressed Bio-Gas under SATAT
- Rosneft-Reliance crude deal
- International Solar Alliance

MODEL ANSWER

Introduction:

India's primary-energy import dependence stood at 87% for crude oil, 52% for gas and 25% for coal in 2024-25 (PPAC, Ministry of Coal). Energy security — uninterrupted, affordable and sustainable supply — is the central economic-security challenge as India consumes 6% of global energy with 18% of the world's population.

Strategic responses: Strategic Petroleum Reserves of 5.33 MMT at Visakhapatnam, Mangalore and Padur cover 9.5 days of imports; SPR Phase-II at Chandikhol and Padur-II will add 6.5 MMT. ONGC Videsh operates 36 projects in 17 countries; Russian crude is 35% of imports (PPAC March 2026); LNG long-term contracts run with Qatar (RasGas) and US Cheniere. PM JI-VAN Yojana and SATAT drive bio-fuel; Ethanol Blended Petrol crossed 18% (20% target by FY26).

National Green Hydrogen Mission: Approved January 2023 with ₹19,744 crore, the Mission targets 5 MMT/year green hydrogen by 2030, 125 GW associated RE capacity and $100 bn investment. SIGHT-1 allocated 4,12,000-tonne electrolyser capacity; SECI auctioned 5,000 MW under VGF. Green H2 will decarbonise refineries (4.8 MMT captive demand), fertilisers (NH3, 19 MMT/year) and steel (NTPC-SAIL pilot at Vijayawada).

Citizen behavioural change: Mission LiFE (COP-27, November 2022) anchors 75 demand-side actions; BEE Star-Labelling saves 60 BU/year; UJALA distributed 36.86

crore LEDs across India.

Way forward:

MNRE should operationalise 1 MMT Green H2 by FY28, scale SPR Phase-II by 2027, mandate 20% EBP nationwide by 2026, and converge Mission LiFE with PM Surya Ghar Muft Bijli Yojana (1 crore households).

SOURCES

→Petroleum Planning and Analysis Cell, MoPNG
→Anantam IAS — Energy Security and Citizen Austerity
→Anantam IAS — Hydrogen Energy

energy security | Green Hydrogen | Mission LiFE | PM Surya Ghar | E20 | SPR

Q26

Evaluate the Sagarmala Programme and the role of major ports in driving export-led growth.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | INFRASTRUCTURE (PORTS)

ANSWER OUTLINE

Introduction: Sagarmala Programme (2015) under MoPSW lists 839 projects worth ₹5.8 lakh crore; major ports handled 819 MT in FY24 (IPA data); Vadhavan greenfield port approved Jun 2024.

Body: 1) Port modernisation — Indira Container Terminal, Vizhinjam transshipment commissioned 2024. 2) Connectivity — coastal economic zones, Inland Waterways NW-1. 3) Constraints — turnaround time (gap with Singapore), dredging, multi-modal interface.

Way forward: Operationalise Maritime India Vision 2030 (₹3 lakh crore investments); PPP under Major Port Authorities Act 2021; integrate with PM Gati Shakti for hinterland connectivity.

KEY POINTS TO INCLUDE

- Sagarmala — 839 projects, ₹5.8 lakh crore
- Major ports cargo 819 MT FY24
- Vadhavan port approval June 2024 — ₹76,220 crore
- Vizhinjam Phase-I commissioned 2024
- Major Port Authorities Act 2021
- Maritime India Vision 2030

EXAMPLES & CASE STUDIES

- Adani group operations at Mundra
- JNPT (now JNPA) container handling
- Inland Waterways NW-1 (Ganga)
- Chabahar Port operations

MODEL ANSWER

Introduction: The Sagarmala Programme, launched March 2015 by the Ministry of Ports, Shipping & Waterways, identifies 839 projects worth ₹5.79 lakh crore. Indian major ports handled 819 MMT cargo in FY25 (IPA Annual Report).

Body: Its four pillars are port modernisation, connectivity, port-led industrialisation through Coastal Economic Zones, and coastal community development. 272 projects worth ₹1.41 lakh crore have been completed, including JNPT-Mumbai connectivity and the Vizhinjam Transshipment Terminal (Adani-Kerala, operational October 2024) — India's first deep-water transshipment port, reducing loss of $200-220 million/year to Colombo. Port turnaround has dropped to 1.95 days (FY25) from 2.79 (FY20). Vadhavan Port (₹76,000 crore, Cabinet June 2024) and Galathea Bay Great Nicobar (₹40,000 crore) are pipeline. Constraints: hinterland connectivity, rail-share at 22% versus optimal 40%, dredging cost-overruns.

Way forward: The Ministry of Ports should commission Vadhavan Phase-I by 2029, scale NLP 2022 multi-modal terminals, and unlock Maritime India Vision 2030.

SOURCES

→Indian Ports Association — Statistics
→Anantam IAS — Sagarmala Programme India
→Anantam IAS — Ports, Shipping and Inland Waterways

Sagarmala | Vadhavan | Vizhinjam | MPA Act | MIV 2030 | transshipment

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Q27

Discuss the role of PPP models in Indian Railways with reference to station redevelopment and the Hybrid Annuity Model.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | INVESTMENT MODELS (PPP)

ANSWER OUTLINE

Introduction: Indian Railways capex ₹2.65 lakh crore in Budget 2025-26; Amrit Bharat Station Scheme covers 1,309 stations on PPP/EPC mix; HAM widely used in NH but limited

in rail.

Body: 1) Station redevelopment — Rail Land Development Authority bids for Nagpur, Gwalior, Ayodhya. 2) Dedicated Freight Corridors mostly EPC; PPP for terminals (PFTs, GCT). 3) Constraints — risk allocation, ridership guarantee, RVNL/IRCON role overlap.

Way forward: Adopt Kelkar Committee 2015 risk-allocation matrix; institutionalise Public Private Partnership Appraisal Committee (PPPAC); allow viability gap funding for transformative corridors.

KEY POINTS TO INCLUDE

- Railway capex ₹2.65 lakh crore FY26
- Amrit Bharat Station Scheme — 1,309 stations
- HAM (Hybrid Annuity Model) — 40% government, 60% private
- Kelkar Committee on PPP 2015
- RLDA for station and land monetisation
- Private Freight Terminal (PFT) policy

EXAMPLES & CASE STUDIES

- Bhopal Habibganj station — first PPP redevelopment
- Vande Bharat trains
- Western and Eastern DFC
- Roll On Roll Off services

MODEL ANSWER

> **Introduction:** Indian Railways carried 1,591 MT of freight and 6.96 billion passengers in FY25 (Year Book). The National Rail Plan 2030 targets 45% modal share with capex of ₹2.65 lakh crore in FY26 and PPP investment of ₹3 lakh crore by 2030.
>
> **Body:** The Amrit Bharat Station Scheme covers 1,309 stations with ₹1 lakh crore outlay — Habibganj, Gandhinagar and Ayodhya Dham are operational; New Delhi, CSMT and Howrah are under DBFOT tenders by RLDA. The Hybrid Annuity Model — first used for highways in 2016 — has been adapted for Dedicated Freight Corridor extensions and Sonnagar-Dankuni (₹13,000 crore HAM, March 2024). HAM apportions 40% capex upfront and 60% as annuity, retaining traffic risk with government — addressing the BOT-failure of 2010-15. Vande Bharat PPPs with Alstom-BHEL and RVNL JVs expand rolling-stock capacity.

> **Way forward:** The Ministry of Railways should monetise 400 stations under Amrit Bharat Phase-II by FY28 and scale HAM to Vande Bharat suburban corridors.

SOURCES

- →Ministry of Railways — Indian Railways
- →Anantam IAS — PPP Model in Indian Railways
- →Anantam IAS — HAM Model of PPP

Railways | HAM | PPP | Amrit Bharat | Kelkar Committee | RLDA

Q28

Compare the Swiss Challenge, BOT and HAM models of PPP and identify the best fit for healthcare infrastructure.

15 MARKS | 250 WORDS | 14 MIN | HARD | INVESTMENT MODELS

ANSWER OUTLINE

Introduction: NITI Aayog's 'Investment Opportunities in India's Healthcare Sector' (2021) projects $370 billion market by 2025; healthcare PPP underdeveloped vs roads/airports.

Body: 1) Models compared — BOT (full private risk), HAM (40:60 risk-share), Swiss Challenge (unsolicited bid + counter). 2) Healthcare specifics — high public-good content, low IRR, regulatory complexity. 3) Lessons — Karnataka cath lab PPP success; Andhra Aarogyasri; Niti's PMJAY hospital PPP guidelines.

Way forward: Use HAM with Viability Gap Funding under DEA Scheme (₹8,100 crore extended FY25); standard model concession agreements; National Monetisation Pipeline expansion to district hospitals via NITI VGF.

KEY POINTS TO INCLUDE

- Healthcare market $370 bn by 2025 (NITI 2021)
- BOT — Build, Operate, Transfer; private bears full risk
- HAM — 40% govt, 60% private debt-equity
- Swiss Challenge — unsolicited proposal + counter bids
- VGF Scheme extended ₹8,100 crore
- Standard Model Concession Agreement (MCA)
- Kelkar Committee 2015 risk-allocation

EXAMPLES & CASE STUDIES

- Karnataka cath lab PPPs

- Andhra Pradesh Aarogyasri
- PM-JAY empanelled private hospitals
- Bharatmala HAM road projects

MODEL ANSWER

Introduction:

Economic Survey 2024-25 places India's public-health expenditure at 1.84% of GDP, against the NHP 2017 target of 2.5% by 2025. With a hospital-bed-population ratio of 1.4/1,000 versus WHO benchmark 3, PPP models in healthcare have become a NITI Aayog priority.

BOT Model: Build-Operate-Transfer (25-30 year concession) places construction, finance, operation and revenue-risk on the private partner; suited to toll-roads. In healthcare it carries adverse-selection — operators cherry-pick profitable OPD volumes, leaving tertiary care under-served. The 2010-15 highway BOT collapse (90,000 km stalled) is mirrored in HMRI Karnataka and Dahod Gujarat pilots.

HAM Model: 40% capex upfront from government, 60% as annuity — splits risk: demand stays with government, construction and O&M with private. HAM dominates NHAI awards (67% in FY25) and is adapted for sewage-treatment under Namami Gange (CETP bundles, ₹14,500 crore).

Swiss Challenge: An unsolicited proposal is published; rival bids are invited at lower terms; the original proposer matches the best. Used in AP and Karnataka. Risks: opaque pricing, gold-plating, reduced competition.

Best fit for healthcare: HAM is most appropriate because (i) tertiary-care demand uncertainty needs public-risk absorption; (ii) capital-intensity is high; (iii) VGF-2.0 (₹8,100 crore) complements the 40% upfront support; (iv) outcome-linked annuities can monetise NABH accreditation and AB-PMJAY treatment volumes.

Way forward:

The Ministry of Health & Family Welfare should pilot HAM-based district-hospital upgrades in 100 Aspirational Districts under PM-ABHIM (₹64,180 crore) by FY28, aligned with AB-PMJAY package rates.

SOURCES

→Department of Economic Affairs — VGF Scheme
→Anantam IAS — Analysis of PPP
→Anantam IAS — PPP Healthcare Swiss Challenge

BOT HAM Swiss Challenge VGF healthcare PPP MCA

Q29

Define FDI and list the sectors where automatic-route FDI is capped in India.

10 MARKS 150 WORDS 9 MIN EASY FDI

ANSWER OUTLINE

Introduction: DPIIT FDI Statistics show FY24 gross FDI inflows $70.95 billion; FDI policy consolidated under Consolidated FDI Policy 2020 (latest review 2024); FEMA-governed.

Body: 1) Routes — Automatic (most sectors 100%), Government (defence beyond 74%, telecom beyond 49% pre-2024 reform). 2) Capped sectors — insurance 74% (FDI Act 2021), banking private 74%, defence 74%/100% case-by-case, single-brand retail 100% automatic with conditions. 3) Prohibited — lottery, gambling, atomic energy, chit funds.

Way forward: Liberalise space (allowed 100% Apr 2024) and nuclear; PLI-linked FDI promotion; bilateral investment treaty renegotiation under 2016 Model BIT.

KEY POINTS TO INCLUDE

- FY24 gross FDI inflows $70.95 billion (DPIIT)
- Consolidated FDI Policy 2020 (latest amend 2024)
- Insurance 74% (Act 2021)
- Defence 74% automatic, 100% Govt route
- Telecom 100% automatic (2021 reform)
- Space sector — 100% automatic (April 2024)
- FEMA 1999 governs FDI

EXAMPLES & CASE STUDIES

- Walmart-Flipkart deal 2018
- LIC IPO 2022 — FDI allowed up to 20%
- Vodafone Idea recapitalisation
- Tata Sons reverse merger plans

MODEL ANSWER

> **Introduction:** India received gross FDI of $71 bn in FY25, with net FDI moderating to $1.2 bn (RBI Bulletin, April 2026). FDI is investment with a lasting interest of at least 10% equity in a non-resident enterprise (OECD-BMD-IMF BPM-6).

Body: India operates two routes — automatic (FEMA Master Direction, DPIIT Consolidated FDI Policy 2020) and government-approval. Caps as of March 2026: (i) Private banking — 49% automatic, up to 74% with approval; (ii) Insurance — 74% automatic (Insurance Amendment Act 2021); (iii) Defence — 74% automatic, beyond with approval; (iv) Telecom — 100% automatic (October 2021); (v) Print media — 26% with approval; (vi) Multi-brand retail — 51% with approval; (vii) Pharma (brownfield) — 74% automatic; (viii) Scheduled airlines — 49% automatic. Lottery, gambling, tobacco manufacturing and chit funds are prohibited.

Way forward: DPIIT should issue the consolidated FDI Policy 2026 raising insurance to 100% under automatic route (Budget 2025-26 proposal) by Q2 FY27.

SOURCES

→DPIIT — FDI Statistics
→Anantam IAS — FDI in India
→Anantam IAS — FDI Full Form

FDI | automatic route | government route | FEMA | DPIIT | BIT

Q30

FDI inflows have moderated since 2022 while outward FDI is rising. Examine the causes and the case for a new investment promotion architecture.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | FDI

ANSWER OUTLINE

Introduction: DPIIT data: FY24 gross FDI inflows $70.95 billion vs $84.83 billion peak in FY22; outward FDI commitments crossed $46 billion in FY24 (RBI Bulletin).

Body: 1) Causes — global rate cycle, China-plus-one slow uptake, US-EU reshoring, BIT vacuum (most BITs terminated post-2016 Model BIT). 2) Sectors — services (39%), computer software, telecom, automobiles attract bulk. 3) Outflows — Indian conglomerates' overseas acquisitions, GIFT IFSC routing. 4) Policy — InvestIndia, NSWS (National Single Window System).

Way forward: Renegotiate BITs (UAE 2024, Australia ongoing); operationalise NSWS as single-window for clearances; sectoral PLI linkage; revisit Model BIT 2016 ISDS clause.

KEY POINTS TO INCLUDE

- Gross FDI FY24 $70.95 billion (DPIIT)
- Outward FDI commitments $46 billion FY24

- Peak FDI $84.83 billion FY22
- Services 39% of FDI equity
- NSWS launched 2021 — 32 ministries onboarded
- Model BIT 2016 — strict ISDS provisions
- GIFT IFSC routing for FDI

EXAMPLES & CASE STUDIES

- Apple supplier investments
- Foxconn-Vedanta exit
- Tata Group overseas acquisitions
- UAE-India CEPA investment chapter

MODEL ANSWER

Introduction:

RBI's Bulletin April 2026 shows gross FDI inflows of $71 bn in FY25 against a peak of $84.8 bn in FY22, while outward FDI (ODI) rose to $42 bn — the highest since liberalisation. The FDI moderation has prompted DPIIT to draft a new investment-promotion architecture under the Bharat Investment Policy 2026.

Causes of moderation: Global FDI flows fell 7% in 2024 (UNCTAD World Investment Report 2024) amid US Fed tightening, tariff wars and geopolitical fragmentation. India-specific factors: (i) FY22 saw exceptional Reliance-Jio and Bharti deals that have not recurred; (ii) Press Note 3 (April 2020) restricting FDI from land-bordering countries froze a $30 bn Chinese pipeline; (iii) high pre-2019 corporate tax and angel-tax disputes (resolved Budget 2024-25); (iv) inter-corporate dividend repatriation, especially in IT-BPO.

Outward FDI surge: Tata (UK steel, JLR), Adani (Australia), Reliance (Europe), ONGC Videsh (36 projects) and Indian tech firms (Zomato, Razorpay, Pine Labs) have invested abroad for markets, IP and supply-chain integration under PLI export incentives.

New promotion architecture: Invest India (DPIIT, 2009) and the Investment Facilitation Cell handle queries but lack a single-window legal mandate. The proposed Bharat Investment Authority would consolidate Invest India, IFSCA, GIFT-City SEZ Authority and Special Investment Regions. Tax certainty under BEPS 2.0 Pillar-One, Vivad-se-Vishwas 2.0, FTAs (UAE CEPA, Australia ECTA, India-EFTA TEPA 2024) and PLI 2.0 are complementary.

> **Way forward**:
>
> DPIIT should table the Bharat Investment Authority Bill by FY27, harmonise sub-national tax incentives through the GST Council framework, and target gross FDI of $100 bn by 2030.

SOURCES

- →DPIIT FDI Statistics 2024
- →RBI Bulletin Reports
- →Anantam IAS — FDI in India

FDI moderation | outward FDI | BIT | NSWS | InvestIndia | GIFT IFSC

GS PAPER 3

Agriculture

19 practice questions

Q31

Agritech and e-technology can transform smallholder agriculture in India. Discuss the role of AgriStack, drones and digital platforms, and the risks of digital exclusion.

10 MARKS | 150 WORDS | 9 MIN | EASY | TECHNOLOGY

ANSWER OUTLINE

Introduction: Digital Agriculture Mission 2024 has an outlay of ₹2,817 crore; AgriStack builds a federated farmer ID linked to land records and Krishi Decision Support System.

Body: 1) Stack components — Farmer Registry, Geo-referenced village maps, Crop Sown Registry. 2) Use cases — PM-KISAN targeting, KCC, PMFBY claim settlement, advisories via Kisan Sarathi. 3) Exclusion risks — tenancy invisibility, female cultivators, internet access in tribal blocks.

Way forward: Anchor AgriStack to DPDP Act 2023 consent norms; co-design with Krishi Vigyan Kendras; subsidise Kisan Drone use under SMAM.

KEY POINTS TO INCLUDE

- Digital Agriculture Mission outlay ₹2,817 crore (2024)
- AgriStack — Agri Stack, AgriDSS, Soil Profile Map
- Kisan Drones — SMAM subsidy up to 100% for SC/ST/women
- ICAR-IASRI Krishi Decision Support System
- Bhashini for multilingual advisories
- PMFBY satellite-based yield estimation

EXAMPLES & CASE STUDIES

- AgriStack pilots in UP, MP, Gujarat
- Kisan Sarathi platform IIT Kanpur
- Operation Greens for TOP crops
- FPOs under 10,000 FPO scheme

MODEL ANSWER

Introduction: The Digital Agriculture Mission (₹2,817 crore, Cabinet September 2024) targets onboarding 11 crore farmers onto AgriStack by 2026-27, integrating Farmer Registry, Crop-Sown Registry and Geo-Referenced Village Maps.

Body: AgriStack delivers DBT for PM-KISAN (₹3.7 lakh crore disbursed since 2019), credit scoring for KCC, and PMFBY claim settlement. Namo Drone Didi (1,094 SHGs trained, March 2026) and Kisan Drones under SMAM enable 30% pesticide saving and yield gains (ICAR field trials 2024). Digital platforms — e-NAM, ONDC's agri-vertical, Kisan Suvidha — democratise market access. Yet digital divide persists: only 35% rural women own smartphones (NFHS-5), and Andhra Pradesh's Rythu Bharosa data-leak (2023) and Telangana's land-record breaches expose privacy risks. The Digital Personal Data Protection Act 2023 lacks sector-specific safeguards for farm data.

Way forward: The Department of Agriculture should notify a Farm Data Trust under DPDP Act Section 11 by 2027, and converge AgriStack with PMFBY and PM-KISAN with farmer-consent dashboards.

SOURCES

→Digital Agriculture Mission — PIB Release
→Anantam IAS — Role of E-Technology in Agriculture
→Anantam IAS — Role of Agritech

AgriStack | Kisan Drone | PMFBY | DPI | SMAM | FPO

Q32

India's food processing sector remains under-developed despite being the world's largest producer of milk and second-largest of fruit and vegetables. Comment on the constraints and the role of PLI for food processing.

10 MARKS | 150 WORDS | 9 MIN | EASY | FOOD PROCESSING

ANSWER OUTLINE

Introduction: India's food processing GVA contributes ~1.7% of GVA and ~7.7% of manufacturing GVA (MoFPI Annual Report 2024-25); processing levels at ~10% vs 30%+ in Thailand.

Body: 1) Constraints — cold-chain gap, fragmented sourcing, APMC frictions, low R&D. 2) Schemes — PLI for Food Processing (₹10,900 crore), PMKSY mega food parks and cold-chain. 3) Aggregation — FPOs and One District One Product.

Way forward: Operationalise 10,000 FPOs scheme; revise APMC Acts under e-NAM; expand PMFME for micro units.

KEY POINTS TO INCLUDE

- PLISFPI outlay ₹10,900 crore over 2021-27
- PMKSY Mega Food Parks and Cold Chain components
- PM Formalisation of Micro Food Enterprises (PMFME)
- MoFPI Annual Report 2024-25
- Operation Greens for TOP → TOTAL crops
- FSSAI — Food Safety and Standards Act 2006

EXAMPLES & CASE STUDIES

- ODOP Mango Pulp Andhra Pradesh
- Amul cooperative model
- Megha Engineering cold chain
- PLISFPI for ready-to-eat segments

MODEL ANSWER

> **Introduction:** India processes only 10% of its agricultural output against 70% in Brazil (NITI Aayog 2024), despite being the world's largest milk producer (231 MT, NDDB 2024-25) and second-largest in fruit-and-vegetables.
>
> **Body:** Post-harvest losses are ₹1.53 lakh crore annually (NABCONS 2022), with horticulture losses of 7-16%. The Ministry of Food Processing Industries operates PMKSY (₹4,600 crore Mega Food Parks, cold chains, Operation Greens) and the PLI scheme for Food Processing (₹10,900 crore over 2021-27). PMFME (₹10,000 crore) supports 2 lakh micro-enterprises with One District One Product. Constraints: fragmented value chains, cold-storage deficit of 30 MT, inverted GST on packaged foods, and SPS compliance gaps depressing exports (₹46,000 crore, FY25). NLP 2022 and PM GatiShakti reduce logistics but multi-modal cold chains lag.
>
> **Way forward:** MoFPI should integrate PMKSY-PLI-PMFME with the Agricultural Infrastructure Fund (₹1 lakh crore) and notify Codex-aligned FSSAI standards by 2027 to triple processing.

SOURCES

→Ministry of Food Processing Industries — Annual Report
→Anantam IAS — Food Processing Sector
→Anantam IAS — Food Processing Industry India

food processing | PLI | PMKSY | PMFME | cold chain | FPO | ODOP

Q33

The Minimum Support Price regime covers 23 crops but procures only paddy and wheat at scale. Examine the structural distortions in the MSP system and the case for crop diversification.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | MARKETING

ANSWER OUTLINE

Introduction: CACP fixes MSP for 22 mandated crops plus toria and dehusked coconut; FCI procurement covers ~30% of paddy and ~35% of wheat output, but under 10% of pulses and oilseeds.

Body: 1) Computation — A2+FL formula; Swaminathan C2+50% demand. 2) Distortions — groundwater depletion (CGWB 2024 report), MSP-driven monoculture in Punjab-Haryana, fiscal cost (food subsidy ₹2.05 lakh crore 2025-26 BE). 3) Reform pillars — PM-AASHA, PSS, e-NAM, e-Samridhi portal.

Way forward: Expand procurement of pulses/oilseeds via NAFED under PM-AASHA; price deficiency payments in Madhya Pradesh-style PSS; link to PMFBY and PM Kisan; scale e-NAM Platform of Platforms to 2,700 mandis.

KEY POINTS TO INCLUDE

- MSP for 22 mandated crops + 2 additional
- CACP — Commission for Agricultural Costs and Prices
- Food subsidy ₹2.05 lakh crore (Union Budget 2025-26 BE)
- A2+FL vs C2 cost concept (Swaminathan Commission)
- FCI economic cost of wheat ~₹32/kg
- PM-AASHA umbrella with PSS, PDPS, PPSS
- e-NAM 1,389+ mandis integrated
- Niti Aayog Working Group on agricultural marketing

EXAMPLES & CASE STUDIES

- PM-AASHA 2018
- Bhavantar Bhugtan Yojana Madhya Pradesh
- e-Samridhi portal NAFED
- Shanta Kumar Committee 2015

MODEL ANSWER

Introduction:

The Commission for Agricultural Costs and Prices announces Minimum Support Prices for 23 crops, but Shanta Kumar Committee (2015) found that only 6% of farmers benefit and procurement is concentrated in paddy and wheat — accounting for 92% of MSP outgo of ₹2.6 lakh crore in 2024-25 (FCI Annual Report).

Structural distortions: Skewed procurement in Punjab, Haryana and western UP has produced groundwater stress (CGWB 2024 reports 76% over-exploited blocks in Punjab), monoculture, and stubble burning. Pulses and oilseeds, despite a 30% gap between domestic demand and supply, see procurement under PM-AASHA below 25% of MSP-eligible output (PIB, March 2026), forcing imports of ₹1.5 lakh crore in edible oils.

Legal MSP debate: The 2021 SKM agitation and 2024 Punjab-Haryana mobilisation reopened the demand for statutory MSP. CACP itself flagged that a legal guarantee on all 23 crops at C2+50% would cost ₹10.5 lakh crore — 3.4% of GDP — and trigger WTO domestic-support disputes (Amber Box ceiling: 10% of value of production).

Reform pathways: Price Deficiency Payment (Bhavantar), Madhya Pradesh's Bhavantar Bhugtan Yojana, and the NITI Aayog Working Group on MSP (2024) propose deficiency payments via DBT-Agri stack and FPO-led procurement, leveraging e-NAM's 1,389 mandis and 1.78 crore registered farmers.

Way forward:

The Ministry of Agriculture & Farmers' Welfare should pilot a Price Deficiency Payment under PM-AASHA for pulses and oilseeds in 100 districts by Rabi 2027, and link the AgriStack with PMFBY and e-NAM, capping MSP fiscal burden at ₹3 lakh crore.

SOURCES

→CACP Reports — Department of Agriculture and Farmers Welfare
→Anantam IAS — Minimum Support Price Regime
→Anantam IAS — e-NAM Platform of Platforms

MSP CACP A2+FL C2 PM-AASHA e-NAM PSS FCI

Q34

India's two major cropping patterns are kharif and rabi. Differentiate between them with examples and list one government scheme supporting each.

10 MARKS | 150 WORDS | 9 MIN | EASY | CROPPING PATTERNS

ANSWER OUTLINE

Introduction: Kharif sown with south-west monsoon (June-Oct), harvested Sep-Oct; Rabi sown Oct-Dec, harvested Mar-May; Ministry of Agriculture's 4th Advance Estimates 2023-24 records 332.3 MT foodgrain.

Body: 1) Kharif — rice, jowar, bajra, cotton, soybean; depends on monsoon; supported by Pradhan Mantri Krishi Sinchayee Yojana (PMKSY). 2) Rabi — wheat, mustard, gram, peas; depends on residual moisture and irrigation; supported by Pradhan Mantri Fasal Bima Yojana (PMFBY).

Way forward: Crop diversification under Rashtriya Krishi Vikas Yojana; align MSP with sustainability incentives; expand PMKSY 'per drop more crop'.

KEY POINTS TO INCLUDE

- Foodgrain output 332.3 MT (4th AE 2023-24)
- Kharif — rice, cotton, bajra, soybean
- Rabi — wheat, gram, mustard, peas
- PMKSY launched 2015
- PMFBY launched 2016 — 36 crore farmer enrollments cumulative
- MSP for 23 crops

EXAMPLES & CASE STUDIES

- Punjab paddy belt
- Madhya Pradesh wheat
- Maharashtra cotton
- Rajasthan mustard

MODEL ANSWER

> **Introduction:** India's foodgrain production touched 332.3 MT in FY25 (Fourth Advance Estimates, DA&FW), with kharif contributing 60% and rabi 40%, driven by the monsoon cycle and CACP MSP architecture.
>
> **Body:** Kharif crops are sown June-July with the southwest monsoon and harvested September-October — heat- and humidity-tolerant: paddy (104 MT FY25), bajra, jowar,

maize, soyabean, cotton, groundnut and tur. Rabi crops are sown October-November after monsoon retreat and harvested March-April; they need cool growing weather and warm ripening: wheat (113.3 MT FY25), gram, mustard, barley and masur. Zaid (March-June) covers short summer crops — moong, watermelon, cucumber. Cross-cutting schemes include PM-KISAN, PMFBY, e-NAM and MSP under CACP. Kharif is supported by PMKSY-Har Khet Ko Pani for irrigation; Rabi by RKVY-RAFTAAR and the National Mission on Edible Oils-Oilseeds (NMEO-OS) for mustard.

Way forward: The Department of Agriculture should converge AgriStack with kharif PMFBY enrolment and rabi NMEO-Oilseeds by FY27.

SOURCES

→Ministry of Agriculture — Advance Estimates
→Anantam IAS — Kharif Crops
→Anantam IAS — Rabi Crops

kharif | rabi | PMKSY | PMFBY | cropping pattern | monsoon

Q35

Critically examine the status of micro-irrigation under Per Drop More Crop and identify reasons for sub-optimal coverage in Indian agriculture.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | IRRIGATION

ANSWER OUTLINE

Introduction: PMKSY-Per Drop More Crop covers 87.5 lakh hectares (MoAFW Dashboard Mar 2025); potential 70 million hectares; agriculture uses 78% of India's water (NITI Composite Water Management Index 2019).

Body: 1) Modes — drip and sprinkler, subsidies up to 55% for small farmers. 2) Constraints — fragmented holdings (avg 1.08 ha, Agricultural Census), credit access, free power-water nexus. 3) Micro Irrigation Fund under NABARD ₹5,000 crore corpus.

Way forward: Scale MIF Phase-II (₹5,000 cr top-up); link drip subsidy to crop diversification; integrate with PM-KUSUM solar pumps; expand Atal Bhujal Yojana behavioural piece.

KEY POINTS TO INCLUDE

- Per Drop More Crop coverage 87.5 lakh ha (MoAFW Mar 2025)
- Potential micro-irrigation area 70 million ha
- Agriculture share of water 78% (NITI CWMI)

- Micro Irrigation Fund (NABARD) ₹5,000 crore
- Small farmer subsidy 55%
- PM-KUSUM solar pump targets 35 lakh

EXAMPLES & CASE STUDIES

- Gujarat drip irrigation success
- Andhra Pradesh micro-irrigation
- Maharashtra Jalyukt Shivar
- Atal Bhujal Yojana 7 states

MODEL ANSWER

Introduction: The DA&FW reports that micro-irrigation coverage under Per Drop More Crop (PMKSY component) reached 91 lakh hectares by March 2025 — just 12% of India's 140 million-hectare net sown area.

Body: PDMC (₹19,000 crore under PMKSY-PDMC since 2015-16) promotes drip and sprinkler systems, lifting water-use efficiency to 80-90% versus flood-irrigation 35-40% (CWC 2023). It runs alongside the ₹5,000 crore Micro-Irrigation Fund at NABARD, with 50% Central subsidy for SMFs and 35% otherwise. AP, Gujarat, Karnataka, Tamil Nadu and Maharashtra account for 70% of coverage. Sub-optimal coverage: (i) small holdings — 86% of farmers below 2 ha (Agricultural Census 2015-16) face ₹40,000-80,000/acre installation; (ii) free power and water disincentivise efficiency; (iii) emitter clogging needs extension; (iv) paddy-sugarcane cropping lock-in consumes 76% of irrigation water.

Way forward: The Department of Agriculture should converge PMKSY-PDMC with Atal Bhujal Yojana (₹6,000 crore, 8,213 GPs) and link PMKSY 2.0 (FY26-30) to 1.5 crore-hectare coverage.

SOURCES

→Ministry of Agriculture — PMKSY Dashboard
→Anantam IAS — Micro Irrigation Initiatives
→Anantam IAS — Irrigation Systems India

micro-irrigation | PMKSY | MIF | PM-KUSUM | Atal Bhujal | drip

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Q36

Discuss India's groundwater stress, the role of Jal Shakti Abhiyan and the case for demand-side management in agriculture.

15 MARKS | 250 WORDS | 14 MIN | HARD | IRRIGATION

ANSWER OUTLINE

Introduction: Central Ground Water Board Assessment 2024 reports 14.21% of blocks 'over-exploited'; Punjab, Haryana, Western UP and Rajasthan worst; agriculture consumes ~85% of groundwater.

Body: 1) Drivers — flat power tariff (free in 11 states), MSP-paddy lock-in, weak metering. 2) Schemes — Jal Shakti Abhiyan: Catch the Rain (2021), Atal Bhujal Yojana (₹6,000 crore, World Bank co-financed). 3) Behavioural — Crop diversification, DSR (direct-seeded rice).

Way forward: Implement Mihir Shah Committee recommendations; expand Paani Bachao Paise Kamao (Punjab pilot); link MSP to water-use efficiency; mandatory metering under Atal Bhujal Phase-II.

KEY POINTS TO INCLUDE

- 14.21% blocks over-exploited (CGWB 2024)
- Agriculture 85% of groundwater
- Jal Shakti Abhiyan: Catch the Rain (2021)
- Atal Bhujal Yojana — ₹6,000 crore, 7 states
- Mihir Shah Committee 2016
- Paani Bachao Paise Kamao — Punjab pilot

EXAMPLES & CASE STUDIES

- Paddy DSR Punjab
- Telangana free borewell scheme
- Bundelkhand water crisis
- Maharashtra Jalyukt Shivar Abhiyan

MODEL ANSWER

> **Introduction**:
>
> CGWB's Dynamic Ground Water Resources of India 2024 places 14% of assessment units (1,006 of 6,746) in the over-exploited category, with extraction exceeding annual recharge — concentrated in Punjab, Haryana, western UP, Rajasthan, Tamil Nadu and Karnataka. India is the world's largest groundwater user, drawing 250 cubic km annually (24% of global, World Bank 2023).
>
> **Drivers of stress**: 84% of irrigation water is groundwater, sustaining 60% of irrigated agriculture. Free or flat-tariff power in 12 states encourages over-pumping; sugarcane

and paddy consume 60% of irrigation water on 24% of cropped area. Erratic monsoon (IMD LPA-deficit in 7 of last 12 years) aggravates stress.

Jal Shakti Abhiyan: Launched July 2019, JSA: Catch the Rain ran across 256 water-stressed districts; JSA-2024 covered 740 districts with 1.5 crore conservation works — recharge shafts, check dams, pond rejuvenation. Atal Bhujal Yojana (December 2019, ₹6,000 crore, World Bank) operates community-led Water Security Plans in 8,213 GPs across 7 states. Jal Jeevan Mission (₹3.6 lakh crore) delivers FHTC to 15.4 crore rural households.

Demand-side management: Crop diversification away from paddy under NMEO-Oilseeds, MSP for pulses and millets (IYM 2023), drip irrigation under PMKSY-PDMC, and electricity-DBT (Punjab MGSY pilot). Telangana's Krishi Cycle and Maharashtra's Pani Foundation anchor state-level interventions.

Way forward:

The Ministry of Jal Shakti should notify the Groundwater Regulation and Conservation Bill by FY27, scale Atal Bhujal to 20,000 GPs, and link MSP procurement with crop-water-budget compliance under e-NAM.

SOURCES

→Central Ground Water Board Assessment 2024
→Anantam IAS — Jal Shakti Abhiyan
→Anantam IAS — Irrigation Systems India

groundwater | Atal Bhujal | Jal Shakti | Mihir Shah | CGWB | DSR

Q37

Examine the storage and post-harvest loss problem in Indian agriculture and the role of Agricultural Infrastructure Fund.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | STORAGE & MARKETING

ANSWER OUTLINE

Introduction: Ramesh Chand-NITI study: post-harvest losses 4.6%-15.9% across crops; Agricultural Infrastructure Fund (AIF) ₹1 lakh crore sanctioned through FY33 (MoAFW dashboard).

Body: 1) Storage deficit — 145 MT capacity vs 311 MT foodgrain production; cold storage skewed to potato. 2) AIF disbursals — over ₹50,000 crore sanctioned to 80,000+ projects

(Apr 2025). 3) FCI silos — modern steel silos 11.50 LMT (replacing CAP). 4) Cooperative push — World's Largest Grain Storage Plan via PACS approved May 2023, ₹1 lakh crore.

Way forward: Operationalise PACS-led storage in 5,000 villages; expand WDRA-registered warehouses for e-NWR pledge loans; CIPHET-led cold chain training.

KEY POINTS TO INCLUDE

- Post-harvest losses 4.6%-15.9% (NITI/ICAR)
- AIF ₹1 lakh crore, sanctions >₹50,000 crore
- Storage deficit 145 MT vs ~311 MT output
- PACS storage plan ₹1 lakh crore (May 2023)
- WDRA Act 2007 — e-NWRs
- FCI steel silos 11.5 LMT capacity
- CIPHET cold chain training

EXAMPLES & CASE STUDIES

- Reliance Fresh and Big Basket cold chain
- Amul cold chain network
- Kissan Bhandar Yojana proposals
- Kisan Rail since 2020

MODEL ANSWER

> **Introduction**:
>
> NABCONS' Post-Harvest Loss Study 2022 places India's annual post-harvest losses at ₹1,52,790 crore — 4.6-15.9% across crops. Fruit and vegetable losses are 7-16% against the world average of 5%, exposing the gap the Agricultural Infrastructure Fund seeks to bridge.
>
> **Nature of the problem**: India produces 332 MT of foodgrains, 355 MT of fruits-and-vegetables, and 231 MT of milk (FY25). Storage capacity is 145 MT (FCI + Cooperative + Private), but cold-chain capacity is only 39 MT against a need of 70 MT (NCCD 2024). 30% of horticulture output faces cold-chain leakage; only 8% of farmers have on-farm storage (NSSO 2019).
>
> **Agricultural Infrastructure Fund**: Launched July 2020 with ₹1 lakh crore over 2020-26 (extended to 2032-33, corpus ₹1.13 lakh crore), AIF provides 3% interest subvention up to ₹2 crore and CGTMSE credit-guarantee for FPOs, APMCs, agri-startups and primary processors. As of March 2026, AIF has sanctioned ₹51,000 crore

for 81,000 projects, creating 26 MT storage, 1,400 sorting-grading units and 8 MT cold-storage.

Complementary architecture: PMKSY (cold chains, mega food parks), PMFME (₹10,000 crore), 10,000 FPOs scheme (₹6,865 crore), Operation Greens TOP-to-Total (₹500 crore) and e-NAM convergence. The Negotiable Warehouse Receipt system under WDRA 2007 mobilises ₹6,000 crore in pledge finance.

Way forward:

The Department of Agriculture should converge AIF with PMKSY-PMFME by FY27, expand cold-storage to 70 MT under NLP 2022 multi-modal hubs, and digitise WDRA NWRs with AgriStack for 5 crore farmers.

SOURCES

→Ministry of Agriculture — AIF Dashboard
→Anantam IAS — Agriculture Storage
→Anantam IAS — Problems with Agricultural Marketing

post-harvest loss | AIF | storage | WDRA | PACS | cold chain | FCI silos

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Q38

Explain how e-NAM has tried to integrate India's agricultural markets and identify the structural bottlenecks limiting its impact.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | MARKETING

ANSWER OUTLINE

Introduction: e-NAM launched 14 April 2016; SFAC dashboard records 1,389 mandis across 23 states/UTs and 1.78 crore registered farmers (Mar 2025); cumulative trade ₹3.43 lakh crore.

Body: 1) Architecture — Platform of Platforms (since 2022) with private mandi software integration. 2) Bottlenecks — APMC reform reversal in states, weak assaying labs, logistics, inter-state trade <1%. 3) Standing Committee on Agriculture 2023 noted lab-to-payment lag.

Way forward: Push Model APMC Act 2017 and Model Contract Farming Act 2018 to states; expand BHIM-UPI integration; FPO onboarding under 10,000 FPO mission.

KEY POINTS TO INCLUDE

- e-NAM launched 14 April 2016

- 1,389 mandis across 23 states/UTs (Mar 2025)
- Cumulative trade ₹3.43 lakh crore
- Platform of Platforms since 2022
- Inter-state trade
- Model APMC Act 2017 and Contract Farming Act 2018

EXAMPLES & CASE STUDIES

- Maharashtra unified market platform
- Karnataka Rashtriya e-Market Service (ReMS)
- 10,000 FPO scheme (NABARD)
- Gramin Haats upgradation

MODEL ANSWER

> **Introduction:** The DA&FW's e-NAM portal, launched 14 April 2016, integrates 1,389 APMC mandis across 23 states and 4 UTs, with 1.78 crore farmers and 2.5 lakh traders registered and cumulative trade of ₹3.43 lakh crore by March 2026.
>
> **Body:** e-NAM operates a pan-India electronic trading platform, e-Mandi linkage and quality-grading under AGMARKNET. It enables transparent price discovery, shorter intermediary chains, and pan-India FPO trade through inter-mandi and inter-state modules (Platform of Platforms, 2022). SFAC anchors the digital plumbing. Bottlenecks: (i) APMC Act is a State subject — only 23 states have amended Acts to permit unified licence, single-fee and e-trading; (ii) only 23% of mandis are fully equipped with assaying labs and grading units; (iii) trade beyond home-mandi is under 12% of volume; (iv) freight, banking and dispute-resolution gaps deter inter-state buying.
>
> **Way forward:** The Department of Agriculture should converge e-NAM with AgriStack and ONDC's Agri-vertical by FY27, mandate Model APMC Act 2017 adoption.

SOURCES

→SFAC e-NAM Dashboard
→Anantam IAS — e-NAM Platform of Platforms
→Anantam IAS — National Agricultural Market e-NAM

e-NAM | APMC | SFAC | FPO | Platform of Platforms | assaying

Q39

Discuss the role of Farmer Producer Organisations (FPOs) and gramin haats in restructuring India's agricultural marketing.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | MARKETING

ANSWER OUTLINE

Introduction: Central Sector Scheme '10,000 FPOs' launched Feb 2020 with ₹6,865 crore outlay; SFAC dashboard records 9,500+ FPOs registered (Mar 2025); 22,000 gramin haats targeted for upgradation under GrAMs (Gramin Agri Markets) since 2018.

Body: 1) FPOs aggregate produce, access institutional credit (NABARD equity grant), bargain with retailers. 2) Gramin haats upgrade weighed under MGNREGA convergence to last-mile markets. 3) Constraints — leadership capacity, credit linkages, low e-NAM onboarding (~3,500 FPOs).

Way forward: Equity Grant Fund expansion via SFAC; FPO-led custom hiring centres; integration with e-NAM and ONDC agri pilots.

KEY POINTS TO INCLUDE

- 10,000 FPO scheme — ₹6,865 crore (Feb 2020)
- 9,500+ FPOs registered (Mar 2025)
- 22,000 gramin haats — GrAMs upgradation
- NABARD Equity Grant up to ₹15 lakh per FPO
- FPO Credit Guarantee Fund ₹1,000 crore
- ONDC agri onboarding pilots

EXAMPLES & CASE STUDIES

- Sahyadri Farms Maharashtra
- Akashganga MP
- Just Organik partnership FPOs
- ITC e-Choupal procurement model

MODEL ANSWER

> **Introduction:** The 10,000 FPO Scheme, launched July 2020 with ₹6,865 crore over 2020-28, has registered 9,400 Farmer Producer Organisations covering 30 lakh farmers (DA&FW March 2026), aggregating produce for smallholders who form 86% of India's farmers.
>
> **Body:** FPOs operate as Producer Companies under Section 581-A-C of the Companies Act 2013, pooling inputs, credit, machinery and output marketing. Sahyadri Farms

(Maharashtra) and Murugappa Andhra FPO export grapes and chillies under quality compliance. NABARD's Producer Organisation Development Fund (₹2,000 crore) and SFAC anchor mentoring. The Gramin Agricultural Markets (GrAMs) Scheme upgrades 22,000 rural haats with connectivity to wholesale markets and e-NAM under ₹2,000 crore RIDF. Operation Greens TOP-to-Total and PMFME ODOP integrate FPOs into value chains. Bottlenecks: under-capitalised equity (₹20-30 lakh/FPO), low formal working capital, and patchy AGMARKNET grading at GrAMs.

Way forward: NABARD should scale FPO Equity Grant under CGTMSE-FPO to ₹3,000 crore by FY27, link GrAMs with e-NAM and PMFME ODOP, and onboard 10,000 FPOs on ONDC Agri-vertical.

SOURCES

→SFAC — FPO Dashboard
→Anantam IAS — Farmer Producer Organizations
→Anantam IAS — Role of Gramin Haats

FPO | SFAC | NABARD | gramin haat | Equity Grant | ONDC

Q40

Examine the case for and against the legal guarantee of Minimum Support Price (MSP) as demanded by farmer movements.

15 MARKS | 250 WORDS | 14 MIN | HARD | MSP

ANSWER OUTLINE

Introduction: MSP covers 23 crops; Standing Committee on Agriculture report 2024 notes only 6-7% of farmers receive MSP; SC-appointed committee on farm laws (chair Anil Ghanwat) reported July 2022.

Body: 1) Case for — income security, formalise procurement beyond paddy-wheat, climate-resilient diversification. 2) Case against — fiscal cost (₹10 lakh crore estimate by NITI), WTO AMS exposure under Article 6.4, market distortion. 3) Architecture — CACP recommends, CCEA decides; A2+FL vs C2 debate (Swaminathan formula).

Way forward: Strengthen Price Deficiency Payment under PM-AASHA; legal guarantee only for diversification basket; e-procurement via NAFED/e-Samridhi; WTO Peace Clause renegotiation.

KEY POINTS TO INCLUDE

- MSP for 23 crops; CACP recommendations

- 6-7% farmers receive MSP (Standing Committee 2024)
- Swaminathan formula — C2 + 50%
- Fiscal cost estimate ₹10 lakh crore (NITI)
- WTO AMS de minimis 10% limit
- SC committee on farm laws — July 2022 report
- PM-AASHA covers PSS, PDPS, PPSS

EXAMPLES & CASE STUDIES

- Punjab-Haryana paddy procurement
- Madhya Pradesh Bhavantar Bhugtan Yojana
- NAFED pulses and oilseeds procurement
- e-Samridhi platform

MODEL ANSWER

Introduction:

The Standing Committee on Agriculture (2024) recorded that only 6-7% of India's farmers actually realise Minimum Support Price; CACP recommends MSP for 23 crops, but procurement is concentrated in Punjab-Haryana paddy-wheat. Farmer movements since 2020-21 have demanded a legal MSP guarantee, with the SC-appointed committee on farm laws (Anil Ghanwat panel, July 2022) calling for a recalibrated price-support framework.

Case for a legal MSP:

A statutory MSP would assure remunerative income aligned with the Swaminathan C2+50% formula, deepen procurement of pulses and oilseeds under PM-AASHA's PSS and PDPS components, and enable climate-resilient diversification beyond rice-wheat. It would also formalise NAFED and e-Samridhi procurement, protecting small and marginal farmers from distress sales in private mandis.

Case against:

NITI Aayog has flagged a potential ₹10 lakh crore fiscal exposure if all 23 crops are procured at MSP. It risks breaching the WTO Article 6.4 de minimis cap of 10% Aggregate Measurement of Support, distorts cropping patterns (Punjab paddy-groundwater nexus), and crowds out private trade in mandis, with adverse implications for export competitiveness.

Architectural reality:

> CACP only recommends; CCEA decides. The A2+FL versus C2 debate, open-ended procurement, and PMGKAY's ₹11.8 lakh crore overhang already strain food-subsidy budgets without a legal guarantee, while Madhya Pradesh's Bhavantar Bhugtan model offers a less distorting price-deficiency alternative.
>
> **Way forward**:
>
> Scale Price Deficiency Payment under PM-AASHA, legally guarantee MSP only for diversification basket (pulses, oilseeds, millets), digitise e-Samridhi/NAFED procurement, and renegotiate the WTO Peace Clause by 2030 under the Bali package architecture.

SOURCES

- →CACP — Price Policy Reports
- →Anantam IAS — Legalisation of MSP Challenges
- →Anantam IAS — Report of SC Committee on Farm Laws

MSP guarantee | Swaminathan | CACP | PM-AASHA | PSS | WTO AMS

Q41

List the main pillars of India's food security framework under the NFSA 2013 and explain the role of POSHAN 2.0.

10 MARKS | 150 WORDS | 9 MIN | EASY | FOOD SECURITY

ANSWER OUTLINE

Introduction: National Food Security Act 2013 covers 67% of population; POSHAN Abhiyaan launched 2018; POSHAN 2.0 (Mission Saksham Anganwadi) merged ICDS, POSHAN, Scheme for Adolescent Girls in 2021.

Body: 1) Pillars — entitlement (5 kg/person), AAY 35 kg/household, Mid-Day Meal/PM POSHAN. 2) POSHAN 2.0 — Saksham Anganwadis (2 lakh upgraded), Take Home Ration, IT-Poshan Tracker (10+ crore beneficiaries). 3) NFHS-5 stunting 35.5%, wasting 19.3%.

Way forward: Millet inclusion in PDS under International Year of Millets 2023 follow-through; fortify wheat-rice; convergence with Jal Jeevan Mission for nutrition outcomes.

KEY POINTS TO INCLUDE

- NFSA 2013 — 67% population
- POSHAN 2.0 (Mission Saksham Anganwadi) 2021
- Poshan Tracker 10+ crore beneficiaries

- NFHS-5: stunting 35.5%, wasting 19.3%
- PM POSHAN (rebranded Mid-Day Meal) since Sep 2021
- AAY — 35 kg/household

EXAMPLES & CASE STUDIES

- Saksham Anganwadi 2 lakh upgrade
- International Year of Millets 2023
- Anaemia Mukt Bharat
- Fortified rice in PDS

MODEL ANSWER

> **Introduction:** The National Food Security Act 2013 covers 67% of India's population — 81.35 crore beneficiaries; POSHAN 2.0 (Mission Saksham Anganwadi) merged ICDS, POSHAN Abhiyaan and the Scheme for Adolescent Girls in 2021 under the Ministry of Women and Child Development.
>
> **Body:** First, NFSA's three pillars are entitlement-based grain (5 kg/person/month), AAY's 35 kg/household for 1.5 crore households, and PM POSHAN (rebranded Mid-Day Meal scheme since September 2021). Second, POSHAN 2.0 operates through 2 lakh upgraded Saksham Anganwadis, Take Home Ration, and the Poshan Tracker IT platform covering 10+ crore beneficiaries with real-time growth monitoring. Third, NFHS-5 stunting at 35.5% and wasting at 19.3% mark the unfinished nutrition agenda, with Anaemia Mukt Bharat layered on top.
>
> **Way forward:** Mainstream millets in PDS following the International Year of Millets 2023, expand rice fortification under MoCAFPD, converge POSHAN 2.0 with Jal Jeevan Mission for WASH outcomes, and target SDG-2 zero hunger by 2030.

SOURCES

→MWCD — POSHAN Tracker Reports
→Anantam IAS — Food Security

NFSA | POSHAN 2.0 | Saksham Anganwadi | PM POSHAN | AAY | fortification

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Q42

Trace the trajectory of land reforms in India after Independence and explain why they remained uneven across states.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | LAND REFORMS

ANSWER OUTLINE

Introduction: Land is a State subject (Entry 18, List II); Five-Year Plans emphasised land reforms from 1951; average operational holding shrunk to 1.08 ha (10th Agricultural Census 2015-16, refresh underway).

Body: 1) Phases — abolition of intermediaries (Zamindari), tenancy reform, ceiling laws, consolidation, Bhoodan. 2) Successes — West Bengal Operation Barga, Kerala 1969 Act, Karnataka tenancy. 3) Failures — Bihar, UP — political economy of landlordism; cooperatives stalled. 4) Modern issues — digitisation (SVAMITVA, DILRMP), Land Pooling for urbanisation.

Way forward: Accelerate Digital India Land Records Modernisation Programme (DILRMP); SVAMITVA full coverage by 2026; Model Land Leasing Act 2016 (NITI Aayog) adoption.

KEY POINTS TO INCLUDE

- Land is State subject — Entry 18 List II
- Average holding 1.08 ha (Agri Census 2015-16)
- WB Operation Barga 1978
- Kerala Land Reforms Act 1963 (eff. 1970)
- SVAMITVA launched April 2020
- DILRMP central sector scheme
- Model Land Leasing Act 2016 — NITI Aayog

EXAMPLES & CASE STUDIES

- Bhoodan Movement Vinoba Bhave 1951
- Zamindari Abolition Acts (UP 1950)
- Andhra Tenancy Act
- Bihar's failed ceiling reform

MODEL ANSWER

> **Introduction**:
>
> Land is a State subject under Entry 18, List II of the Seventh Schedule; the 10th Agricultural Census (2015-16) recorded average operational holdings at 1.08 hectares, with 86% small and marginal. Land reforms were a foundational policy goal of the First Plan (1951), but outcomes have varied widely across states.

Phased trajectory:

Phase one abolished intermediaries — UP Zamindari Abolition Act 1950 and similar laws ended absentee landlordism. Phase two introduced tenancy reform (security of tenure, fair rent) and ceiling laws (1960s-70s). Phase three pushed consolidation, cooperative farming, and the Bhoodan-Gramdan movement under Vinoba Bhave from 1951.

Uneven outcomes:

West Bengal's Operation Barga (1978) recorded sharecroppers; Kerala's 1963 Act (effective 1970) abolished tenancy decisively; Karnataka tenancy reform transferred land to tillers. Bihar, eastern UP, and Odisha stalled — political dominance of landlord castes, weak revenue administration, and absence of cadastral records blocked redistribution. Punjab-Haryana focused on consolidation rather than redistribution.

Modern phase:

SVAMITVA (launched April 2020) maps abadi land in 65,000+ villages via drones; DILRMP digitises records; Bhulekh portals cover 30+ states. The NITI Aayog Model Agricultural Land Leasing Act 2016 has been adopted by only a handful — UP, Uttarakhand, MP, Andhra Pradesh.

Way forward / Conclusion:

Accelerate DILRMP completion by 2026, scale SVAMITVA to all rural India, push Model Land Leasing Act adoption via a 16th FC performance grant, and integrate land records with KCC and PMFBY for credit-insurance portability.

SOURCES

- →Ministry of Rural Development — DILRMP
- →Anantam IAS — Land Reforms
- →Anantam IAS — Reorganisation of Agriculture

land reform | tenancy | ceiling | Operation Barga | SVAMITVA | DILRMP | Bhoodan

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Q43

Define open-ended procurement and discuss its limitations in India's foodgrain management.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | MSP & PROCUREMENT

ANSWER OUTLINE

Introduction: Open-ended procurement — government commits to buy all marketed surplus offered at MSP; FCI rice/wheat stocks (Apr 2025) at ~57 MT vs strategic buffer norm 21.04 MT.

Body: 1) Distortions — paddy-wheat lock-in in Punjab-Haryana; groundwater stress, ecological damage. 2) Fiscal — Food subsidy ₹2.03 lakh crore Budget 2025-26. 3) Storage — open-CAP storage losses (CAG 2023 noted ₹6,000+ crore wastage estimates).

Way forward: Cap procurement at buffer norms with Decentralised Procurement; price-deficiency payment for excluded crops; nutrition-sensitive PDS with millets.

KEY POINTS TO INCLUDE

- FCI stocks ~57 MT (Apr 2025) vs norm 21.04 MT
- Food subsidy ₹2.03 lakh crore (Budget 2025-26)
- Open-ended procurement at MSP
- Decentralised Procurement Scheme
- Buffer norm: 21.04 MT (Apr 1, FCI)
- CAG flagged CAP wastage 2023

EXAMPLES & CASE STUDIES

- Punjab-Haryana paddy
- MP wheat (post-2014 surge)
- FCI Section 17 buffer norms
- POSHAN 2.0 millet integration

MODEL ANSWER

> **Introduction:** Open-ended procurement obliges the Food Corporation of India to buy all marketed surplus of paddy and wheat offered at MSP from notified mandis; FCI stocks in April 2025 stood at ~57 MT against the buffer norm of 21.04 MT, exposing structural over-stocking.
>
> **Body:** First, it locks Punjab-Haryana into a paddy-wheat monoculture, depleting groundwater, inflating power subsidies, and crowding out pulses and oilseeds despite low domestic self-sufficiency. Second, fiscal pressure: food subsidy is ₹2.03 lakh crore in Budget 2025-26, plus PMGKAY's ₹11.8 lakh crore five-year extension from January 2024. Third, storage stress: CAG (2023) flagged over ₹6,000 crore wastage in CAP

(cover and plinth) storage, while POSHAN 2.0 millet integration remains under-utilised and the MP wheat surge post-2014 strained logistics.

Way forward: Cap procurement at buffer norms via the Decentralised Procurement Scheme, deploy Price Deficiency Payment under PM-AASHA for excluded crops, and integrate nutri-millets into PDS by 2030 under MoCAFPD.

SOURCES

→FCI — Stocks Position Reports
→Anantam IAS — Flaws in Open-Ended Procurement
→Anantam IAS — MSP Regime

open-ended procurement | FCI | buffer stock | DCP | food subsidy

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Q44

Trace the evolution of India's Public Distribution System and evaluate the One Nation One Ration Card (ONORC) initiative.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | PDS

ANSWER OUTLINE

Introduction: PDS launched 1960s for urban areas; TPDS 1997 introduced; National Food Security Act 2013 entitles 81.35 crore beneficiaries; ONORC operational across all 36 states/UTs since June 2022.

Body: 1) Evolution — TPDS, Antyodaya Anna Yojana (1.5 crore households), PMGKAY extended five years from Jan 2024 (₹11.8 lakh crore). 2) ONORC — Integrated Management of PDS (IMPDS) on Annavitran portal; over 145 crore portability transactions. 3) Gaps — exclusion errors (Census 2011 base), 35 kg vs PMGKAY 5 kg per person per month difference, FPS leakage.

Way forward: Use SECC 2021 once finalised; e-PoS Aadhaar authentication penetration; cash transfer pilots in surplus states; biometric exemption for elderly.

KEY POINTS TO INCLUDE

- NFSA 2013 covers 81.35 crore
- ONORC operational across 36 states/UTs (Jun 2022)
- PMGKAY extended 5 years Jan 2024 — ₹11.8 lakh crore
- AAY — 1.5 crore households
- IMPDS-Annavitran portal

- 145+ crore portability transactions
- Census 2011 still the base

EXAMPLES & CASE STUDIES

- Tamil Nadu universal PDS
- Chhattisgarh CORE PDS reform
- Andhra Pradesh smart card
- e-PoS coverage at 95%+ FPS

MODEL ANSWER

Introduction:

The National Food Security Act 2013 entitles 81.35 crore beneficiaries to subsidised foodgrain; the One Nation One Ration Card (ONORC) has been operational across all 36 states and UTs since June 2022, recording over 145 crore portability transactions on the Annavitran portal — making India's PDS the world's largest food-security platform.

Evolution:

PDS began as an urban rationing system in the 1960s, was reorganised as the Targeted PDS in 1997, and graduated to a rights-based regime under NFSA 2013. Antyodaya Anna Yojana extends 35 kg per household to 1.5 crore poorest families, while PMGKAY (extended for five years from January 2024 with a ₹11.8 lakh crore outlay) doubled entitlements during COVID-19. Tamil Nadu's universal PDS and Chhattisgarh's CORE reforms became national benchmarks.

ONORC architecture:

Built on the Integrated Management of PDS (IMPDS) and Annavitran portals, ONORC uses Aadhaar-based biometric authentication at e-PoS terminals in over 95% of Fair Price Shops. Migrant workers can draw partial rations anywhere — a structural answer to interstate labour mobility revealed during the 2020 lockdown.

Persistent gaps:

Coverage still uses Census 2011 ratios, excluding millions added since; biometric failures hurt the elderly, disabled, and labourers with worn fingerprints; PMGKAY's 5 kg per person sits awkwardly beside AAY's 35 kg household entitlement. Leakages persist in non-DCP states, and many migrants are unaware of portability.

Way forward / Conclusion:

> Adopt SECC 2021 data once finalised, mandate biometric exemption for the elderly, scale cash-transfer pilots in surplus states, and integrate ONORC with the e-Shram migrant database by 2027 under MoCAFPD.

SOURCES

→Department of Food and Public Distribution
→Anantam IAS — Public Distribution System

PDS ONORC NFSA PMGKAY AAY IMPDS FPS

Q45

What is the function of buffer stocks in India's food security architecture? Explain the operational role of FCI.

10 MARKS | 150 WORDS | 9 MIN | EASY | FOOD SECURITY

ANSWER OUTLINE

Introduction: Food Corporation of India Act 1964; Section 17 mandates price stability via procurement and buffer; current buffer norms — wheat 21 LMT (Jan 1) to 275 LMT (Apr 1), rice scaling similarly.

Body: 1) Functions — price support, market stabilisation, PDS supply, strategic reserve. 2) Operations — MSP procurement from Punjab-Haryana, intra-state transport, storage at 1,800+ depots. 3) Open Market Sale Scheme (OMSS) for price moderation.

Way forward: Cost optimisation under Shanta Kumar Committee 2015; outsource procurement to states (DCP expansion); modernise depots via steel silos.

KEY POINTS TO INCLUDE

- FCI Act 1964 — Section 17
- Buffer norms 21.04 MT (Apr 1)
- OMSS for price stabilisation
- Shanta Kumar Committee 2015
- 1,800+ FCI depots
- PMGKAY extended five years

EXAMPLES & CASE STUDIES

- Tomato OMSS 2023
- Bharat Atta and Bharat Dal NAFED
- Wheat OMSS February 2023

- Onion buffer NAFED/NCCF

MODEL ANSWER

Introduction: The Food Corporation of India Act 1964, especially Section 17, mandates FCI to ensure price stability through procurement and buffer stocking; wheat buffer norms scale from 21 LMT (1 January) to 275 LMT (1 April), while rice norms follow a parallel quarterly grid.

Body: First, buffer stocks underpin price support to farmers, market stabilisation, NFSA-PDS supply, and a strategic reserve against shocks like droughts or geopolitical disruption. Second, FCI operates 1,800+ depots, procures from Punjab-Haryana mandis at MSP, and moves grain through dedicated rail rakes coordinated with the Indian Railways. Third, the Open Market Sale Scheme (OMSS) is used to cool retail prices, as seen in tomato (2023), wheat OMSS (February 2023), and Bharat Atta and Bharat Dal under NAFED-NCCF channels.

Way forward: Implement Shanta Kumar Committee 2015 recommendations — expand Decentralised Procurement, modernise depots into steel silos, outsource non-core logistics, and link OMSS releases to a real-time price-trigger dashboard at MoCAFPD by FY28.

SOURCES

→Food Corporation of India
→Anantam IAS — Food Security

FCI | buffer stock | OMSS | MSP | Shanta Kumar | DCP

Q46

Examine the constraints in India's food processing sector and the role of the Mega Food Park and SAMPADA schemes in addressing them.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | FOOD PROCESSING

ANSWER OUTLINE

Introduction: MoFPI Annual Report 2023-24: food processing 7.7% of manufacturing GVA, 12.2% of agri GVA; PMKSY (Pradhan Mantri Kisan Sampada Yojana, formerly SAMPADA) operational since 2017; perishable processing only ~10%.

Body: 1) Constraints — backward linkages, cold chain (only 8.4 lakh MT vs 31 lakh MT demand), credit, MSME formalisation. 2) PMKSY components — Mega Food Parks (24

operational), cold chain (320), integrated cold chains. 3) Operation Greens for TOP (tomato-onion-potato) → All Fruits & Vegetables since 2021.

Way forward: Converge with PM Formalisation of Micro Food Processing Enterprises (PMFME, ₹10,000 crore); align with ONE District ONE Product (ODOP); CIPHET R&D for shelf-life extension.

KEY POINTS TO INCLUDE

- Food processing 7.7% of mfg GVA (MoFPI 2023-24)
- PMKSY since 2017 (rebranded SAMPADA)
- 24 Mega Food Parks operational
- 320 cold chain projects
- PMFME ₹10,000 crore (2020)
- Operation Greens expanded to all F&V (2021)
- ODOP integration via PMFME

EXAMPLES & CASE STUDIES

- Patanjali Mega Food Park
- Srini Food Park, Chittoor
- Amul cold chain leadership
- MoFPI PLI ₹10,900 crore for food processing

MODEL ANSWER

> **Introduction**:
>
> MoFPI's Annual Report 2023-24 records food processing at 7.7% of manufacturing GVA and 12.2% of agricultural GVA; the Pradhan Mantri Kisan Sampada Yojana (PMKSY), formerly SAMPADA, has been operational since 2017, anchoring backward-forward linkages. Yet perishable processing remains under 10%, betraying a structural gap between farm output and value addition.
>
> **Structural constraints**:
>
> Backward linkages are weak — fragmented holdings, poor aggregation, and FPO immaturity raise raw-material variability. Cold-chain capacity stands at ~8.4 lakh MT against an estimated 31 lakh MT demand. MSME formalisation lags, credit is costly, skilled labour for food technology is thin outside metros, and post-harvest losses for fruits and vegetables remain near 30%.
>
> **Role of Mega Food Parks and PMKSY**:

24 Mega Food Parks (e.g., Patanjali, Srini Chittoor) are operational, alongside 320 integrated cold-chain projects under PMKSY. Operation Greens, expanded from TOP (tomato-onion-potato) to all fruits and vegetables in 2021, stabilises perishable prices. PM Formalisation of Micro Food Processing Enterprises (PMFME), with a ₹10,000 crore outlay since 2020, anchors ODOP-linked clusters across districts.

Limits and convergence:

Many Food Parks operate below capacity due to anchor-unit gaps; cold-chain monitoring is patchy. The ₹10,900 crore PLI for food processing has yet to attract sufficient brand-led aggregation in millets and ready-to-eat segments, and the Amul cold-chain model has not been replicated outside dairy.

Way forward / Conclusion:

Converge PMKSY, PMFME, and ODOP through a single MoFPI dashboard; deploy CIPHET R&D for shelf-life extension; mandate FPO-anchored backward linkages in Mega Food Parks; raise processing share to 25% by 2030.

SOURCES

- →MoFPI Annual Report 2023-24
- →Anantam IAS — Food Processing Sector
- →Anantam IAS — Food Processing Industry India

food processing | PMKSY | Mega Food Park | PMFME | Operation Greens | ODOP | cold chain

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Q47

Critically examine the constraints of land consolidation in India and the case for a Model Agricultural Land Leasing framework.

15 MARKS | 250 WORDS | 14 MIN | HARD | LAND REFORMS

ANSWER OUTLINE

Introduction: Fragmented holdings — 86% small/marginal (Agri Census 2015-16); leasing legally restricted in many states; NITI Aayog Model Agricultural Land Leasing Act 2016 adopted by only a handful (UP, Uttarakhand, MP, AP).

Body: 1) Constraints — informal tenancy hides 25-30% leased area, locks credit, insurance access. 2) Existing consolidation — Punjab, Haryana, Western UP successes; eastern stagnation. 3) Land records — digitisation via DILRMP, geo-referencing under SVAMITVA, Bhulekh portals.

Way forward: Adoption of Model Land Leasing Act by states; recognise tenant rights without adversarial possession; integrate with KCC and PMFBY portability; National Spatial Data Infrastructure expansion.

KEY POINTS TO INCLUDE

- 86% holdings small/marginal (Agri Census 2015-16)
- Model Land Leasing Act 2016 — NITI Aayog
- Informal tenancy 25-30%
- SVAMITVA — 65,000+ villages covered
- DILRMP digitisation
- Bhumi/Bhulekh portals in 30+ states

EXAMPLES & CASE STUDIES

- UP adoption 2018
- Karnataka Land Reforms Amendment 2020
- Madhya Pradesh tenancy
- Andhra crop e-Pattadar Pass

MODEL ANSWER

Introduction:

The 10th Agricultural Census (2015-16) recorded 86% of operational holdings as small or marginal, with an average size of 1.08 hectares; informal tenancy estimated at 25-30% of operated area remains legally hidden. The NITI Aayog Model Agricultural Land Leasing Act 2016 has been adopted by only Uttar Pradesh, Uttarakhand, Madhya Pradesh, and Andhra Pradesh — leaving most farmers stranded between fragmentation and informal leasing.

Constraints in consolidation:

Tenancy restrictions in many states force concealed leasing, denying tenants access to KCC, PMFBY, and PM-KISAN. Cadastral records are outdated, with overlapping mutations and unrecorded inheritances. Consolidation has succeeded in Punjab, Haryana, and western UP but stalled across the eastern belt, where caste, political economy, and revenue-administration weakness constrain reform.

Case for a Model Leasing framework:

A statutory recognition of leasing without adverse-possession risk would formalise the 25-30% concealed tenant economy, unlock credit and insurance, and incentivise

tenant investment. It would also enable landowners to lease out without fear of permanent forfeiture, encouraging consolidation of operational units even where ownership remains fragmented.

Digital land-records backbone:

SVAMITVA (April 2020) has drone-mapped 65,000+ villages, generating property cards. DILRMP integrates record-of-rights, registration, cadastral maps, and survey via Bhumi/Bhulekh portals in 30+ states. Geo-referenced records are the precondition for credible leasing.

Way forward / Conclusion:

Push Model Land Leasing Act adoption through a 16th Finance Commission incentive grant, complete DILRMP and SVAMITVA by 2027 under MoRD, integrate records with KCC and PMFBY, and recognise tenant rights without adversarial possession.

SOURCES

→NITI Aayog — Model Agricultural Land Leasing Act 2016
→Anantam IAS — Land Reforms
→Anantam IAS — Reorganisation of Agriculture

land leasing | consolidation | SVAMITVA | DILRMP | tenancy | Model Act

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Q48

Discuss the achievements of Operation Flood and the role of NDDB in sustaining India's leadership in milk production.

10 MARKS | 150 WORDS | 9 MIN | EASY | ANIMAL HUSBANDRY

ANSWER OUTLINE

Introduction: India produced 230.58 MT of milk in 2022-23 (DAHD Basic Animal Husbandry Statistics 2024), world's largest producer (~24% global); Operation Flood (1970-96) under V. Kurien and NDDB.

Body: 1) Achievements — Anand pattern cooperatives, milk per capita 459 g/day. 2) Schemes — Rashtriya Gokul Mission (RGM, ₹2,400 crore), National Dairy Plan-II, e-Gopala app, IVF Mission Sex-Sorted Semen. 3) Constraints — low productivity (4-5 kg/day vs global 25 kg), feed costs, climate stress.

Way forward: Multi-State Cooperative Societies Act amendment for inter-state cooperatives; Animal Husbandry Infrastructure Development Fund (₹29,610 crore) deployment.

KEY POINTS TO INCLUDE

- Milk output 230.58 MT (DAHD 2022-23)
- Per capita 459 g/day
- Operation Flood 1970-96
- Rashtriya Gokul Mission ₹2,400 crore
- AHIDF ₹29,610 crore
- e-Gopala digital platform

EXAMPLES & CASE STUDIES

- Amul, Mother Dairy
- NDDB Anand model
- Banas Dairy Gujarat
- Sahakar Se Samriddhi push

MODEL ANSWER

> **Introduction:** India produced 230.58 million tonnes of milk in 2022-23 (DAHD Basic Animal Husbandry Statistics 2024), retaining its position as the world's largest producer with ~24% of global output; Operation Flood under V. Kurien and the National Dairy Development Board (1970-96) created the cooperative architecture.
>
> **Body:** First, Operation Flood replicated the Anand pattern across India, lifting per-capita availability to 459 g/day and embedding Amul, Mother Dairy, and Banas Dairy as anchor brands. Second, current support flows through the Rashtriya Gokul Mission (₹2,400 crore) for indigenous breeds, the Animal Husbandry Infrastructure Development Fund (₹29,610 crore), and the e-Gopala digital platform. Third, productivity remains 4-5 kg/day per animal versus ~25 kg globally, with feed costs and climate stress as binding constraints.
>
> **Way forward:** Operationalise Multi-State Cooperative Societies Act amendments under "Sahakar Se Samriddhi," expand IVF Sex-Sorted Semen Mission, and deploy AHIDF for chilling-processing infrastructure by 2030 under DAHD.

SOURCES

→DAHD Basic Animal Husbandry Statistics 2024
→Anantam IAS — White Revolution India
→Anantam IAS — Animal Husbandry Dairy India

Operation Flood | NDDB | Rashtriya Gokul Mission | AHIDF | white revolution

Q49

Evaluate the Pradhan Mantri Matsya Sampada Yojana and India's emerging blue economy strategy under the Sagarmala framework.

15 MARKS | 250 WORDS | 14 MIN | HARD | FISHERIES & BLUE ECONOMY

ANSWER OUTLINE

Introduction: India is second-largest fish producer (16.25 MT in FY23, DAHD); PMMSY (₹20,050 crore, 2020-25) targets fish output 22 MT by FY25; Draft Blue Economy Policy under MoES, 2022.

Body: 1) PMMSY achievements — sub-component PM-MKSSY (₹6,000 crore, 2024) for formalisation; sea-cage culture, fishing harbours. 2) Blue economy pillars — marine fisheries, deep-sea mining, port-led growth, coastal tourism (Niti Aayog framework 2021). 3) Constraints — overfishing, IUU, climate impact, livelihood vulnerability.

Way forward: Implement Marine Fisheries Bill (pending) with state cooperation; Sagar Mitra extension; FFPOs analogous to FPOs; PMMSY-II post-FY25 with climate adaptation focus.

KEY POINTS TO INCLUDE

- Fish output 16.25 MT FY23 (DAHD)
- PMMSY ₹20,050 crore (2020-25)
- PM-MKSSY ₹6,000 crore (2024) for formalisation
- Target 22 MT by FY25
- Draft Blue Economy Policy 2022 (MoES)
- Sagarmala blue economy convergence
- India 2nd largest fish producer globally

EXAMPLES & CASE STUDIES

- Andhra Pradesh shrimp exports
- Kerala FFPOs
- Deep Ocean Mission (MoES)
- Sagar Parikrama yatra

MODEL ANSWER

> **Introduction:**
>
> India is the world's second-largest fish producer at 16.25 million tonnes in FY23 (DAHD); the Pradhan Mantri Matsya Sampada Yojana (PMMSY) commits ₹20,050

crore over 2020-25, targeting fish output of 22 MT by FY25, while the Draft Blue Economy Policy under MoES (2022) frames marine fisheries within a multi-sector ocean strategy aligned with SDG-14.

PMMSY achievements:

PMMSY has rolled out sea-cage culture, modern fishing harbours, ice-plants, and aquaculture insurance. The sub-component PM-MKSSY (₹6,000 crore, 2024) formalises 40 lakh fish workers via Aadhaar-linked Fisheries IDs and credit access. Andhra Pradesh leads shrimp exports; Kerala has pioneered Fish Farmer Producer Organisations; Sagar Mitra extension workers anchor coastal villages.

Blue economy pillars:

The Draft Blue Economy Policy identifies seven verticals — marine fisheries, deep-sea mining, port-led growth via Sagarmala, coastal tourism, marine renewable energy, marine biotechnology, and maritime services. The Deep Ocean Mission under MoES (₹4,077 crore) targets seabed mineral exploration; the Sagar Parikrama yatra integrates coastal community feedback into policy.

Constraints:

Overfishing in nearshore zones, IUU fishing, climate-driven shifts in fish migration, and weak post-harvest cold chains depress export quality. The Marine Fisheries Bill remains pending, weakening federal coordination on EEZ regulation, and livelihood vulnerability among traditional fishers persists.

Way forward / Conclusion:

Pass the Marine Fisheries Bill, scale Fish FPOs analogous to agri-FPOs, launch PMMSY-II post-FY25 under DoF with climate-adaptation modules, and integrate Deep Ocean Mission with Sagar Mitra extension by 2030.

SOURCES

- →Department of Fisheries — Annual Report 2023-24
- →Anantam IAS — Fisheries Blue Revolution
- →Anantam IAS — Fisheries India

PMMSY | Blue Economy | FFPO | MKSSY | Deep Ocean Mission | Sagar Mitra

GS PAPER 3

Sci-Tech

20 practice questions

Q50

India's Semiconductor Mission has approved five fabs and committed ₹76,000 crore in incentives. Examine the strategic logic, the demand-supply gap, and the policy risks of building chip sovereignty.

15 MARKS | 250 WORDS | 14 MIN | HARD | SEMICONDUCTORS

ANSWER OUTLINE

Introduction: India Semiconductor Mission (ISM) launched 2021 with ₹76,000 crore outlay; approved fabs include Tata-PSMC Dholera, Micron ATMP Sanand, CG Power-Renesas, Kaynes Sanand and Tata Jagiroad OSAT (cumulative ~₹1.5 lakh crore investment).

Body: 1) Strategic logic — chip imports ~$30 bn FY24; geopolitical concentration in Taiwan and Korea; Pax Silica framing. 2) Programme architecture — SPECS, DLI, modified incentive scheme covering 50% capex. 3) Risks — IP and talent gap, water and power needs (Dholera 110 ML/day), trailing-edge node focus (28-65 nm).

Way forward: Scale Semicon India 2.0 with leading-edge node pathway; expand C-DAC and IITs through Chips to Startup; align with US CHIPS Act dialogue and Quad supply chain.

KEY POINTS TO INCLUDE

- ISM outlay ₹76,000 crore (2021)
- Approved fabs — Tata-PSMC Dholera 28nm, Micron ATMP Sanand, Tata OSAT Jagiroad, CG-Renesas, Kaynes
- DLI scheme for fabless design
- MeitY and SemiconIndia programme
- Pax Silica — chip geopolitics framing
- Quad Critical and Emerging Technology Working Group
- Chips to Startup Programme — 85,000 engineers target
- Electronics Component Manufacturing Scheme (ECMS) 2025

EXAMPLES & CASE STUDIES

- Tata-PSMC Dholera fab (28-110nm)

- Micron Sanand OSAT first chip 2025
- Tata Jagiroad OSAT Assam
- L&T Semiconductor Technologies

MODEL ANSWER

Introduction:

The India Semiconductor Mission, launched under MeitY in December 2021 with a corpus of ₹76,000 crore, has approved five fabrication and ATMP units — Tata-PSMC Dholera (28 nm logic), Micron Sanand, Tata-OSAT Morigaon, CG Power Sanand and Kaynes Sanand — committing investment of ₹1.5 lakh crore (PIB, March 2026).

Strategic logic: Global chip supply was disrupted by COVID-19 and the 2022 Taiwan contingency planning; the US CHIPS and Science Act 2022 ($52 bn) and EU Chips Act ($46 bn) reset state-backed industrial policy. India's mission aligns with QUAD Critical and Emerging Tech Working Group commitments and reduces import reliance — current chip imports were $28 bn in FY25 (DGFT data).

Demand-supply gap: Domestic semiconductor consumption will rise from $38 bn (2023) to $109 bn by 2030 (IESA-Counterpoint 2024). The five approved units cover only mature nodes (28 nm and above); leading-edge logic (sub-7 nm) remains absent, and the Compound Semiconductor Mission and the second tranche of ISM Phase-2 are awaiting Cabinet clearance.

Policy gaps: India lacks fab-grade ultra-pure water (8 million litres/day per fab), continuous power, ASML EUV access, and a deep talent pool — only 35,000 chip design engineers against a 2030 need of 1 lakh (NASSCOM 2024). The DLI scheme for design start-ups has approved 24 firms.

Way forward:

MeitY should clear ISM Phase-2 (₹40,000 crore additional) by FY27, integrate the Compound Semiconductor Mission, finance 85,000 Chips-to-Startup engineers under C2S, and align ISM with Skill India and IndiaAI Mission for sovereign capability.

SOURCES

→MeitY — SemiconIndia Programme
→Anantam IAS — India Semiconductor Mission
→Anantam IAS — India Semiconductor Plants Locations

ISM OSAT ATMP DLI Pax Silica Dholera node Quad

Q51

Digital Public Infrastructure has been called India's most consequential tech export. Examine the architecture of the India Stack and the governance gaps highlighted by the DPDP Act 2023.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | DPI

ANSWER OUTLINE

Introduction: UPI processed 18.4 billion transactions worth ₹24.77 lakh crore in May 2025 (NPCI data); Aadhaar enrolment crossed 1.4 billion; the India Stack now spans identity, payment, data and discovery layers.

Body: 1) Four layers — Aadhaar/DigiLocker (identity), UPI/AePS (payment), Account Aggregator/DEPA (data), ONDC/OCEN (discovery and credit). 2) DPDP Act 2023 — Data Principal rights, Consent Manager, Data Protection Board, child data norms. 3) Gaps — algorithmic accountability, deemed consent narrowness, cross-border data flow rules pending.

Way forward: Notify DPDP Rules with grievance redress; standardise Account Aggregator under RBI Master Directions; export DPI through G20 Global DPI Repository; preserve open standards via MOSIP.

KEY POINTS TO INCLUDE

- UPI 18.4 bn transactions May 2025 (NPCI)
- Aadhaar enrolments 1.4 billion+ (UIDAI)
- India Stack — four layers identity/payment/data/discovery
- DPDP Act 2023 — Sections 6 (consent), 11 (rights), 18-26 (DPB)
- Account Aggregator framework RBI 2016, 2022
- ONDC Open Network for Digital Commerce
- G20 Global DPI Repository launched under India presidency
- MOSIP open-source identity stack

EXAMPLES & CASE STUDIES

- UPI launched 2016 by NPCI
- DigiLocker for academic records
- Bhashini for vernacular DPI
- PM Jan Dhan Yojana — 53 crore accounts

MODEL ANSWER

Introduction:

India's Digital Public Infrastructure stack — Aadhaar (138 crore IDs), UPI (16,800 crore transactions worth ₹247 lakh crore in FY25, NPCI), DigiLocker (35 crore users) and CoWIN — has been adopted across 30 countries under the G20 New Delhi Leaders' Declaration 2023 DPI compact. India's DEPA 2.0, ONDC and Account Aggregator framework form the second generation.

Architecture: India Stack is built on the JAM trinity (Jan Dhan-Aadhaar-Mobile), enabling ₹38 lakh crore DBT transfers and saving the exchequer ₹3.48 lakh crore in leakage (NeGD, 2024). The stack is layered — identity (Aadhaar), payment (UPI), data (Account Aggregator under RBI's NBFC-AA licence), and commerce (ONDC with 6.3 lakh sellers, March 2026).

Governance gaps: The Justice K.S. Puttaswamy judgment (2017) and the Digital Personal Data Protection Act 2023 establish rights but lack the operationalised Data Protection Board, which the IndiaAI Mission also relies upon. The Srikrishna Committee's deletion right and consent-manager safeguards await Rules. Deepfake threats, Aadhaar enrolment-quality issues (CAG Report 2022 noted 4.75 crore duplicate authentications), and platform exclusion of digitally-illiterate users persist.

Global exports: India has signed MoUs with Brazil, Sri Lanka, France and the African Union to export India Stack components under the Modular Open Source Identity Platform. The DPI as a global public good was anchored in the G20 framework.

Way forward:

MeitY should notify DPDP Rules and constitute the Data Protection Board by Q2 FY27, fund the IndiaAI Compute facility (₹10,372 crore), and create a DPI Safe Harbour for cross-border interoperability under the Global DPI Repository.

SOURCES

→MeitY — DPDP Act 2023 and Draft Rules
→Anantam IAS — Digital Public Infrastructure and India Stack
→Anantam IAS — DPDP Act 2023

UPI | Aadhaar | DPI | DPDP | Account Aggregator | ONDC | MOSIP | Consent Manager

Q52

Indian Space Policy 2023 has opened the sector to private players. Evaluate the policy's design, the role of IN-SPACe and NSIL, and the gaps in financing and IP frameworks.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | SPACE

ANSWER OUTLINE

Introduction: Indian Space Policy 2023 demarcates roles of ISRO (R&D), IN-SPACe (regulator-promoter), NSIL (commercial arm) and NGEs (private entities); India's space economy is targeted at $44 bn by 2033 (IN-SPACe Decadal Vision).

Body: 1) Policy enablers — 100% FDI under automatic route (revised 2024), GST relief, technology transfer norms. 2) Achievements — SpaDeX docking, EOS-08, Agnikul Cosmos, Skyroot Vikram-S. 3) Gaps — Space Activities Bill pending, IP and liability law, venture capital depth.

Way forward: Enact Space Activities Bill in 2026; expand IN-SPACe Technology Transfer Centre; deepen ANIC and venture financing under DPIIT.

KEY POINTS TO INCLUDE

- Indian Space Policy 2023
- IN-SPACe under DoS; NSIL CPSE
- 100% FDI automatic route 2024 amendment
- Space economy target $44 bn by 2033 (IN-SPACe)
- SpaDeX docking 2025 — fourth nation
- Agnikul SOrTeD, Skyroot Vikram-S
- Space Activities Bill in drafting

EXAMPLES & CASE STUDIES

- Agnikul Cosmos semi-cryogenic engine
- Pixxel hyperspectral constellation
- Bellatrix Aerospace electric propulsion
- Dhruva Space

MODEL ANSWER

> **Introduction:** The Indian Space Policy 2023, notified 6 April 2023, opens the entire value chain to non-government entities and targets 8% of the $630 bn global space economy by 2030 (ISRO Vision).

Body: IN-SPACe (autonomous body, single-window authoriser) has authorised 75+ private players including Skyroot, Agnikul and Pixxel. NSIL, the commercial arm, raised ₹2,300 crore through GSAT-N2 lease and SSLV technology transfer. The Cabinet (February 2024) approved 100% FDI under automatic route up to 74% in satellite manufacturing, with a ₹1,000 crore Venture Capital Fund (October 2024). Gaps: absent national space law (Space Activities Bill pre-legislative), unclear IP regime for ISRO-private collaborations, low demand aggregation, and limited insurance and launch-pad capacity beyond SDSC-SHAR.

Way forward: The Department of Space should table the Space Activities Bill by Q3 FY27, operationalise the IN-SPACe Tech Adoption Fund (₹500 crore), and notify IP-licensing norms for ISRO technology.

SOURCES

→Indian Space Policy 2023 — Department of Space
→Anantam IAS — Indian Space Policy 2023
→Anantam IAS — SpaDeX Space Docking Experiment

IN-SPACe | NSIL | NGE | SpaDeX | FDI | space economy | Space Activities Bill

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Q53

The BioE3 Policy 2024 envisions a bio-manufacturing-led economy. Discuss its pillars, the Genome India Project's role in precision medicine, and the regulatory architecture for gene editing.

15 MARKS | 250 WORDS | 14 MIN | HARD | BIOTECH

ANSWER OUTLINE

Introduction: Cabinet approved the BioE3 Policy (Biotechnology for Economy, Environment, Employment) in August 2024; India's bioeconomy is estimated at $165.7 billion (~5.2% of GDP, India BioEconomy Report 2024) and is targeted at $300 billion by 2030.

Body: 1) BioE3 pillars — bio-based chemicals, functional foods, precision biotherapeutics, climate-resilient agriculture, marine and space research, carbon capture. 2) Genome India Project sequenced 10,000 whole genomes (Jan 2025 milestone); IBDC repository. 3) Gene editing — DBT 2022 guidelines exempt SDN-1, SDN-2 from GM regulation under EPA 1986.

Way forward: Operationalise National Bio-manufacturing Hubs; align Drugs and Cosmetics Act with CDSCO biosimilar pathway; fast-track Cell and Gene Therapy NexCAR19 commercialisation.

KEY POINTS TO INCLUDE

- BioE3 Policy August 2024 — DBT
- Bioeconomy size $165.7 bn (~5.2% GDP)
- Genome India Project 10,000 genomes (CSIR-IGIB)
- IBDC Indian Biological Data Centre
- SDN-1 SDN-2 SDN-3 classification
- DBT 2022 Genome Edited Crops Guidelines
- NexCAR19 IIT Bombay CAR-T therapy
- CDSCO biosimilar pathway

EXAMPLES & CASE STUDIES

- GenRobotics drone
- Bharat Biotech Covaxin
- NexCAR19 ImmunoACT
- Biological E vaccines

MODEL ANSWER

Introduction:

The BioE3 Policy 2024 (Biotechnology for Economy, Environment and Employment), approved by the Cabinet in August 2024 under the Department of Biotechnology, targets the bio-economy at $300 bn by 2030 and $1.1 trillion by 2047, up from $151 bn in 2023 (India BioEconomy Report 2024).

Pillars: BioE3 builds six thematic verticals — high-value bio-based chemicals, smart proteins, precision biotherapeutics, climate-resilient agriculture, carbon-capture, and marine and space bio-manufacturing. It establishes Bio-AI Hubs, Biofoundries and Biomanufacturing Hubs co-funded with the Anusandhan National Research Foundation Act 2023 (₹50,000 crore over 2023-28).

Genome India Project: The DBT-funded Genome India Project completed whole-genome sequencing of 10,000 individuals across 99 ethnic groups by January 2025 (DBT release). It anchors precision medicine for monogenic disorders such as sickle-cell anaemia — under the National Sickle Cell Anaemia Elimination Mission 2047 (₹1,500 crore, 17 states), 3.6 crore people have been screened. The Indian Biological Data Centre at RCB stores 8 petabytes of sequence data.

Regulatory architecture: GMO clearance under EPA 1986 Rules 1989 by GEAC remains contested — the Bt-brinjal moratorium (2010) and DMH-11 mustard Supreme

> Court split verdict (July 2024) reflect public-trust gaps. The DNA Technology Bill 2019 lapsed; the BSL-4 lab at NIV Pune handles only ten select agents.
>
> **Way forward**:
>
> DBT should table the Biosafety and Genetic Engineering Authority Bill by FY27, operationalise BioRRAP and ANRF Biofoundries in 5 cities, and tier Genome India Phase-2 to 1 lakh genomes for SCD, thalassemia and rare-disease precision care.

SOURCES

→Department of Biotechnology — BioE3 Policy
→Anantam IAS — Genome India Project
→Anantam IAS — SDN-1 SDN-2 SDN-3 Techniques

BioE3 | bioeconomy | GIP | SDN | CAR-T | biosimilar | CDSCO | DBT

Q54

The IndiaAI Mission has been called the country's most ambitious sovereign AI bet. Examine its seven pillars, the compute strategy, and the gaps in indigenous foundation-model capacity.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | IT AND AI

ANSWER OUTLINE

Introduction: Union Cabinet approved the IndiaAI Mission on 7 March 2024 with an outlay of ₹10,371.92 crore over five years (MeitY); Stanford HAI AI Index 2025 ranks India 2nd globally on AI talent with ~50,460 AI authors and inventors.

Body: 1) Seven pillars — AIKosh datasets, Compute Capacity (10,000+ GPUs PPP), Innovation Centre, Application Development, FutureSkills, Startup Financing, Safe and Trusted AI. 2) Compute gap — single empanelled provider concentration risk; lag against US and China hyperscalers. 3) Foundation-model gap — India funds applied AI but lacks a sovereign frontier model; Sarvam-1 and Krutrim are small relative to GPT-4 class.

Way forward: Operationalise the AI Safety Institute; pre-fund a sovereign frontier-model consortium; mandate compute neutrality; align with the IT (Intermediary) Amendment Rules 2026 on synthetic content.

KEY POINTS TO INCLUDE

- IndiaAI Mission outlay ₹10,371.92 crore over five years (Cabinet, 7 March 2024)
- Seven pillars include AIKosh, Compute Capacity, Innovation Centre, FutureSkills
- Target of 10,000+ GPUs through public-private partnership

- Stanford HAI AI Index 2025 — India 2nd on AI talent (~50,460 authors)
- India passed only one AI-related law 2016-2025 per Stanford index
- Public concern about AI rose ~14 percentage points 2024-2025
- IT (Intermediary) Amendment Rules 2026 notified 10 Feb 2026
- AI Safety Institute announced under IndiaAI Mission

EXAMPLES & CASE STUDIES

- AIKosh data platform launch March 2025
- AI Compute Portal empanelment under IndiaAI
- Sarvam AI, Krutrim, Ola foundation-model bets
- EU AI Act risk-based framework as comparator

MODEL ANSWER

Introduction:

The Union Cabinet approved the IndiaAI Mission on 7 March 2024 with an outlay of ₹10,371.92 crore over five years under MeitY; Stanford HAI's AI Index 2025 ranks India 2nd globally on AI talent with ~50,460 authors and inventors. The mission is India's sovereign bet to translate a deep talent base into compute, data, and frontier-model capacity, against a global race led by US-China hyperscalers.

Seven pillars:

The mission rests on AIKosh datasets, Compute Capacity targeting 10,000+ GPUs through PPP, the IndiaAI Innovation Centre, Application Development, FutureSkills, Startup Financing, and Safe & Trusted AI anchored by an AI Safety Institute. AIKosh launched in March 2025 to anchor non-personal data for Indic-language models.

Compute strategy and concentration risk:

The AI Compute Portal empanels providers for subsidised GPU access. However, a thin set of empanelled hyperscalers creates concentration risk — India's compute footprint remains an order of magnitude below US and Chinese clusters, and equipment depends on imported NVIDIA H100/H200-class accelerators subject to US export-control regimes.

Foundation-model gap:

India funds application AI but no sovereign frontier model. Sarvam-1, Krutrim, and Ola Krutrim are small relative to GPT-4-class systems. Stanford 2025 notes India

passed only one AI-related law during 2016-2025, with public concern rising ~14 percentage points in a single year against an under-developed governance ecosystem.

Way forward / Conclusion:

Operationalise the AI Safety Institute, pre-fund a sovereign frontier-model consortium with ₹5,000 crore catalytic capital, mandate compute neutrality, and align IT (Intermediary) Amendment Rules 2026 with risk-tiered model governance by 2027 under MeitY.

SOURCES

→IndiaAI Mission — MeitY
→Stanford HAI AI Index 2025
→Anantam IAS — Generative AI and LLMs Explainer

IndiaAI Mission | foundation model | AIKosh | AI Safety Institute | compute | GPU | sovereign AI | MeitY

Q55

India's Unified Payments Interface processes over 18 billion transactions a month and has been described as India's most consequential tech export. Examine UPI's global footprint and the systemic risks of payment concentration.

10 MARKS | 150 WORDS | 9 MIN | EASY | FINTECH AND DPI

ANSWER OUTLINE

Introduction: NPCI reported 18.4 billion UPI transactions in March 2025, worth ₹24.77 lakh crore — the world's largest real-time retail payments rail.

Body: 1) Global rollout — UPI live in UAE, Singapore PayNow link, France (Eiffel Tower), Sri Lanka, Mauritius, Bhutan. 2) Concentration risk — PhonePe and Google Pay together ~85% market share against NPCI's 30% cap (deferred to Dec 2026). 3) Zero-MDR sustainability vs incentive scheme of ₹1,500 crore (Budget 2025-26).

Way forward: Operationalise the 30% market-share cap; expand UPI-PayNow style linkages; price small-merchant MDR transparently.

KEY POINTS TO INCLUDE

- UPI transactions 18.4 billion in March 2025 (NPCI)
- Value ₹24.77 lakh crore in March 2025
- PhonePe + Google Pay >85% market share
- NPCI 30% cap deferred to 31 December 2026

- UPI-PayNow linkage with Singapore live February 2023
- Zero-MDR for P2M up to ₹2,000; ₹1,500 crore incentive in Budget 2025-26

EXAMPLES & CASE STUDIES

- UPI launch 11 April 2016 by NPCI
- UPI live at Eiffel Tower from February 2024
- BHIM app and UPI Lite 2.0

MODEL ANSWER

Introduction: NPCI reported 18.4 billion UPI transactions worth ₹24.77 lakh crore in March 2025, making it the world's largest real-time retail payments rail and arguably India's most consequential tech export since its launch on 11 April 2016 by the National Payments Corporation of India.

Body: First, global footprint — UPI is live in UAE, Singapore (PayNow linkage from February 2023), France (Eiffel Tower from February 2024), Sri Lanka, Mauritius, Bhutan, and Nepal, anchoring India's digital diplomacy. Second, concentration risk — PhonePe and Google Pay together command over 85% market share against NPCI's 30% market-share cap (deferred to 31 December 2026), creating systemic single-point-of-failure risk. Third, zero-MDR for P2M up to ₹2,000 strains payment-aggregator economics; Budget 2025-26 carries a ₹1,500 crore incentive scheme.

Way forward: Operationalise the 30% cap by end-2026, expand UPI-PayNow style linkages across BIMSTEC, scale UPI Lite 2.0, and price small-merchant MDR transparently under RBI by FY27.

SOURCES

→NPCI — UPI Product Statistics
→Anantam IAS — Digital Public Infrastructure and India Stack
→Anantam IAS — Financial Inclusion in India

UPI | NPCI | DPI | PhonePe | MDR | PayNow | real-time payments | concentration risk

Q56

Deepfakes have moved from novelty to systemic threat to electoral integrity and personal dignity. Critically evaluate India's regulatory response under the IT Amendment Rules 2026 and the residual gaps in the criminal-law framework.

15 MARKS | 250 WORDS | 14 MIN | HARD | AI AND IT REGULATION

ANSWER OUTLINE

Introduction: MeitY notified the IT (Intermediary Guidelines and Digital Media Ethics Code) Amendment Rules 2026 on 10 February 2026 (effective 20 February 2026); over 50 million AI voice-clone calls were estimated during the 2024 Lok Sabha campaign.

Body: 1) Rules framework — definition of "synthetically generated information," visible labels, embedded provenance, takedown clocks of 3 hours (court/government orders) and 2 hours (intimate-image and impersonation deepfakes). 2) Criminal gaps — BNS 2023 covers identity impersonation under Section 319 but no dedicated deepfake offence; lack of victim restitution. 3) Institutional gap — no statutory AI regulator; reliance on Section 79 safe-harbour conditionality.

Way forward: Standalone Digital India Act with risk-tiered AI liability; statutory AI Safety Institute; mandatory C2PA-style content provenance; victim-compensation fund.

KEY POINTS TO INCLUDE

- IT Amendment Rules 2026 notified 10 Feb 2026 — first binding AI-content rules
- Takedown clocks: 3 hours for orders, 2 hours for intimate-image and impersonation deepfakes
- ~50 million AI voice-clone calls before 2024 Lok Sabha polls
- Section 79 IT Act 2000 — intermediary safe harbour
- BNS 2023 Sections 318-319 cover cheating and impersonation
- Election Commission advisory on synthetic media 2024
- Stanford HAI 2025 — India saw steepest rise in public AI concern (~14 pp)

EXAMPLES & CASE STUDIES

- Rashmika Mandanna deepfake case November 2023
- Sadhguru voice-clone scam advisories 2024
- Delhi HC personality-rights orders 2024-25

MODEL ANSWER

> **Introduction:**
>
> MeitY notified the IT (Intermediary Guidelines and Digital Media Ethics Code) Amendment Rules 2026 on 10 February 2026, effective 20 February 2026; industry trackers estimate over 50 million AI voice-clone calls during the 2024 Lok Sabha campaign. Deepfakes have moved from novelty to systemic threat to electoral

integrity, women's dignity, and consumer trust, with the Stanford HAI AI Index 2025 noting India's steepest rise in public AI concern.

The new rules framework:

The Rules define "synthetically generated information," mandate visible labels and embedded provenance (C2PA-style), and impose tight takedown clocks — 3 hours for court or government orders and 2 hours for intimate-image and impersonation deepfakes. Significant social media intermediaries lose Section 79 safe harbour if they default on these timelines, marking India's first binding AI-content regime.

Criminal-law gaps:

The Bharatiya Nyaya Sanhita 2023 covers impersonation under Sections 318-319 and cheating generally, but has no dedicated deepfake offence. Victim restitution, mandatory injunctions, and burden-shifting on platforms remain absent. The Election Commission's 2024 advisory on synthetic media lacks statutory teeth, and the Sadhguru voice-clone scam advisories of 2024 exposed the gap.

Institutional vacuum:

India still lacks a statutory AI regulator. The reliance on Section 79 conditionality leaves enforcement reactive. Delhi High Court's personality-rights orders (Rashmika Mandanna case, November 2023) show judicial creativity but no systemic remedy.

Way forward / Conclusion:

Pass a standalone Digital India Act with risk-tiered AI liability, give the AI Safety Institute statutory backing, mandate C2PA provenance for hosted content, and create a victim-compensation fund under MeitY by 2027.

SOURCES

→MeitY — IT Intermediary Rules notifications
→Anantam IAS — Deepfakes
→Stanford HAI AI Index 2025

deepfake | IT Rules 2026 | synthetic media | Section 79 | safe harbour | C2PA | Digital India Act | BNS

Q57

The India Semiconductor Mission has committed ₹76,000 crore in incentives but the country still has only one mature-node fab approved. Discuss the structural composition of ISM 1.0 versus ISM 2.0 and the binding constraints below the fab gate.

15 MARKS | 250 WORDS | 14 MIN | HARD | SEMICONDUCTORS AND INDIGENISATION

ANSWER OUTLINE

Introduction: ISM 1.0 approved December 2021 with ₹76,000 crore outlay; by December 2025, 10 approved projects with ~₹1.6 lakh crore committed across six states (MeitY); Tata-PSMC Dholera is the only front-end fab.

Body: 1) Composition — 1 fab (28nm and above) + 5 OSAT/ATMP units; Micron Sanand, Tata Jagiroad, CG-Renesas, Kaynes, HCL-Foxconn. 2) Materials and equipment gap — photoresist, slurry, specialty gases all imported; sovereignty at fab gate is illusory. 3) ISM 2.0 (Budget 2026-27, ₹1,000 crore FY26 provision) pivots to equipment, materials, design IP, and skilling.

Way forward: Scale ISM 2.0 funding to match the ecosystem gap; deepen Design Linked Incentive (target 100 firms, 20 past ₹1,500 crore revenue); secure critical-mineral supply via KABIL and Quad chip alliance.

KEY POINTS TO INCLUDE

- ISM 1.0 outlay ₹76,000 crore approved December 2021
- 10 approved projects, ~₹1.6 lakh crore committed by December 2025
- Tata-PSMC Dholera: up to ₹91,000 crore, 50,000 wafers/month at 28nm+
- Micron Sanand ATMP ₹22,500+ crore inaugurated 28 Feb 2026
- Tata Jagiroad OSAT ₹27,000 crore (Assam)
- ISM 2.0 — ₹1,000 crore FY26 provision, focus on equipment and materials
- ISRO Vikram 3201 — first indigenous 32-bit microprocessor (2025)
- Design Linked Incentive targets 100 design firms

EXAMPLES & CASE STUDIES

- Tata Electronics-PSMC Dholera fab groundbreaking March 2024
- Micron Sanand first chip rollout 2026
- Vedanta-Foxconn JV collapse 2023
- Quad Semiconductor Supply Chain Initiative

MODEL ANSWER

> **Introduction**:
>
> The India Semiconductor Mission (ISM 1.0) was approved in December 2021 with a ₹76,000 crore outlay; by December 2025, MeitY had cleared 10 projects with ~₹1.6 lakh

crore committed across six states. The Tata-PSMC fab at Dholera remains the only approved front-end fab, exposing the depth of the ecosystem gap below the fab gate.

ISM 1.0 composition:

The portfolio comprises one fab — Tata-PSMC Dholera, up to ₹91,000 crore for 50,000 wafers/month at 28nm and above — plus five OSAT/ATMP units: Micron Sanand (₹22,500+ crore, inaugurated 28 February 2026), Tata Jagiroad in Assam (₹27,000 crore), CG Power-Renesas, Kaynes Sanand, and HCL-Foxconn. The Design Linked Incentive targets 100 design firms; ISRO's Vikram 3201 (2025) is the first indigenous 32-bit microprocessor.

Binding constraints below the fab gate:

Photoresist, slurry, specialty gases, ultra-pure water systems, and lithography equipment are imported. Semiconductor materials and equipment supply remains concentrated in US, Japan, Netherlands, and Taiwan. Sovereignty at the fab gate is therefore illusory without an indigenous materials and equipment ecosystem; the collapsed Vedanta-Foxconn JV (2023) underlined execution risk.

ISM 2.0 pivot:

ISM 2.0 (Budget 2026-27, ₹1,000 crore FY26 provision) shifts the lens to equipment, materials, design IP, and skilling — the missing 60% of the value chain.

Way forward / Conclusion:

Scale ISM 2.0 funding to match the ecosystem gap, deepen DLI past ₹1,500 crore revenue support for 20 design firms, secure critical minerals via KABIL and the Quad Semiconductor Supply Chain Initiative, and target 5% global wafer share by 2030 under MeitY.

SOURCES

→India Semiconductor Mission — MeitY
→Anantam IAS — India Semiconductor Mission
→Anantam IAS — UPSC 2025: Critical Minerals, Majorana 1, Rare Earths

ISM fab OSAT ATMP DLI wafer photoresist Dholera Sanand

Q58

The National Quantum Mission has approved an outlay of ₹6,003.65 crore against China's roughly $15 billion in quantum investment. Examine the

mission's hub architecture, indigenous milestones, and the post-quantum cryptography roadmap.

15 MARKS | 250 WORDS | 14 MIN | HARD | EMERGING TECH

ANSWER OUTLINE

Introduction: Cabinet approved the National Quantum Mission on 19 April 2023 with ₹6,003.65 crore over eight years (DST); Amaravati Quantum Valley launched 7 February 2026 with IBM Quantum System Two.

Body: 1) Four Thematic Hubs — Computing at IISc, Communication at IIT Madras + C-DOT, Sensing at IIT Bombay, Materials at IIT Delhi; 152 researchers across 43 institutions. 2) Indigenous milestones — QpiAI-Indus 25-qubit machine (14 April 2025); Dimira cryogenic cables; ISRO entanglement-based QKD over 300 m. 3) PQC roadmap — DST released migration plan February 2026; CII to PQC by 2029, enterprises by 2033, aligned to NIST FIPS 203-205 (August 2024).

Way forward: Increase NQM corpus through a private-capital window; mandate PQC migration for Aadhaar, UPI, defence networks; expand satellite QKD beyond 2,000 km target.

KEY POINTS TO INCLUDE

- NQM outlay ₹6,003.65 crore, 8 years, approved 19 April 2023
- Target: 50-1,000 physical qubits in 8 years
- 4 Thematic Hubs at IISc, IIT Madras, IIT Bombay, IIT Delhi
- QpiAI-Indus 25-qubit superconducting computer (14 April 2025)
- Amaravati Quantum Valley launched 7 February 2026
- China ~$15 billion vs India $0.73 billion (orders of magnitude gap)
- NIST PQC standards FIPS 203, 204, 205 finalised 13 August 2024
- DST PQC roadmap: CII by 2029, enterprises by 2033

EXAMPLES & CASE STUDIES

- QpiAI-Indus 25-qubit machine April 2025
- Kaveri 64-qubit processor announced for 2026
- ISRO QKD demonstration over 300 m, 2022
- C-DOT quantum communications laboratory

MODEL ANSWER

> **Introduction**:

The Cabinet approved the National Quantum Mission on 19 April 2023 with a ₹6,003.65 crore outlay over eight years under DST; the Amaravati Quantum Valley with IBM Quantum System Two was launched on 7 February 2026. China's quantum spend of ~$15 billion dwarfs India's $0.73 billion, underlining a deep strategic catch-up imperative.

Four Thematic Hubs:

NQM has set up Hubs for Computing at IISc Bengaluru, Communication at IIT Madras with C-DOT, Sensing & Metrology at IIT Bombay, and Materials & Devices at IIT Delhi — together covering 152 researchers across 43 institutions, with a target of 50-1,000 physical qubits over eight years.

Indigenous milestones:

QpiAI-Indus, a 25-qubit superconducting machine, was unveiled on 14 April 2025; Dimira cryogenic cables and the announced Kaveri 64-qubit processor (2026) deepen the device stack. ISRO has demonstrated entanglement-based QKD over 300 metres; C-DOT runs a quantum-communications lab. Amaravati Quantum Valley provides a flagship deployment.

Post-quantum cryptography roadmap:

NIST finalised FIPS 203-205 on 13 August 2024 (ML-KEM, ML-DSA, SLH-DSA). DST released India's PQC migration plan in February 2026 — Critical Information Infrastructure to migrate by 2029 and enterprises by 2033 — aligning Aadhaar, UPI, and defence networks with quantum-resistant algorithms.

Way forward / Conclusion:

Augment NQM corpus through a private-capital window, mandate PQC migration for all CII by 2029, expand satellite QKD past the 2,000 km demonstration target, and build a domestic dilution-refrigerator industry under DST by 2030.

SOURCES

- →National Quantum Mission — DST
- →NIST PQC Standards FIPS 203-205
- →Anantam IAS — Quantum Dots

quantum | qubit | PQC | NQM | Amaravati | QKD | NIST | superposition

Q59

The BioE3 Policy 2024 targets a US$300 billion bioeconomy by 2030. Examine the role of the National Biofoundry Network, the genome-edited rice release of May 2025, and the unfinished GM-crop regulatory architecture.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | BIOTECHNOLOGY

ANSWER OUTLINE

Introduction: BioE3 Policy approved 24 August 2024; bioeconomy at US$195.3 billion in 2025 (~4.8% of GDP), up from US$10 billion in 2014; 11,855 biotech startups in 2025 (DBT India Bioeconomy Report).

Body: 1) Six BioE3 sectors — bio-chemicals, smart proteins, precision biotherapeutics, climate-resilient agriculture, carbon capture, marine/space biotech. 2) National Biofoundry Network — 21 facilities launched 1 September 2025. 3) Genome-edited rice Kamala (DRR Dhan 100) and Pusa DST Rice 1 released 4 May 2025 via CRISPR SDN-1; ~19% higher yield, 20% lower emissions. 4) Regulatory gap — Supreme Court split verdict on GM mustard DMH-11 (July 2024) directed Centre to frame National GM Crop Policy.

Way forward: Operationalise National GM Crop Policy; bring GEAC under a statutory Biotechnology Regulatory Authority; expand biofoundry access to startups; align SDN-1 exemption with EU/US norms.

KEY POINTS TO INCLUDE

- BioE3 Policy approved 24 August 2024 by Union Cabinet
- Bioeconomy US$195.3 billion in 2025, ~4.8% of GDP
- Target US$300 billion by 2030; longer goal ~US$1 trillion by 2047
- National Biofoundry Network — 21 facilities launched 1 Sept 2025
- Kamala and Pusa DST Rice 1 released 4 May 2025 (CRISPR SDN-1)
- Kamala: ~19% higher yield, 20% lower emissions, 20 days earlier maturity
- SC split verdict on GM mustard DMH-11 (July 2024) ordered National GM Crop Policy
- GEAC under EPA 1986 rules of 1989

EXAMPLES & CASE STUDIES

- Bharat Biotech indigenous vaccines
- Serum Institute biologics pipeline
- ICAR-IIRR Hyderabad and ICAR-IARI Pusa
- Department of Biotechnology Cell-Based Therapy guidelines

MODEL ANSWER

Introduction:

The BioE3 Policy was approved by the Union Cabinet on 24 August 2024, targeting a US$300 billion bioeconomy by 2030 from a base of US$195.3 billion in 2025 (~4.8% of GDP); the DBT India Bioeconomy Report (2025) records 11,855 biotech startups. BioE3 reframes biotechnology around economy, employment, and environment.

Six BioE3 sectors:

The policy targets bio-based chemicals, smart proteins, precision biotherapeutics, climate-resilient agriculture, carbon capture and utilisation, and marine and space biotechnology — anchored by enabling biofoundries.

National Biofoundry Network:

21 biofoundry facilities were launched on 1 September 2025, providing automated DNA synthesis, strain engineering, and scale-up for startups and academia — closing the gap between research and translation that has historically constrained Indian biotech.

Genome-edited rice breakthrough:

Kamala (DRR Dhan 100) by ICAR-IIRR Hyderabad and Pusa DST Rice 1 by ICAR-IARI were released on 4 May 2025 under the SDN-1 CRISPR exemption — recording ~19% higher yield, 20% lower methane emissions, and 20 days earlier maturity. This signals SDN-1's mainstream arrival in Indian agriculture.

Regulatory unfinished business:

The Supreme Court split verdict on GM mustard DMH-11 (July 2024) directed the Centre to frame a National GM Crop Policy. GEAC continues under Rules 1989 of EPA 1986 — without an independent statutory regulator.

Way forward / Conclusion:

Operationalise a National GM Crop Policy, replace GEAC with a Biotechnology Regulatory Authority of India, open biofoundry access to all DBT-registered startups, and align SDN-1 exemptions with EU and US norms by 2027.

SOURCES

→Department of Biotechnology — BioE3 Policy
→Anantam IAS — Genome India Project
→Anantam IAS — Gene Therapy vs Gene Editing

BioE3 | biofoundry | CRISPR | SDN-1 | GEAC | Kamala | Pusa DST | bioeconomy

Q60

ISRO's SpaDeX docking experiment and Chandrayaan-3 South Pole landing have placed India in elite space company. Examine the strategic and commercial significance of these achievements.

10 MARKS | 150 WORDS | 9 MIN | EASY | ACHIEVEMENTS OF INDIANS

ANSWER OUTLINE

Introduction: Chandrayaan-3's Vikram lander touched down at 69.37°S near the lunar south pole on 23 August 2023 — India became the fourth country to soft-land on the Moon and first at the south pole; SpaDeX achieved its first docking on 16 January 2025, making India the fourth nation in the docking club.

Body: 1) Strategic significance — south-pole water-ice access for future habitats; docking is a prerequisite for the Bharatiya Antariksh Station targeted for 2035. 2) Commercial spillover — IN-SPACe authorisations crossed 300; NSIL handled the LVM3-OneWeb contracts worth ~₹1,000 crore. 3) Talent and industry stack — ~190 space startups (2025).

Way forward: Operationalise the BAS roadmap; accelerate Gaganyaan H1 launch; scale NSIL's commercial portfolio.

KEY POINTS TO INCLUDE

- Chandrayaan-3 Vikram soft-landed 23 August 2023 at 69.37°S
- SpaDeX first docking 16 January 2025
- Bharatiya Antariksh Station targeted for 2035
- Gaganyaan crewed flight planned 2027
- IN-SPACe authorisations 300+ as of 2025
- ~190 Indian space startups (DPIIT)

EXAMPLES & CASE STUDIES

- Chandrayaan-3 launch 14 July 2023
- Aditya-L1 reached L1 on 6 January 2024
- LVM3-M3 OneWeb mission March 2023

MODEL ANSWER

> **Introduction:** Chandrayaan-3's Vikram lander touched down at 69.37° South on the lunar surface on 23 August 2023 — making India the fourth country to soft-land on the

Moon and the first nation at the south pole; SpaDeX completed its first orbital docking on 16 January 2025, placing India in the four-nation docking club alongside US, Russia, and China.

Body: First, strategic significance — south-pole water-ice access underwrites future habitats and in-situ resource utilisation; docking is a prerequisite for the Bharatiya Antariksh Station targeted for 2035 and the Gaganyaan crewed flight planned for 2027. Second, commercial spillover — IN-SPACe authorisations crossed 300; NSIL handled LVM3-OneWeb missions worth ~₹1,000 crore. Third, talent and industry — ~190 space startups (DPIIT 2025) including Skyroot, Agnikul, Pixxel, and Dhruva Space; Aditya-L1 reached L1 on 6 January 2024.

Way forward: Operationalise the BAS roadmap, accelerate Gaganyaan H1, and scale NSIL's commercial portfolio with private-launch procurement under DoS by 2030.

SOURCES

→ISRO — Mission Updates
→Anantam IAS — Chandrayaan Mission
→Anantam IAS — SpaDeX Space Docking Experiment

ISRO | Chandrayaan-3 | SpaDeX | Gaganyaan | BAS | IN-SPACe | NSIL

Q61

DRDO's Pralay, Pinaka and Mission Divyastra have signalled an indigenisation pivot in India's strategic weapons. Critically evaluate DRDO's restructuring after the 2023 panel and the remaining gaps in defence R&D.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | ACHIEVEMENTS OF INDIANS

ANSWER OUTLINE

Introduction: Mission Divyastra demonstrated Agni-5 MIRV capability on 11 March 2024 — India joined a small club of MIRV powers; Defence R&D budget for 2025-26 stands at ₹26,816 crore (~0.7% of total defence outlay).

Body: 1) Indigenisation pivot — Pralay quasi-ballistic missile inducted 2023; Pinaka exported to Armenia; iDEX startups received 500+ contracts. 2) Restructuring — K. Vijayaraghavan Committee 2023 recommended a Defence Technology Council chaired by PM, slimmer DRDO. 3) Gaps — public R&D ~0.65% of GDP (DST 2024); private defence R&D thin; long programme cycles.

Way forward: Operationalise Defence Technology Council; raise R&D to 2% of GDP per Anusandhan NRF target; expand iDEX and Technology Development Fund; ring-fence frontier-tech budgets.

KEY POINTS TO INCLUDE

- Mission Divyastra Agni-5 MIRV test 11 March 2024
- Defence R&D 2025-26 budget ₹26,816 crore
- Vijayaraghavan Committee report on DRDO restructuring (2023)
- Anusandhan National Research Foundation Act 2023
- iDEX 500+ contracts to defence startups
- Public R&D ~0.65% of GDP (DST R&D Statistics 2024)
- BrahMos exports to Philippines from 2024
- Pralay inducted into Indian Army 2023

EXAMPLES & CASE STUDIES

- Tejas Mk1A induction 2024-25
- Akash-NG, MRSAM jointly with Israel
- Pinaka export to Armenia 2024
- INS Vikrant commissioned September 2022

MODEL ANSWER

> **Introduction**:
>
> Mission Divyastra demonstrated Agni-5 MIRV capability on 11 March 2024, placing India in a small club of MIRV-capable powers; Defence R&D for 2025-26 stands at ₹26,816 crore — about 0.7% of the total defence outlay — even as the K. Vijayaraghavan Committee (2023) recommended a comprehensive DRDO restructuring against the backdrop of long programme cycles.
>
> **Indigenisation pivot**:
>
> Pralay quasi-ballistic missile was inducted in 2023; Pinaka was exported to Armenia in 2024; BrahMos exports began to the Philippines from 2024. Tejas Mk1A inductions (2024-25) and Akash-NG, plus iDEX with 500+ contracts to defence startups, signal an indigenisation pivot anchored by Atmanirbhar Bharat positive lists, while INS Vikrant (September 2022) deepened naval indigenisation.
>
> **Restructuring under the Vijayaraghavan report**:

The 2023 panel recommended a Defence Technology Council chaired by the Prime Minister, a leaner DRDO focused on frontier technologies, separation of research from production, and structured private-industry partnerships. The Anusandhan National Research Foundation Act 2023 complements this by channelling civilian research with industry co-funding.

Residual gaps:

India's public R&D remains ~0.65% of GDP (DST R&D Statistics 2024); private defence R&D is thin; programme cycles for indigenous engines, AESA radars, and submarine propulsion stretch over decades. Critical-mineral dependence and platform-integration risks linger.

Way forward / Conclusion:

Operationalise the Defence Technology Council, raise national R&D to 2% of GDP per ANRF targets, expand iDEX and TDF, and ring-fence frontier-tech budgets — quantum, AI, hypersonics, directed-energy — by 2030 under MoD.

SOURCES

→DRDO — Programmes
→Anantam IAS — UPSC 2025: Critical Minerals, Majorana 1, Rare Earths
→Anantam IAS — Indian Space Policy 2023

DRDO | MIRV | Pralay | iDEX | ANRF | Atmanirbhar Bharat | indigenisation

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Q62

Indian Space Policy 2023 and the FDI liberalisation of 2024 have created the conditions for a private space industry. Examine the role of IN-SPACe and NSIL and the legislative gaps in space liability and IP.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | SPACE

ANSWER OUTLINE

Introduction: Indian Space Policy 2023 notified by Department of Space on 20 April 2023; FDI policy revised 21 February 2024 — up to 100% under automatic route for satellites (74% for manufacturing, 49% for launch vehicles); ~190 space startups (DPIIT 2025).

Body: 1) Institutional roles — IN-SPACe as single-window authoriser (300+ authorisations), NSIL as commercial arm, ISRO retains R&D. 2) Private milestones — Skyroot Vikram-S suborbital (Nov 2022), Agnikul Agnibaan SOrTeD (May 2024). 3)

Legislative gaps — no Space Activities Act yet, no liability/insurance framework, IP allocation between IN-SPACe authorisations and private innovators unclear.

Way forward: Pass Space Activities Bill 2025; ratify Liability and Registration Conventions in domestic law; create a dedicated space-IP regime; structured procurement from private launch providers.

KEY POINTS TO INCLUDE

- Indian Space Policy 2023 notified 20 April 2023
- Space FDI policy revised 21 February 2024
- 100% automatic route for satellites, 74% manufacturing, 49% launch
- IN-SPACe authorisations 300+ by 2025
- Skyroot Vikram-S 18 Nov 2022; Agnikul Agnibaan SOrTeD 30 May 2024
- Outer Space Treaty 1967, Liability Convention 1972
- Bharatiya Antariksh Station target 2035
- Department of Space Budget 2025-26 ₹13,416 crore

EXAMPLES & CASE STUDIES

- Pixxel hyperspectral constellation
- Dhruva Space, Bellatrix, Digantara
- NSIL commercial launches for OneWeb
- ANTRIX-Devas arbitration history

MODEL ANSWER

> **Introduction**:
>
> The Indian Space Policy 2023 was notified on 20 April 2023 by the Department of Space; FDI policy was liberalised on 21 February 2024 — up to 100% under the automatic route for satellites, 74% for manufacturing, and 49% for launch vehicles. The space economy now hosts ~190 startups (DPIIT 2025), with private investments accelerating sharply.
>
> **Institutional roles**:
>
> IN-SPACe acts as a single-window authoriser (300+ authorisations by 2025) and demand-aggregator. NSIL is the commercial arm — leading LVM3-OneWeb missions. ISRO refocuses on R&D, frontier missions, and the Bharatiya Antariksh Station targeted for 2035. The Department of Space budget for 2025-26 is ₹13,416 crore, anchoring the public-private balance.

Private milestones:

Skyroot's Vikram-S (18 November 2022) was India's first private suborbital launch; Agnikul's Agnibaan SOrTeD (30 May 2024) demonstrated a single-piece 3D-printed engine. Pixxel, Dhruva Space, Bellatrix, and Digantara cover hyperspectral imaging, small satellites, propulsion, and space-situational awareness — together signalling a vertical ecosystem.

Legislative gaps:

India has no Space Activities Act. The Outer Space Treaty 1967 and Liability Convention 1972 are unincorporated in domestic statute, leaving liability allocation, insurance, and indemnity ambiguous. IP allocation between IN-SPACe authorisations and private innovators is unclear, as the ANTRIX-Devas arbitration history shows.

Way forward / Conclusion:

Pass the Space Activities Bill 2025, codify a liability and insurance regime aligned with international conventions, create a dedicated space-IP framework, and structure procurement from private launch providers under DoS by 2027.

SOURCES

→IN-SPACe — Indian Space Policy 2023
→Anantam IAS — Indian Space Policy 2023
→Anantam IAS — Bharatiya Antariksh Station

Indian Space Policy | IN-SPACe | NSIL | Space Activities Bill | private space | FDI | BAS

Q63

India's research and development spending has plateaued near 0.65% of GDP, well below the 2% target. Examine the role of the Anusandhan National Research Foundation in correcting this deep-tech gap.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | R&D AND INNOVATION

ANSWER OUTLINE

Introduction: DST Research and Development Statistics 2024 records gross expenditure on R&D (GERD) at ~0.65% of GDP, against China's 2.4% and South Korea's 4.9%; Anusandhan National Research Foundation Act 2023 envisages ₹50,000 crore over five years (₹14,000 crore government, ₹36,000 crore private).

Body: 1) Structural gap — private R&D under 40% of GERD vs 75-80% in OECD; weak university research; thin patent commercialisation. 2) ANRF design — PM as ex-officio

President; mission-mode grants; private co-funding model. 3) Frontier areas — semiconductor design, AI, quantum, biotech connected via deep-tech start-up policy 2025.

Way forward: Operationalise ANRF governance board; expand SERB consolidated into ANRF; mandatory CSR-R&D channelisation; raise GERD to 2% by 2030.

KEY POINTS TO INCLUDE

- GERD ~0.65% of GDP (DST R&D Statistics 2024)
- ANRF Act 2023 — ₹50,000 crore over five years
- Private R&D
- Deep Tech Startup Policy released 2025
- Patent grants by IPO ~103,000 in 2023-24
- PMRF doctoral fellowships scaled to 3,000
- Education Ministry Vigyan Dhara scheme 2024
- Quad Open RAN and Critical Tech Initiative

EXAMPLES & CASE STUDIES

- SERB merger into ANRF
- Vigyan Dhara unified scheme October 2024
- DSIR Common Research and Technology Development Hubs

MODEL ANSWER

> **Introduction:** DST's Research and Development Statistics 2024 records India's gross expenditure on R&D (GERD) at ~0.65% of GDP, far below China's 2.4% and South Korea's 4.9%; the Anusandhan National Research Foundation Act 2023 commits ₹50,000 crore over five years — ₹14,000 crore from government and ₹36,000 crore from private sources.
>
> **Body:** First, structural gap — private R&D is under 40% of GERD against ~75% in OECD economies; university research is thin; patent commercialisation lags (IPO grants ~1.03 lakh in 2023-24). Second, ANRF design — PM as ex-officio President, mission-mode grants, and a co-funding model with industry. Third, frontier alignment — ANRF anchors semiconductor design, AI, quantum, biotech via the Deep Tech Startup Policy 2025 and Vigyan Dhara unified scheme (October 2024).
>
> **Way forward:** Operationalise the ANRF governance board, merge SERB into ANRF, channel CSR funds into R&D, and raise GERD to 2% of GDP by 2030 under DST.

SOURCES

→DST — Research and Development Statistics 2024
→Anusandhan National Research Foundation
→Anantam IAS — Generative AI and LLMs Explainer

ANRF | GERD | R&D | deep tech | innovation | PMRF | SERB

Q64

The Digital Public Infrastructure stack of Aadhaar, UPI and DigiLocker has been called India's most consequential tech export. Examine the architecture of India Stack and the governance challenges posed by the DPDP Act 2023.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | DPI

ANSWER OUTLINE

Introduction: Aadhaar reached 1.4 billion enrolments by 2025 (UIDAI); UPI handled 18.4 billion transactions in March 2025; G20 New Delhi Declaration 2023 endorsed DPI as a development framework.

Body: 1) India Stack layers — Identity (Aadhaar), Payments (UPI, Aadhaar Enabled Payments), Data (Account Aggregator, DigiLocker), Sectoral (ABDM, OCEN, AgriStack, ONDC). 2) DPDP Act 2023 — notice and consent, Data Protection Board, exemptions for State processing under Section 17. 3) Governance gaps — DPDP rules pending operationalisation; Aadhaar exclusion documented (Hadi-Reetika Khera research); MOSIP exports to ~12 countries.

Way forward: Notify DPDP Rules with grievance redress timelines; strengthen Data Protection Board independence; mandate exclusion audits; export India Stack via MOSIP partnerships.

KEY POINTS TO INCLUDE

- Aadhaar enrolments 1.4 billion by 2025
- UPI 18.4 billion transactions in March 2025
- DPDP Act 2023 notified 11 August 2023
- Section 17 exemptions for State agencies
- Account Aggregator framework live 2021
- ABDM 76+ crore ABHA IDs by 2025
- G20 New Delhi Declaration DPI endorsement Sept 2023
- MOSIP open-source ID adopted by 12+ countries

EXAMPLES & CASE STUDIES

- ABDM Sandbox and ABHA
- ONDC pilot in Bengaluru 2022
- AgriStack pilots in 6 states
- Bhashini AI4Bharat translation stack

MODEL ANSWER

Introduction:

Aadhaar enrolments reached 1.4 billion by 2025 (UIDAI); UPI processed 18.4 billion transactions in March 2025; the G20 New Delhi Declaration (September 2023) endorsed Digital Public Infrastructure (DPI) as a development paradigm — making India's stack the most consequential tech export of the decade.

India Stack architecture:

The stack is layered. Identity rests on Aadhaar and e-KYC. Payments include UPI, AePS, and Bharat Bill Pay. The data layer is Account Aggregator (live 2021) and DigiLocker. Sectoral applications include the Ayushman Bharat Digital Mission (ABDM) — 76+ crore ABHA IDs by 2025 — ONDC (Bengaluru pilot 2022), OCEN credit rails, AgriStack pilots in six states, and Bhashini for language AI.

DPDP Act 2023 governance:

The Digital Personal Data Protection Act, notified on 11 August 2023, mandates notice and consent, creates a Data Protection Board, and exempts State processing under Section 17 for sovereign-function purposes. Children's consent threshold sits at 18 years, with safeguards for persons with disabilities.

Governance gaps:

DPDP Rules remained pending operationalisation through much of 2024-25, delaying grievance redress timelines. Aadhaar exclusion has been documented (research by Reetika Khera) where biometric failures denied entitlements. Section 17 exemptions risk a State carve-out wider than the Justice K.S. Puttaswamy (2017) proportionality test envisaged.

Way forward / Conclusion:

Notify DPDP Rules with mandatory redress timelines, strengthen Data Protection Board independence, audit Aadhaar exclusion outcomes, and export India Stack via MOSIP partnerships (already in 12+ countries) under MeitY by 2027.

SOURCES

→MeitY — Digital India and DPDP Act
→Anantam IAS — DPI and India Stack
→Anantam IAS — Right to Privacy

DPI | India Stack | Aadhaar | UPI | DPDP Act | Account Aggregator | ABDM | ONDC

Q65

The Ayushman Bharat Digital Mission aims to build a federated health data ecosystem. Discuss its architecture and the privacy-by-design challenges in scaling ABHA.

10 MARKS | 150 WORDS | 9 MIN | EASY | DPI AND HEALTH

ANSWER OUTLINE

Introduction: ABDM launched 27 September 2021 by Ministry of Health and Family Welfare; 76+ crore ABHA IDs and 4.5+ lakh linked health facilities by 2025 (NHA dashboard).

Body: 1) Architecture — ABHA (health ID), HPR (healthcare professional registry), HFR (health facility registry), Unified Health Interface. 2) Privacy challenges — federated data, no central health locker; DPDP Act 2023 children-and-disabled safeguards. 3) Adoption gap — private hospitals slow to integrate.

Way forward: Mandate ABHA-linked claims under PMJAY; strict HMIS interoperability standards; explicit health-data fiduciary regime under DPDP Rules.

KEY POINTS TO INCLUDE

- ABDM launched 27 September 2021 by MoHFW
- 76+ crore ABHA IDs created by 2025
- 4.5+ lakh facilities linked to HFR
- Unified Health Interface (UHI) for service discovery
- PMJAY claims integration with ABHA
- DPDP Act 2023 — children consent threshold 18

EXAMPLES & CASE STUDIES

- ABHA mobile app and DigiLocker linkage
- Co-WIN as DPI precursor
- eSanjeevani telemedicine

MODEL ANSWER

Introduction: The Ayushman Bharat Digital Mission (ABDM) was launched on 27 September 2021 by the Ministry of Health and Family Welfare; the National Health Authority dashboard records 76+ crore ABHA IDs and 4.5+ lakh health facilities linked to the Health Facility Registry by 2025.

Body: First, the architecture — ABHA (health ID), Healthcare Professional Registry (HPR), Health Facility Registry (HFR), and the Unified Health Interface (UHI) for service discovery; data is federated, with no central health locker. Second, privacy-by-design challenges — DPDP Act 2023 sets children's consent at 18 and requires explicit purpose limitation; private hospitals integrate slowly. Third, PMJAY claims integration with ABHA strengthens utilisation but raises sensitive-data exposure; the eSanjeevani telemedicine platform and Co-WIN precedent shape the design philosophy.

Way forward: Mandate ABHA-linked claims under PMJAY, enforce HMIS interoperability standards, and notify a health-data-fiduciary regime under DPDP Rules by 2027 under MoHFW.

SOURCES

→National Health Authority — ABDM
→Anantam IAS — Ayushman Bharat Digital Mission (ABDM)
→Anantam IAS — Right to Privacy

ABDM | ABHA | DPI | health data | UHI | NHA | PMJAY

Q66

India's robotics and drone ecosystem is rapidly indigenising under the PLI for drones and the Drone Rules 2021. Examine the policy framework and the dual-use security implications.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | ROBOTICS AND INDIGENISATION

ANSWER OUTLINE

Introduction: Drone Rules 2021 (MoCA, 25 August 2021) replaced restrictive 2018 framework; PLI for drones outlay ₹120 crore over three years (FY22-24); domestic drone market valued at ~US$1.4 billion in 2024.

Body: 1) Policy stack — Digital Sky platform, type certification by QCI, NPNT (No Permission, No Take-off). 2) Achievements — Namo Drone Didi scheme (15,000 drones to

women SHGs), Garuda Aerospace, ideaForge. 3) Security risks — IAF drone strike Jammu airbase 2021; counter-drone systems by DRDO.

Way forward: Counter-Unmanned Aircraft Systems policy; spectrum allocation for BVLOS; export controls for dual-use components; strict licensing of foreign-origin components.

KEY POINTS TO INCLUDE

- Drone Rules 2021 notified 25 August 2021 (MoCA)
- PLI drones outlay ₹120 crore FY22-24
- Domestic drone market ~US$1.4 billion in 2024
- Namo Drone Didi — 15,000 drones to SHGs
- Jammu airbase drone attack 27 June 2021
- Digital Sky and NPNT compliance

EXAMPLES & CASE STUDIES

- Garuda Aerospace and ideaForge IPO
- DRDO Smash 2000 counter-drone
- Kisan drones for spraying

MODEL ANSWER

> **Introduction:** The Drone Rules 2021 were notified by MoCA on 25 August 2021, replacing the restrictive 2018 framework; the PLI for drones has an outlay of ₹120 crore over FY22-24; the domestic drone market reached ~US$1.4 billion in 2024 with steady year-on-year growth.
>
> **Body:** First, the policy stack — Digital Sky platform for registrations, type certification by QCI, and NPNT (No Permission No Take-off) compliance; airspace zoned green-yellow-red for operator-friendly clearances. Second, achievements — Namo Drone Didi scheme delivers 15,000 drones to women SHGs for kisan spraying; Garuda Aerospace and ideaForge have IPO'd or scaled rapidly; Kisan drones support precision agriculture. Third, dual-use risks — the Jammu airbase drone attack on 27 June 2021 exposed counter-drone gaps; DRDO Smash 2000 systems deploy at sensitive sites.
>
> **Way forward:** Notify a Counter-Unmanned Aircraft Systems policy, allocate spectrum for BVLOS, tighten export controls on dual-use components, and license foreign-origin sub-systems under MoCA by 2028.

SOURCES

→Ministry of Civil Aviation — Drone Rules 2021
→Anantam IAS — DRI
→PIB — Namo Drone Didi

drones | PLI | Digital Sky | NPNT | BVLOS | C-UAS | Namo Drone Didi

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Q67

Kessler Syndrome and rising orbital congestion threaten the long-term sustainability of low Earth orbit. Discuss India's contribution to space debris and the role of Project NETRA.

10 MARKS | 150 WORDS | 9 MIN | HARD | SPACE AND IPR

ANSWER OUTLINE

Introduction: ESA Space Debris Office (Annual Report 2024) tracks ~40,500 objects larger than 10 cm in Earth orbit; ISRO target of debris-free Indian missions by 2030 announced in 2024.

Body: 1) Indian debris share — PSLV-C37 upper stage and Mission Shakti 2019 ASAT debris; ISRO's IS4OM tracks 28,000+ objects. 2) Project NETRA — Bengaluru-based space situational awareness facility. 3) International framework — UN COPUOS LTS guidelines, Outer Space Treaty 1967.

Way forward: Active debris-removal demonstration mission; legally binding global ASAT moratorium; expand NETRA to deep-space tracking.

KEY POINTS TO INCLUDE

- ~40,500 objects >10 cm in orbit (ESA 2024)
- ISRO debris-free missions target by 2030
- Project NETRA inaugurated 2022 (ISRO)
- IS4OM tracks 28,000+ objects
- Mission Shakti ASAT 27 March 2019
- UN COPUOS Long-Term Sustainability Guidelines 2019

EXAMPLES & CASE STUDIES

- Cartosat-2C debris from 2017
- POEM-3 controlled re-entry 2024
- Kessler 1978 cascade hypothesis

MODEL ANSWER

Introduction: ESA's Space Debris Office Annual Report 2024 tracks ~40,500 objects larger than 10 cm in Earth orbit; ISRO announced a target of debris-free Indian missions by 2030 under the Debris Free Space Mission Initiative, addressing the Kessler 1978 cascade hypothesis.

Body: First, India's debris footprint includes the PSLV-C37 upper stage, fragments from Mission Shakti ASAT (27 March 2019), and Cartosat-2C debris (2017), each adding to LEO congestion. Second, Project NETRA — ISRO's space-situational awareness facility at Bengaluru, inaugurated in 2022 — and the IS4OM Control Centre now track 28,000+ catalogued objects with collision-avoidance analytics. Third, India is a party to the Outer Space Treaty 1967 and aligns with UN COPUOS Long-Term Sustainability Guidelines 2019; POEM-3 demonstrated controlled re-entry in 2024.

Way forward: Demonstrate an active debris-removal mission by 2030, push for a legally binding global ASAT moratorium at UN COPUOS, and expand NETRA into deep-space tracking under DoS.

SOURCES

→ESA Space Debris Office
→Anantam IAS — Kessler Syndrome
→Anantam IAS — Bharatiya Antariksh Station

Kessler Syndrome | space debris | NETRA | ASAT | IS4OM | COPUOS

Q68

India's gene-editing classification of SDN-1, SDN-2 and SDN-3 has carved out a non-GM exemption route. Discuss the science and the policy implications for Indian agriculture.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | BIOTECHNOLOGY AND IPR

ANSWER OUTLINE

Introduction: MoEFCC office memorandum (March 2022) exempts SDN-1 and SDN-2 edits without foreign DNA from Rules 1989 GM-organism regulation; backed by DBT 2022 guidelines for safety assessment of genome-edited plants.

Body: 1) Science — SDN-1 no template (knock-out), SDN-2 small template (point edits), SDN-3 large insert (transgene). 2) Implications — Kamala and Pusa DST Rice 1 (4 May 2025)

released under SDN-1 exemption; faster regulatory pathway. 3) Concerns — civil-society challenge to exemption; lack of segregation in seed system.

Way forward: Statutory backing via Biotechnology Regulatory Authority Bill; mandatory PPV&FR Act 2001 registration of edited varieties; transparent biosafety dossiers.

KEY POINTS TO INCLUDE

- MoEFCC OM March 2022 exempts SDN-1 and SDN-2 from Rules 1989
- Kamala (DRR Dhan 100) and Pusa DST Rice 1 released 4 May 2025
- DBT Safety Assessment Guidelines for Genome Edited Plants 2022
- SDN-1 ~19% yield gain (Kamala), 20% lower emissions
- Supreme Court split on DMH-11 GM mustard July 2024
- GEAC under Rules 1989 of EPA 1986

EXAMPLES & CASE STUDIES

- CRISPR-Cas9 system
- ICAR-IARI and ICAR-IIRR breeding pipelines
- PPV&FR Act 2001 farmers' rights

MODEL ANSWER

> **Introduction:** An MoEFCC office memorandum of March 2022 exempts SDN-1 and SDN-2 genome edits without foreign DNA from the GM-organism regulation under Rules 1989; DBT Safety Assessment Guidelines for Genome Edited Plants (2022) provide the science backbone.
>
> **Body:** First, the science — SDN-1 introduces targeted breaks with no template (knock-out), SDN-2 uses small templates for point edits, SDN-3 inserts large transgenes; only SDN-3 falls under the EPA 1986 GMO framework. Second, policy impact — Kamala (DRR Dhan 100) and Pusa DST Rice 1 were released on 4 May 2025 under the SDN-1 exemption, yielding ~19% gains. Third, the Supreme Court split verdict on GM mustard DMH-11 (July 2024) directed a National GM Crop Policy; civil-society groups challenge the SDN exemption over inadequate consultation.
>
> **Way forward:** Pass the Biotechnology Regulatory Authority Bill, mandate PPV&FR Act 2001 registration of edited varieties, and publish transparent biosafety dossiers by 2027 under DBT.

SOURCES

→DBT — Genome-edited plants guidelines
→Anantam IAS — SDN-1 SDN-2 SDN-3 Techniques

→Anantam IAS — Gene Therapy vs Gene Editing

SDN-1 | CRISPR | GEAC | Rules 1989 | Kamala | PPV&FR | biosafety

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Q69

Nano-technology is emerging as a transformative platform across health, energy and materials. Discuss the Nano Mission's contributions and the regulatory gaps in nano-safety.

10 MARKS | 150 WORDS | 9 MIN | EASY | NANO-TECH

ANSWER OUTLINE

Introduction: Nano Mission launched by DST in 2007 with ₹1,000 crore Phase II (2014-25); India ranks 3rd globally in nano-science publications (Scopus 2024); 2023 Nobel in Chemistry recognised quantum dots — semiconductors at nanoscale.

Body: 1) Achievements — IIT-Bombay Nanofabrication Facility, Centres of Excellence at IISc and JNCASR, nano-urea by IFFCO commercialised 2021. 2) Gaps — no dedicated nano-safety regulation; FSSAI guidelines pending; occupational exposure standards thin. 3) Strategic value — nano-coatings for stealth, batteries.

Way forward: Notify Nano-Safety Guidelines under EPA 1986; mandatory labelling of food/cosmetics; expand Nano Mission Phase III with industry co-funding.

KEY POINTS TO INCLUDE

- Nano Mission Phase II ₹1,000 crore (DST 2014)
- India 3rd globally in nano publications (Scopus 2024)
- Nano-urea by IFFCO commercialised June 2021
- Quantum dots — Nobel Chemistry 2023
- FSSAI nano-safety guidelines pending
- Centres of Excellence at IISc, JNCASR

EXAMPLES & CASE STUDIES

- Nano-DAP by Coromandel 2023
- Carbon nanotube composites for defence
- Nano-pesticides under PPP

MODEL ANSWER

> **Introduction:** The Nano Mission was launched by DST in 2007, with Phase II (2014-25) carrying a ₹1,000 crore outlay; Scopus 2024 ranks India third globally in nano-

science publications; the 2023 Nobel in Chemistry recognised quantum dots — semiconductor crystals at the nanoscale that anchor displays and solar cells.

Body: First, achievements — IIT Bombay's Nanofabrication Facility, Centres of Excellence at IISc and JNCASR, IFFCO nano-urea commercialised in June 2021, and Coromandel nano-DAP (2023) for precision-fertiliser application. Second, gaps — no dedicated nano-safety regulation under EPA 1986, FSSAI guidelines pending, and thin occupational exposure standards for workers handling nano-particles. Third, strategic value — nano-coatings for stealth, carbon-nanotube composites for defence, and nano-pesticides hold dual-use significance.

Way forward: Notify Nano-Safety Guidelines under EPA 1986, mandate labelling of nano-engineered food and cosmetics, and launch Nano Mission Phase III with industry co-funding by 2027 under DST.

SOURCES

→DST Nano Mission
→Anantam IAS — Quantum Dots
→Anantam IAS — Bio-Plastics

nano-tech | Nano Mission | nano-urea | quantum dots | nano-safety | DST

GS PAPER 3

Security

15 practice questions

Q70

Left-wing extremism has shrunk to a narrow geographical core, yet the security-development binary remains contested. Examine the SAMADHAN doctrine and the role of development financing in the affected districts.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | INTERNAL SECURITY

ANSWER OUTLINE

Introduction: The Ministry of Home Affairs reports LWE-affected districts have shrunk from 126 in 2014 to 38 in 2024, with violent incidents down ~73% since 2010 (MHA Annual Report 2023-24).

Body: 1) SAMADHAN doctrine — Smart Leadership, Aggressive Strategy, Motivation and Training, Actionable Intelligence, Dashboard-based KPIs, Harnessing technology, Action plan for each Theatre, No access to financing. 2) Security forces — CRPF CoBRA, state police, Greyhounds; tech inputs from NTRO, UAVs. 3) Development — Special Central Assistance, Aspirational Districts Programme, road connectivity (RCPLWEA), mobile towers, banking-financial inclusion.

Way forward: Sunset SCA only when violence is zero for 3 consecutive years; expand Skill India in Bastar; align with Forest Rights Act recognition under MoTA.

KEY POINTS TO INCLUDE

- LWE districts down from 126 (2014) to 38 (2024) per MHA
- Violent incidents down ~73% since 2010
- SAMADHAN doctrine 2017 — MHA
- CRPF CoBRA battalions (10), Greyhounds Telangana
- RCPLWEA — Road Connectivity Project for LWE Areas
- Aspirational Districts Programme NITI Aayog (112 districts)
- Forest Rights Act 2006 implementation

EXAMPLES & CASE STUDIES

- Bastar division Chhattisgarh
- Jharkhand Saranda action plan
- Operation Octopus 2022

- PM-JANMAN for PVTGs

MODEL ANSWER

Introduction:

The Ministry of Home Affairs Annual Report 2024-25 records that LWE-affected districts have fallen from 126 (2014) to 38 (April 2026), and incidents from 1,936 (2010) to 374 (2024). The Union Home Minister has set a deadline of 31 March 2026 to eradicate Left-Wing Extremism, anchored in the SAMADHAN doctrine and a renewed development push.

SAMADHAN architecture: SAMADHAN — Smart leadership, Aggressive strategy, Motivation and training, Actionable intelligence, Dashboard-based KPIs, Harnessing technology, Action plan for each theatre, No access to financing — operationalises CRPF, COBRA, District Reserve Guards and state police under unified command. Modernisation grants of ₹1,000 crore and the Special Infrastructure Scheme have hardened 612 police stations in 90 LWE districts.

Development pillars: The Aspirational Districts Programme (NITI Aayog) covers 35 LWE districts. Road Requirement Plan-I (₹7,034 crore, 5,422 km) and RRP-II (₹11,725 crore) reached 6,000+ km of black-topped road; 6,565 mobile towers across 4,500 villages were sanctioned in 2024. Tribal welfare under PVTG Mission (PM-JANMAN, ₹24,000 crore) and PM-KISAN reaches 1.04 crore tribal beneficiaries.

Residual binary: The Forest Rights Act 2006 individual claims under FRA stand at 50% rejection in Chhattisgarh (Status Report 2024), and PESA implementation remains uneven. Surrender-cum-rehabilitation policies need durable livelihoods to prevent re-recruitment in cadre-vacuum areas.

Way forward:

MHA should sustain the SCA-LWE grant beyond March 2027, accelerate FRA title settlement under MoTA, and converge Aspirational Districts with PM-JANMAN and Skill India Mission to consolidate the security-development gains.

SOURCES

→MHA Annual Report 2023-24 — Left Wing Extremism Division
→Anantam IAS — Left Wing Extremism
→Anantam IAS — Terrorism in India

LWE | SAMADHAN | CoBRA | RCPLWEA | Aspirational Districts | Forest Rights Act

Q71

The Disaster Management (Amendment) Act 2024 reshapes India's federal disaster architecture. Examine the changes, the role of UDMA, and the residual gaps in financing and accountability.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | DISASTER MANAGEMENT

ANSWER OUTLINE

Introduction: The Disaster Management (Amendment) Act 2024 introduces statutory backing for the National Crisis Management Committee, creates Urban Disaster Management Authorities (UDMAs) in state capitals, and clarifies the role of NDMA and NEC.

Body: 1) Key changes — statutory plans by NDMA and SDMA; database of disaster losses; database role of NDMA. 2) Financing — NDRF, SDRF, NDMF; 15th FC allocations — ₹1.28 lakh crore for SDRF and ₹68,463 crore for NDRF. 3) Gaps — declaration of 'national disaster' unresolved; man-made disasters under-defined.

Way forward: Notify UDMAs by 2026 in mega-cities; converge with Sendai Framework targets; expand C-FLOOD and INSAT-3DS-based early warning.

KEY POINTS TO INCLUDE

- Disaster Management (Amendment) Act 2024
- UDMAs in state capitals and Class I cities
- NDRF, SDRF, NDMF, SDMF financing
- 15th FC — ₹1.28 lakh crore SDRF, ₹68,463 crore NDRF
- Sendai Framework 2015-30
- NCMC and NEC roles clarified
- C-FLOOD flood forecasting (CWC, NRSC)
- INSAT-3DS meteorological satellite

EXAMPLES & CASE STUDIES

- Wayanad landslides 2024
- Joshimath subsidence 2023
- Sikkim South Lhonak GLOF 2023
- Cyclone Biparjoy 2023

MODEL ANSWER

> **Introduction:**

The Disaster Management (Amendment) Act 2024, passed by Parliament on 3 December 2024, amends the parent Disaster Management Act 2005 to formalise the National Crisis Management Committee and the High-Level Committee at the apex, and to constitute statutory Urban Disaster Management Authorities (UDMA) in major cities under Section 41-A.

Architectural changes: The Amendment grants NDMA the mandate to prepare disaster databases, recognise post-disaster recovery, and assess man-made and emerging risks including climate-induced disasters. SDMAs and DDMAs gain authority to act ex-ante. The NCMC, chaired by the Cabinet Secretary, gets a statutory footing for cross-ministerial coordination during national-level crises.

UDMA's role: Cities with municipal corporations and populations above one million must constitute UDMAs chaired by the Municipal Commissioner, with mandates for urban risk reduction, fire-safety codes, building-bye-laws, drainage and heat. The XV Finance Commission set aside ₹68,463 crore for SDRF-Mitigation and ₹13,693 crore for NDRF-Mitigation — operationalising the Sendai Framework's third priority.

Residual gaps: Financing remains under-quantified: India spends only 0.4% of GDP on disaster risk reduction (UNDRR 2023), against the recommended 1.5%. Local UDMAs lack technical and cartographic capacity; PMAY-U 2.0 codes are not yet harmonised with NDMA guidelines on liquefaction zones and Coastal Vulnerability Index. State DRFs depend heavily on NDRF top-ups for slow-onset disasters such as drought and heatwave.

Way forward:

MHA and NDMA should notify UDMA model rules by FY27, ring-fence 1% of municipal own revenue for DRR under the 16th Finance Commission window, and operationalise risk-pool insurance under the Coalition for Disaster Resilient Infrastructure (CDRI).

SOURCES

→NDMA — Disaster Management Act and Amendments
→Anantam IAS — DM Act 2005 vs Amendment 2024
→Anantam IAS — Disaster Financing

NDMA | UDMA | NDRF | SDRF | NDMF | Sendai | DM Act

Q72

Cybersecurity is now a national-security priority as critical infrastructure goes digital. Examine India's institutional and legal framework and the gaps in

protecting CIIs.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | CYBERSECURITY

ANSWER OUTLINE

Introduction: CERT-In reported over 22 lakh cyber incidents in 2024 (Annual Report); India ranked 10th in ITU Global Cybersecurity Index 2024 (Tier 1).

Body: 1) Institutions — CERT-In (MeitY), NCIIPC under NTRO, I4C under MHA, NCSC, Defence Cyber Agency. 2) Laws — IT Act 2000, DPDP Act 2023, Section 70 CII regime, draft Digital India Act. 3) Gaps — sector-specific CSIRTs limited, attribution lag, OT and IoT exposure.

Way forward: Operationalise Digital India Act; expand NCIIPC sectoral coverage; mandate PQC migration timeline per CERT-In; ratify Budapest Convention dialogue.

KEY POINTS TO INCLUDE

- 22 lakh+ cyber incidents 2024 (CERT-In)
- ITU Global Cybersecurity Index 2024 — Tier 1
- CERT-In under MeitY; NCIIPC under NTRO
- I4C — Indian Cyber Crime Coordination Centre
- Section 70 IT Act — CII protection
- DPDP Act 2023 — data breach reporting
- Defence Cyber Agency under HQ IDS

EXAMPLES & CASE STUDIES

- AIIMS ransomware November 2022
- Power grid Mumbai outage 2020
- RailYatri data leak 2022
- BSNL data leak 2024

MODEL ANSWER

> **Introduction:** CERT-In recorded 15.92 lakh cybersecurity incidents in 2024 (MeitY Lok Sabha reply, March 2025); AIIMS Delhi ransomware (November 2022) and SpiceJet (2022) exposed critical-infrastructure vulnerability.
>
> **Body:** India's framework rests on the IT Act 2000 (Sections 66, 70 for CII), CERT-In Rules 2013, the National Cyber Security Policy 2013, and NCIIPC under NTRO. The DPDP Act 2023, BNS 2023 (Sections 111, 318 on cyber-fraud) and the proposed Digital India Act will replace IT Act 2000. CERT-In's six-hour reporting mandate (April 2022)

and the National Cybersecurity Strategy (draft, PMO since 2020) await notification. Gaps: only seven sectoral CSIRTs operational, low cyber-insurance penetration, a 7.9 lakh-professional talent deficit (NASSCOM 2024), and no active-defence law for cross-border attacks.

Way forward: The National Cyber Security Coordinator should table the National Cybersecurity Strategy by Q2 FY27 and operationalise sectoral CSIRTs for banking, power, telecom and health with ₹1,500 crore under the proposed DIA.

SOURCES

→CERT-In — Annual Reports and Advisories
→Anantam IAS — Cyber Security in India
→Anantam IAS — Types of Attacks on Computer Networks

CERT-In | NCIIPC | I4C | CII | DPDP | ransomware | PQC

Q73

Left-wing extremism has shrunk to a narrow geographical core. Examine the SAMADHAN doctrine and the development-security calibration in affected districts.

10 MARKS | 150 WORDS | 9 MIN | EASY | INTERNAL SECURITY

ANSWER OUTLINE

Introduction: MHA data (2025) records LWE incidents at ~370 in 2024 vs 2,213 in 2010, a ~83% decline; LWE-affected districts cut from 126 to 38 (as of April 2024); Home Minister has set March 2026 deadline to end LWE.

Body: 1) SAMADHAN doctrine — Smart leadership, Aggressive strategy, Motivation, Actionable intelligence, Dashboard-based KPI, Harnessing technology, Action plan, No access to financing. 2) Development — Aspirational Districts Programme, road construction under RCPLWEA. 3) Security forces — CRPF, COBRA, State Police.

Way forward: Sustain ADP investments; deepen FRA 2006 implementation in Bastar; financial-flow choke via PMLA; rehabilitation policy for cadres.

KEY POINTS TO INCLUDE

- LWE incidents ~370 in 2024 vs 2,213 in 2010 (MHA)
- LWE-affected districts cut to 38 by April 2024
- Home Minister deadline March 2026
- SAMADHAN doctrine — 8-pillar strategy

- Aspirational Districts Programme launched 2018
- Road construction under RCPLWEA scheme

EXAMPLES & CASE STUDIES

- Saranda iron-ore belt clearance
- Sukma district encounters 2024
- COBRA battalion deployments

MODEL ANSWER

Introduction: MHA data records Left Wing Extremism incidents at ~370 in 2024 against 2,213 in 2010 — an 83% decline; the count of LWE-affected districts has shrunk from 126 to 38 (as of April 2024), with the Home Minister setting a March 2026 deadline to end LWE in its current form.

Body: First, SAMADHAN doctrine — Smart leadership, Aggressive strategy, Motivation, Actionable intelligence, Dashboard KPIs, Harnessing technology, Action plan, and No access to financing — anchors the kinetic-cum-development response. Second, development levers — Aspirational Districts Programme (launched 2018), road construction under RCPLWEA, and skill-building for tribal youth in Saranda and Bastar. Third, security forces — CRPF, COBRA battalions, and State police now operate forward-operating bases, with Sukma encounters in 2024 marking significant operational success.

Way forward: Sustain ADP investments, deepen FRA 2006 implementation in Bastar, choke financial flows via PMLA, and frame a national surrender-rehabilitation policy under MHA by 2027.

SOURCES

→MHA — LWE Division
→Anantam IAS — Left Wing Extremism
→Anantam IAS — Terrorism in India

LWE | SAMADHAN | CRPF | Aspirational Districts | RCPLWEA | Naxalism

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Q74

The Northeast insurgency landscape has shifted dramatically with the AFSPA rollback and the Manipur ethnic conflict. Critically examine the security architecture and the policy choices required.

15 MARKS | 250 WORDS | 14 MIN | HARD | INTERNAL SECURITY

ANSWER OUTLINE

Introduction: AFSPA 1958 'disturbed area' coverage cut by 70% from 2014 levels (MHA 2024); Manipur ethnic violence since 3 May 2023 has displaced ~60,000 people and seen 200+ deaths; Free Movement Regime with Myanmar suspended in 2024.

Body: 1) Architecture — Assam Rifles, state police, IB, NSA; Bilateral Liaison Mechanism with Myanmar. 2) Manipur drivers — ST-status dispute, drug economy, cross-border arms. 3) FMR suspension — fencing 1,643 km Myanmar border; refugee management gap.

Way forward: President's rule review in Manipur; tri-partite political dialogue with ethnic groups; ratify a refugee policy framework; complete border fencing with displaced-people corridors; AFSPA full rollback district-by-district.

KEY POINTS TO INCLUDE

- AFSPA disturbed area cut by 70% from 2014 (MHA 2024)
- Manipur violence since 3 May 2023; 200+ deaths
- ~60,000 displaced; relief camps in Imphal Valley and Churachandpur
- Free Movement Regime suspended Feb 2024
- Myanmar border 1,643 km fencing announced 2024
- Assam Accord 1985 Section 6A challenge in SC
- NLFT, ULFA-I, NSCN factions
- Sumi Naga and Kuki-Zo-Hmar dialogue tracks

EXAMPLES & CASE STUDIES

- Naga Framework Agreement 2015
- Bru-Reang resettlement Tripura 2020
- Mizo Accord 1986 as model

MODEL ANSWER

> **Introduction**:
>
> MHA records show the AFSPA 1958 "disturbed area" footprint has been cut by 70% from 2014 levels by 2024; the Manipur ethnic conflict since 3 May 2023 has displaced ~60,000 people and seen 200+ deaths; the Free Movement Regime with Myanmar was suspended in February 2024.
>
> **Security architecture**:

The Northeast is held by Assam Rifles, state police, Intelligence Bureau, NIA, and the National Security Advisor's coordination cell, supported by the Bilateral Liaison Mechanism with Myanmar. AFSPA rollback has accompanied historical peace accords — Mizo (1986), Bru-Reang resettlement (2020), and the Naga Framework Agreement (2015) — though final settlements remain elusive.

Manipur drivers:

The Meitei demand for ST status, the cross-border Kuki-Zo-Hmar links into Myanmar's Chin state, post-coup arms inflows, and the methamphetamine economy combine to fuel the conflict. Relief camps in Imphal Valley and Churachandpur reflect deep ethnic segregation; the Article 6A (Assam Accord 1985) constitutional challenge before SC layers federal complexity.

FMR suspension and border fencing:

The 2024 suspension of FMR and the announced 1,643 km Myanmar border fence raise human-mobility and refugee-management questions, given India's non-ratification of the 1951 Refugee Convention. NLFT, ULFA-I, and NSCN factions remain dormant but not extinguished, and arms inflows from the Sagaing region complicate enforcement.

Way forward / Conclusion:

Sustain tri-partite political dialogue with ethnic groups, frame a refugee-protection framework, complete border fencing with managed corridors, and roll back AFSPA district-by-district under MHA by 2027 with Mizo Accord 1986 as the conflict-resolution template.

SOURCES

→MHA — Northeast Division
→Anantam IAS — UAPA Act
→Anantam IAS — Terrorism in India

AFSPA | Manipur | Free Movement Regime | Assam Rifles | Naga Accord | Kuki | Meitei

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Q75

Cross-border terrorism remains a primary national-security threat. Discuss the legal framework of the UAPA and the institutional response post-Pulwama, citing the 2025 Pahalgam attack.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | TERRORISM

ANSWER OUTLINE

Introduction: Pahalgam terror attack on 22 April 2025 killed 26 civilians; India launched Operation Sindoor on 7 May 2025; UAPA conviction rate ~27% (NCRB 2023); SC in Bail is the rule (UAPA bail-speedy-trial line) reiterated speedy trial under Article 21.

Body: 1) Legal framework — UAPA 1967 (amended 2019 individual designation), NIA Act 2008, PMLA 2002. 2) Institutional response — NIA jurisdiction expanded, NATGRID operational, Multi-Agency Centre. 3) International — FATF action; LeT, JeM, TRF designation push at UN 1267.

Way forward: NIA capacity audit; ratify ICRMT and ICSANT comprehensively; speedy-trial benchmarks for UAPA; review individual designation under Section 35.

KEY POINTS TO INCLUDE

- Pahalgam attack 22 April 2025 — 26 killed
- Operation Sindoor launched 7 May 2025
- UAPA conviction rate ~27% (NCRB 2023)
- UAPA Amendment 2019 — individual designation Section 35
- NIA Act 2008 — pan-India jurisdiction
- FATF — Pakistan removed from grey list Oct 2022
- NATGRID operational since 2020
- UNSC 1267 Sanctions Committee designations

EXAMPLES & CASE STUDIES

- Pulwama attack 14 February 2019
- Uri attack 18 September 2016
- Balakot airstrike 26 February 2019
- 26/11 Mumbai 2008

MODEL ANSWER

> **Introduction:**
>
> The Pahalgam terror attack on 22 April 2025 killed 26 civilians; India launched Operation Sindoor on 7 May 2025 in retaliation; the UAPA conviction rate remains around 27% (NCRB 2023); the Supreme Court has repeatedly underlined Article 21 speedy-trial obligations even under UAPA in its bail jurisprudence.
>
> **Legal framework:**

UAPA 1967, substantially amended in 2019 to allow Section 35 designation of individuals as terrorists, is the central counter-terror statute. The NIA Act 2008 grants the National Investigation Agency pan-India jurisdiction and the power to investigate scheduled offences. PMLA 2002 enables attachment of terror-finance proceeds; FCRA monitors foreign funding flows of suspect organisations.

Institutional response post-Pulwama:

After the Pulwama attack of 14 February 2019, NIA's mandate was expanded; NATGRID became operational in 2020; the Multi-Agency Centre under IB deepened intelligence fusion. The Balakot airstrike (26 February 2019) signalled an offensive doctrine continued into Operation Sindoor. The 26/11 Mumbai attack (2008) and Uri (18 September 2016) remain reference points.

International dimension:

The FATF process kept Pakistan on the grey list until October 2022. India has pushed for UNSC 1267 Sanctions Committee designations of LeT, JeM, and TRF operatives. Operation Sindoor was framed as proportionate, calibrated, and non-escalatory under self-defence in Article 51 of the UN Charter.

Way forward / Conclusion:

Audit NIA capacity, ratify the Comprehensive Convention on International Terrorism, set speedy-trial benchmarks for UAPA cases, and review Section 35 individual designations through judicial oversight by 2027 under MHA.

SOURCES

→MHA — Counter-Terrorism Division
→Anantam IAS — UAPA Act
→Anantam IAS — Bail Is a Constitutional Safety Valve, Even Under UAPA

UAPA | NIA | FATF | Pahalgam | Operation Sindoor | NATGRID | UNSC 1267

Q76

Cybersecurity is now a national-security priority as critical infrastructure goes digital. Examine the institutional architecture under CERT-In and the gaps in CII protection.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | CYBERSECURITY

ANSWER OUTLINE

Introduction: CERT-In handled 16.05 lakh cybersecurity incidents in 2024 (CERT-In Annual Report); AIIMS Delhi ransomware attack (23 Nov 2022) compromised 5 servers; National Cyber Security Policy 2013 awaits update.

Body: 1) Institutional stack — CERT-In (CERT-In.org.in) under MeitY, NCIIPC under NTRO, I4C under MHA, Defence Cyber Agency under CDS. 2) CII framework — Section 70 IT Act, NCIIPC empanelled sectors (power, finance, transport, telecom, government). 3) Gaps — no Cybersecurity Act, fragmented breach notification, weak SME hygiene.

Way forward: Pass Cybersecurity Act/National Cybersecurity Strategy; mandatory breach disclosure under DPDP Rules; CERT-In 6-hour reporting reform; bug-bounty programmes for CII.

KEY POINTS TO INCLUDE

- 16.05 lakh cyber incidents handled by CERT-In in 2024
- AIIMS Delhi ransomware 23 November 2022
- Section 70 IT Act 2000 — CII designation
- NCIIPC under NTRO (Section 70A)
- CERT-In 6-hour incident reporting direction (28 April 2022)
- Indian Cyber Crime Coordination Centre (I4C) under MHA
- Defence Cyber Agency under CDS (2019)
- National Cyber Security Strategy draft 2020 pending

EXAMPLES & CASE STUDIES

- AIIMS Delhi ransomware 2022
- Mumbai grid outage Oct 2020 (suspected cyber)
- ICICI and ICEGATE breaches
- Solarwinds-style supply-chain risks

MODEL ANSWER

> **Introduction**:
>
> CERT-In's Annual Report records 16.05 lakh cybersecurity incidents handled in 2024; the AIIMS Delhi ransomware attack of 23 November 2022 compromised five servers and paralysed critical hospital systems for two weeks; the National Cyber Security Policy 2013 still awaits an overdue update.

Institutional architecture:

The Indian Computer Emergency Response Team (CERT-In) under MeitY handles civilian incidents and issued the 6-hour reporting direction of 28 April 2022. The National Critical Information Infrastructure Protection Centre (NCIIPC) under NTRO operates under Section 70A of the IT Act 2000 to protect designated CII sectors — power, finance, transport, telecom, and government. The Indian Cyber Crime Coordination Centre (I4C) under MHA handles cyber-enabled crime; the Defence Cyber Agency under the Chief of Defence Staff (2019) handles military cyber-space.

CII protection framework and gaps:

Section 70 IT Act permits designation of CII, but the empanelment is patchy, and many state-level utilities and hospitals are not covered. The Mumbai grid outage of October 2020 — attributed to suspected cyber activity — exposed power-sector vulnerability. The AIIMS attack revealed that even apex national institutions run inadequate backup, segmentation, and incident-response drills.

Structural gaps:

India has no overarching Cybersecurity Act; breach notification is fragmented; SME hygiene remains weak; supply-chain attack risk (Solarwinds-style) is under-modelled. The draft National Cyber Security Strategy of 2020 remains pending finalisation.

Way forward / Conclusion:

Pass a Cybersecurity Act with a national strategy, mandate breach disclosure under DPDP Rules, harmonise CERT-In reporting timelines, and institutionalise bug-bounty programmes for CII operators under MeitY by 2027.

SOURCES

→CERT-In — Annual Reports
→Anantam IAS — Deepfakes
→Anantam IAS — Dark Web vs Deep Web

CERT-In | NCIIPC | CII | I4C | Defence Cyber Agency | IT Act | ransomware

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Q77

Cyber-enabled financial frauds have surged with UPI penetration. Discuss the role of the Indian Cyber Crime Coordination Centre and the Citizen Financial Cyber Fraud Reporting System.

10 MARKS | 150 WORDS | 9 MIN | EASY | CYBERSECURITY

ANSWER OUTLINE

Introduction: NCRP and CFCFRMS (toll-free 1930) recorded over 36 lakh complaints in 2024 with reported losses exceeding ₹22,800 crore (I4C); BNS 2023 Sections 318-319 cover cheating and impersonation; mule-account ecosystem identified as a key vector.

Body: 1) I4C ecosystem — NCRP portal, 1930 helpline, CyTrain LMS, Joint Cyber Coordination Teams. 2) Bank coordination — RBI's positive-pay system, NPCI fraud-risk-management. 3) Cross-border — fraud farms in SE Asia, MLAT bottlenecks.

Way forward: Statutory backing for 1930; Real-time API for bank freeze; bilateral cyber-MoUs with Cambodia, Laos, Myanmar; AI-based mule-account detection.

KEY POINTS TO INCLUDE

- 36+ lakh cyber complaints on NCRP in 2024
- Reported losses ₹22,800+ crore (I4C 2024)
- 1930 helpline operationalised 2021
- I4C — 7 verticals incl JCCT
- RBI positive pay above ₹50,000
- BNS 2023 Sections 318-319 on cheating

EXAMPLES & CASE STUDIES

- Pig-butchering scams 2024
- Digital arrest scams (PIB advisory 2025)
- Lazarus Group North Korea threats

MODEL ANSWER

> **Introduction:** The National Cybercrime Reporting Portal and the Citizen Financial Cyber Fraud Reporting and Management System on the 1930 helpline recorded over 36 lakh complaints in 2024 with reported losses exceeding ₹22,800 crore (I4C); UPI's deep penetration has widened the cyber-fraud attack surface.
>
> **Body:** First, the I4C ecosystem — NCRP portal, 1930 helpline, CyTrain LMS, and Joint Cyber Coordination Teams across seven verticals; complaints route to bank-NPCI lien within 24 hours. Second, bank coordination — RBI's positive-pay system for cheques above ₹50,000, NPCI fraud-risk-management rules, and BNS 2023 Sections 318-319 on cheating and impersonation. Third, cross-border vector — fraud farms in Cambodia,

Laos, Myanmar exploit MLAT bottlenecks, with pig-butchering scams and digital-arrest scams (PIB advisory 2025) targeting urban professionals.

Way forward: Provide statutory backing to 1930, deploy real-time API for bank account freezing, sign bilateral cyber-MoUs with Southeast Asia, and pilot AI-based mule-account detection under MHA by 2027.

SOURCES

→I4C — National Cybercrime Reporting Portal
→Anantam IAS — Dark Web vs Deep Web
→Anantam IAS — Fintech Sector in India

I4C | NCRP | 1930 | cyber fraud | BNS | mule account | JCCT

Q78

The Prevention of Money Laundering Act 2002 has been called both a powerful weapon and a contested instrument. Examine the SC's Vijay Madanlal verdict and the institutional role of the Enforcement Directorate.

15 MARKS | 250 WORDS | 14 MIN | HARD | MONEY LAUNDERING

ANSWER OUTLINE

Introduction: PMLA conviction rate ~24 of 7,083 cases (PRS Legislative 2024); SC in Vijay Madanlal Choudhary vs Union of India (27 July 2022) upheld ED's wide powers; FATF Mutual Evaluation Report (Sept 2024) placed India in regular follow-up — strongest rating among major economies.

Body: 1) PMLA architecture — predicate offence + proceeds of crime; Section 17 search, Section 19 arrest, Section 24 reverse onus; FIU-IND under Section 12. 2) ED expansion — 7,083 cases registered as of 2024; attachment of ₹1.21 lakh crore. 3) Concerns — low conviction, ECIR not shared with accused, bail twin conditions Section 45.

Way forward: Codify ECIR sharing; statutory time-limit for trial; review reverse-onus clause; strengthen FIU's STR analytics; align with Section 66 BNSS bail jurisprudence.

KEY POINTS TO INCLUDE

- PMLA conviction ~24 out of 7,083 cases (PRS 2024)
- Vijay Madanlal Choudhary SC verdict 27 July 2022
- FATF Mutual Evaluation 2024 — regular follow-up rating
- FIU-IND under Section 12 PMLA
- Section 24 reverse onus on accused

- Section 45 twin conditions for bail
- Attachment ₹1.21 lakh crore (ED 2024)
- PMLA Schedule covers 156 predicate offences

EXAMPLES & CASE STUDIES

- INX Media P. Chidambaram case
- Delhi excise policy case 2024
- Aircel-Maxis ED probe
- Crypto VDA inclusion 2023

MODEL ANSWER

Introduction:

PRS Legislative (2024) records only 24 convictions out of 7,083 PMLA cases registered by the Enforcement Directorate; the Supreme Court in Vijay Madanlal Choudhary vs Union of India (27 July 2022) upheld ED's wide powers under PMLA; the FATF Mutual Evaluation Report (September 2024) placed India in the regular follow-up category — the strongest rating among major economies.

PMLA architecture:

PMLA 2002 criminalises laundering of proceeds of a scheduled "predicate offence," with a list covering 156 offences. Section 17 enables search, Section 19 arrest, Section 24 reverses the onus of proof, and Section 45 imposes twin conditions for bail. FIU-IND under Section 12 receives suspicious transaction reports.

Vijay Madanlal verdict:

The Court upheld ED's powers of search, seizure, attachment, and arrest; held PMLA proceedings to be sui generis and not strictly criminal; sustained the twin-conditions bail regime; and ruled that the ECIR is not a charge-sheet and need not be supplied to the accused. A review petition is pending on key issues.

Institutional role of ED:

ED has attached property worth ~₹1.21 lakh crore by 2024; high-profile cases include Aircel-Maxis, INX Media (P. Chidambaram), the Delhi excise policy case (2024), and inclusion of crypto VDAs in 2023. Yet conviction outcomes remain disproportionately low.

Way forward / Conclusion:

> Codify ECIR sharing post-arrest, impose statutory time-limits for PMLA trials, judicially review the reverse-onus clause, and strengthen FIU-IND's STR analytics — aligning with the Senthil Balaji bail jurisprudence by 2027 under MoF.

SOURCES

→FIU-India — PMLA Reports
→Anantam IAS — Enforcement Directorate
→Anantam IAS — Crypto Assets and VDAs

PMLA | ED | FIU-IND | Vijay Madanlal | ECIR | reverse onus | FATF | predicate offence

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Q79

Virtual Digital Assets and crypto channels are emerging routes for money laundering. Discuss India's regulatory response and the Crypto Asset Reporting Framework roadmap.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | MONEY LAUNDERING

ANSWER OUTLINE

Introduction: MoF notification 7 March 2023 brought VDAs under PMLA; CBDT levies 30% tax + 1% TDS (Finance Act 2022); India committed to OECD Crypto Asset Reporting Framework with first exchange of information by 2027.

Body: 1) PMLA coverage — FIU-IND registration of crypto exchanges; KYC, STR obligations. 2) Show-cause to offshore exchanges 2023-24 (Binance, KuCoin etc.). 3) Gap — no comprehensive legislative framework; G20 IMF-FSB synthesis paper guidance.

Way forward: Pass Crypto-asset Regulation Bill; operationalise CARF; license-based regime via IFSCA at GIFT City; investor-protection rules.

KEY POINTS TO INCLUDE

- VDAs under PMLA from 7 March 2023
- 30% tax + 1% TDS under Finance Act 2022
- CARF OECD roadmap — first exchange by 2027
- FIU-IND registration for crypto exchanges
- Binance and KuCoin show-cause 2023-24
- G20 IMF-FSB Synthesis Paper Sept 2023
- IFSCA crypto-related framework

EXAMPLES & CASE STUDIES

- WazirX hack July 2024 (~$230 million)
- Bitconnect Ponzi cases in Gujarat
- CBDC pilot retail e-rupee

MODEL ANSWER

> **Introduction:** A Ministry of Finance notification of 7 March 2023 brought Virtual Digital Assets under the PMLA reporting regime; the Finance Act 2022 levies 30% income tax plus 1% TDS on VDA transfers; India committed at G20 to the OECD Crypto Asset Reporting Framework (CARF) with first information exchange by 2027.
>
> **Body:** First, PMLA coverage — FIU-IND mandatory registration for crypto exchanges, KYC and STR obligations; Binance and KuCoin received show-cause notices and registered in 2023-24 after offshore operations. Second, no comprehensive Indian crypto law exists; the G20 IMF-FSB Synthesis Paper (September 2023) provides a global template under India's G20 presidency, but domestic legislation lags. Third, the WazirX hack of July 2024 (~US$230 million) exposed custody risks; the CBDC e-rupee retail pilot continues to mature in parallel.
>
> **Way forward:** Pass a Crypto-asset Regulation Bill, operationalise CARF by 2027, license operations via IFSCA at GIFT City, and notify investor-protection rules under SEBI-RBI coordination by 2028.

SOURCES

→OECD — Crypto Asset Reporting Framework
→Anantam IAS — Crypto Assets and Virtual Digital Assets
→Anantam IAS — Central Bank Digital Currency

VDA | PMLA | CARF | FIU-IND | TDS | crypto | IFSCA

Q80

India's land borders span 15,106 km across seven neighbours. Examine the integrated border management approach under the Comprehensive Integrated Border Management System and the residual gaps.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | BORDER MANAGEMENT

ANSWER OUTLINE

Introduction: MHA (Border Management Division 2024) records 15,106.7 km land borders; CIBMS launched 2017 with pilots on Indo-Bangladesh and Indo-Pakistan borders;

BSF, ITBP, SSB, AR are border-guarding forces.

Body: 1) CIBMS components — sensors, fence, command centres, smart fences. 2) Sector-specific — China LAC infrastructure under BRO (Vibrant Villages Programme 2023, ₹4,800 crore), Myanmar fencing 1,643 km, India-Bangladesh dual-use rivers. 3) Gaps — fence breaches, cattle smuggling, drug corridor.

Way forward: Complete CIBMS rollout; UAV-based ISR integration; faster land-port commerce via LPAI; Vibrant Villages Phase II.

KEY POINTS TO INCLUDE

- Land borders 15,106.7 km (MHA 2024)
- CIBMS pilots launched 2017
- Vibrant Villages Programme ₹4,800 crore (2023)
- Myanmar border fencing 1,643 km announced 2024
- BSF, ITBP, SSB, AR — border-guarding forces
- BRO Border Roads under MoD

EXAMPLES & CASE STUDIES

- Sela Tunnel inaugurated March 2024
- BSF Operation Sard Hawa Rajasthan
- Land Ports Authority Petrapole-Benapole

MODEL ANSWER

> **Introduction:** MHA's Border Management Division (2024) records India's land borders at 15,106.7 km across seven neighbours; the Comprehensive Integrated Border Management System (CIBMS) was launched in 2017 with pilots on the Indo-Bangladesh and Indo-Pakistan borders, and the Vibrant Villages Programme (2023) commits ₹4,800 crore for border-area development.
>
> **Body:** First, CIBMS components — smart fences, ground sensors, surveillance towers, command-and-control centres, and UAV integration along sensitive stretches. Second, sector-specific — Border Roads Organisation (BRO) anchors China LAC infrastructure (Sela Tunnel inaugurated March 2024); 1,643 km fencing announced for the Myanmar border in 2024; Indo-Bangladesh dual-use rivers managed via Joint Working Groups. Third, gaps — fence breaches, cattle smuggling, narcotic corridors through Sir Creek and the IGB; BSF Operation Sard Hawa typifies the perennial Rajasthan challenge.

> **Way forward:** Complete CIBMS rollout, integrate UAV-based ISR, accelerate land-port commerce via LPAI, and launch Vibrant Villages Phase II by 2028 under MHA.

SOURCES

→MHA — Border Management Division
→Anantam IAS — Indian States, Boundaries and International Borders
→Anantam IAS — Wular Lake

CIBMS | BSF | ITBP | Vibrant Villages | BRO | LPAI | border fencing

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Q81

Coastal security has been a layered concern since 26/11. Critically evaluate the Coastal Security Scheme, the role of NCSMCS and the residual gaps in Sagarmala-era coastal infrastructure.

15 MARKS | 250 WORDS | 14 MIN | HARD | COASTAL SECURITY

ANSWER OUTLINE

Introduction: 7,516.6 km coastline (MoEFCC 2024); Coastal Security Scheme Phase III rolled out from 2020-21 (~₹1,950 crore); Joint Operations Centres operationalised at Mumbai, Visakhapatnam, Kochi, Port Blair; National Committee on Strengthening Maritime and Coastal Security (NCSMCS) chaired by Cabinet Secretary.

Body: 1) Architecture — Indian Navy (overall), Coast Guard (territorial), Marine Police (12 nm), Customs, MPA. 2) Gaps — fishermen vessel identification (only ~50% have AIS class-B transponders), small-port surveillance, DRI-Customs coordination. 3) Sagarmala-era — port-led development raises commercial-security trade-off.

Way forward: Universal AIS for fishing vessels; CCTV-AIS at all minor ports; integrate Information Fusion Centre IOR (Gurugram); empower MPA training.

KEY POINTS TO INCLUDE

- Coastline 7,516.6 km (MoEFCC 2024)
- 26/11 Mumbai attack 26 November 2008
- Coastal Security Scheme Phase III from 2020-21
- NCSMCS chaired by Cabinet Secretary
- IFC-IOR Gurugram operational since 2018
- Joint Operations Centres at Mumbai, Visakhapatnam, Kochi, Port Blair
- Sagarmala Programme launched 2015
- ICG sanctioned strength ~17,000

EXAMPLES & CASE STUDIES

- 26/11 Mumbai 2008 sea-route entry
- Tuticorin Sterlite security review
- Operation Aakraman ICG vs drug trawlers 2024

MODEL ANSWER

Introduction:

India's coastline is 7,516.6 km (MoEFCC 2024); the Coastal Security Scheme Phase III rolled out from 2020-21 with ~₹1,950 crore; the National Committee on Strengthening Maritime and Coastal Security (NCSMCS) chaired by the Cabinet Secretary coordinates the post-26/11 architecture. Joint Operations Centres operate at Mumbai, Visakhapatnam, Kochi, and Port Blair.

Layered architecture:

The Indian Navy holds overall maritime responsibility. The Indian Coast Guard, with a sanctioned strength of ~17,000, covers territorial waters. State Marine Police patrol the 12-nautical-mile zone, while Customs, DRI, and Maritime Port Authorities anchor commercial security. The Information Fusion Centre — Indian Ocean Region (IFC-IOR) at Gurugram, operational since 2018, fuses regional data with international liaison officers.

Residual gaps:

Only ~50% of fishing vessels carry AIS Class-B transponders; smaller fishing harbours lack CCTV-AIS coverage; minor ports rely on patchy surveillance. Coordination between Customs, ICG, and DRI on smuggling and dual-use cargo remains uneven. Operation Aakraman (2024) showed effective maritime drug interdiction but also exposed the volume of trafficking through fishing boats.

Sagarmala trade-off:

Port-led development under Sagarmala (2015) raises commercial throughput and dual-use security exposure simultaneously. Tuticorin (Sterlite case) and Vizhinjam scaling illustrate the security-economy interplay across India's western seaboard, with the 26/11 Mumbai sea-route entry remaining the cardinal lesson.

Way forward / Conclusion:

> Make AIS Class-B universal for fishing vessels, deploy CCTV-AIS at all minor ports, expand the IFC-IOR partner-station network, modernise Coast Guard interceptor fleet, and upgrade Marine Police Training Institute capacity under MHA-MoD by 2028.

SOURCES

→Indian Coast Guard
→Anantam IAS — Coastal Plains of India
→Anantam IAS — Directorate of Revenue Intelligence (DRI)

coastal security | NCSMCS | AIS | ICG | IFC-IOR | Sagarmala | MPA

Q82

The Disaster Management (Amendment) Act 2024 reshapes India's federal disaster architecture. Examine the changes, the role of the Urban Disaster Management Authority, and the residual gaps in financing.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | DISASTER MANAGEMENT

ANSWER OUTLINE

Introduction: Disaster Management (Amendment) Act 2024 received Presidential assent on 1 March 2025; original DM Act 2005 enacted 26 December 2005 after Indian Ocean tsunami; CRF and SDRF allocations for 2021-26 stand at ₹1,28,122.40 crore (15th FC).

Body: 1) Key changes — NDMA prepares plans (earlier only mandated); statutory backing for NCMC, HLC; new UDMA for state-capital and million-plus cities; NDMA chairperson appointed by PM. 2) Federal tension — states see encroachment on List II 'Public health, Sanitation'. 3) Financing — SDMF and NDMF created; gap in heatwave notification.

Way forward: Notify rules for UDMA; ring-fence SDMF/NDMF allocations; include heatwave under SDRF; align with Sendai Framework 2015-2030 targets.

KEY POINTS TO INCLUDE

- DM Amendment Act 2024 assented 1 March 2025
- Original DM Act 2005 — 26 December 2005
- UDMA for state-capital and million-plus cities
- NDMA chairperson now appointed by PM
- 15th FC SDRF/NDRF ₹1,28,122.40 crore (2021-26)
- SDMF and NDMF created under amendment
- Sendai Framework 2015-2030 alignment
- 12 notified disasters under SDRF (heatwave excluded)

EXAMPLES & CASE STUDIES

- Wayanad landslides July 2024
- Sikkim GLOF October 2023
- Cyclone Biparjoy June 2023
- Joshimath subsidence Jan 2023

MODEL ANSWER

Introduction:

The Disaster Management (Amendment) Act 2024 received Presidential assent on 1 March 2025, two decades after the original DM Act 2005 of 26 December 2005 was passed in the wake of the 2004 Indian Ocean tsunami; the 15th Finance Commission has allocated ₹1,28,122.40 crore for State and National Disaster Response and Mitigation Funds (2021-26).

Key changes:

The NDMA is now empowered to prepare disaster plans directly (earlier only mandated to coordinate). The NDMA Chairperson is appointed by the Prime Minister. The National Crisis Management Committee and High-Level Committee receive statutory backing. State Disaster Mitigation Funds and a National Disaster Mitigation Fund have been created. The Cabinet Secretary's role in NCMC is formalised.

Urban Disaster Management Authority:

The amendment creates a new Urban Disaster Management Authority for state-capital cities and million-plus cities — addressing dense urban risk (Wayanad landslides July 2024, Chennai flooding, Joshimath subsidence January 2023, Sikkim GLOF October 2023, Cyclone Biparjoy June 2023).

Residual gaps:

States flag federal encroachment on List II subjects such as public health and sanitation. Heatwave remains outside the 12 SDRF-notified disasters, despite IMD's record 536 heatwave days in 2024. Climate-induced compound disasters are unevenly mapped. SDMF and NDMF allocations are yet to be ring-fenced from competing demands.

Way forward / Conclusion:

Notify UDMA rules, ring-fence SDMF/NDMF allocations, include heatwave under SDRF, and align India's disaster financing with the Sendai Framework 2015-2030 and

> CDRI targets by 2027 under NDMA.

SOURCES

→NDMA — Disaster Management Act
→Anantam IAS — DM Act 2005 vs Amendment 2024
→Anantam IAS — NDMA Full Form

DM Amendment 2024 | NDMA | UDMA | SDRF | NDRF | Sendai Framework | SDMF

Q83

India's tropical cyclone landfalls have grown more intense and unpredictable. Examine the IMD-NDMA-SDMA response chain and the gaps revealed by recent cyclones.

10 MARKS | 150 WORDS | 9 MIN | EASY | DISASTER MANAGEMENT

ANSWER OUTLINE

Introduction: IMD recorded 8 cyclonic storms in the North Indian Ocean basin in 2023 (above climatological average of ~5); Cyclone Biparjoy (June 2023) had ~14-day track — longest ever recorded over Arabian Sea (IMD).

Body: 1) Response chain — IMD forecast, NDMA SOP, NDRF pre-positioning, SDMA evacuation, ISRO Mausam dissemination. 2) Successes — near-zero casualties in Cyclone Biparjoy. 3) Gaps — compound flood-cyclone events, post-cyclone livelihood restoration.

Way forward: Compound-event modelling; CDRI-led infrastructure resilience; mandatory cyclone shelters under PMAY-G coastal blocks.

KEY POINTS TO INCLUDE

- 8 cyclonic storms in NIO 2023 (IMD)
- Cyclone Biparjoy 14-day track June 2023
- INSAT-3DS launched February 2024 for cyclone tracking
- NDRF 16 battalions
- CDRI launched at UN 2019
- Cyclone Distance Coding under IMD Mumbai

EXAMPLES & CASE STUDIES

- Cyclone Fani 2019 zero-casualty model
- Cyclone Remal May 2024
- Cyclone Michaung Chennai 2023

MODEL ANSWER

Introduction: India recorded 8 cyclones in 2023 — Cyclone Biparjoy ran 14 days, the longest Arabian Sea track ever.

Response chain: IMD generates 72-hour Cyclone Genesis Potential; NDMA SOP triggers NDRF pre-positioning; SDMA drives Zero-Casualty Approach evacuation in coastal blocks.

Gaps: Compound flood-cyclone events overwhelm single-hazard SOPs; post-cyclone livelihood (fisheries, salt-pan workers) lacks structured restoration; smaller IMD-untracked tropical lows still kill.

Way forward: Compound-event ensemble modelling at IMD; CDRI-led coastal infrastructure resilience under MoEFCC; mandatory multi-purpose shelters in PMAY-G coastal blocks; ULB-level last-mile communication via AI4Bharat language stack.

SOURCES

→IMD — Cyclone Warning
→Anantam IAS — Super Typhoon Ragasa
→Anantam IAS — INSAT-3DS

cyclone | IMD | NDRF | Biparjoy | Fani | CDRI | INSAT-3DS

Q84

Glacial Lake Outburst Floods are emerging as a Himalayan disaster of the climate-change era. Discuss the lessons from Sikkim South Lhonak GLOF and the institutional response required.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | DISASTER MANAGEMENT

ANSWER OUTLINE

Introduction: South Lhonak GLOF (3-4 October 2023) destroyed the 1,200 MW Teesta-III dam in Sikkim and killed 100+; ISRO Cartosat mapped 38 high-risk glacial lakes in Indian Himalaya (2024); NDMA Guidelines on GLOF 2020.

Body: 1) Drivers — climate warming, lake expansion, moraine instability. 2) Response — early-warning siren systems pilot at 7 lakes by NDMA; coordination CWC-IMD-Geological Survey. 3) Infrastructure exposure — hydropower projects in the cascade.

Way forward: Universal early-warning at high-risk lakes; mandatory GLOF risk-rating before clearances; siphon-and-pump pilot at Lhonak; relocation of vulnerable settlements.

KEY POINTS TO INCLUDE

- South Lhonak GLOF 3-4 October 2023
- 1,200 MW Teesta-III dam destroyed
- 100+ killed/missing in Sikkim
- 38 high-risk lakes identified (ISRO 2024)
- NDMA GLOF Guidelines 2020
- CWC, IMD, GSI coordination

EXAMPLES & CASE STUDIES

- Chamoli flash flood 7 February 2021
- Kedarnath disaster 2013
- Imja GLOF risk in Nepal as comparator

MODEL ANSWER

> **Introduction:** The South Lhonak Glacial Lake Outburst Flood of 3-4 October 2023 destroyed the 1,200 MW Teesta-III dam and killed 100+ in Sikkim; ISRO Cartosat mapping (2024) identified 38 high-risk glacial lakes in the Indian Himalaya; the NDMA Guidelines on GLOF were released in 2020.
>
> **Body:** First, drivers — climate-driven warming, rapid lake expansion, and moraine instability create cascading risk; the Chamoli flash flood of 7 February 2021 and the Kedarnath disaster (2013) signalled earlier warnings, and Nepal's Imja GLOF risk is a comparator. Second, institutional response — NDMA is piloting early-warning siren systems at seven high-risk lakes, with CWC, IMD, and Geological Survey of India coordinating downstream hazard mapping. Third, infrastructure exposure — multiple hydropower projects sit in the Teesta and Alaknanda cascades.
>
> **Way forward:** Roll out universal early-warning systems at high-risk lakes, mandate GLOF risk-rating before EIA clearances, pilot siphon-and-pump drawdown at Lhonak, and relocate vulnerable settlements under NDMA-MoEFCC by 2028.

SOURCES

→NDMA — GLOF Guidelines 2020
→Anantam IAS — Cloudburst Flooding in India
→Anantam IAS — Earthquake Causes and Types

GLOF | Lhonak | Teesta | NDMA | Cartosat | moraine | early warning

GS PAPER 3

Environment

16 practice questions

Q85

India's updated NDC commits to 45% reduction in emissions intensity by 2030 and net-zero by 2070. Critically evaluate the LT-LEDS pathway and the role of CBAM in shaping India's transition.

15 MARKS | 250 WORDS | 14 MIN | HARD | CLIMATE

ANSWER OUTLINE

Introduction: India's updated NDC (Aug 2022) commits to 45% reduction in GDP emissions intensity by 2030 over 2005 levels and 50% non-fossil installed capacity; India's LT-LEDS was submitted at COP27 (2022) targeting net-zero by 2070.

Body: 1) Pathways — power decarbonisation (500 GW non-fossil by 2030), industrial transition (green hydrogen, steel), urban transport (EV30@30). 2) CBAM — EU Carbon Border Adjustment Mechanism transitional phase since Oct 2023, full from Jan 2026; covers steel, cement, aluminium, fertilisers, electricity, hydrogen. 3) Just transition — RECLAIM Framework for closed coal mines.

Way forward: Operationalise CCTS under Carbon Credit Trading Scheme 2023 (MoEFCC, BEE); negotiate CBAM equivalence with EU; expand National Adaptation Fund and Green Hydrogen Mission.

KEY POINTS TO INCLUDE

- NDC — 45% emissions intensity cut by 2030, 50% non-fossil capacity
- Net-zero target 2070 (LT-LEDS, COP27)
- CBAM transitional phase October 2023, full January 2026
- Carbon Credit Trading Scheme 2023 (CCTS)
- National Green Hydrogen Mission ₹19,744 crore, 5 MMT by 2030
- Energy Conservation (Amendment) Act 2022
- Bureau of Energy Efficiency — PAT scheme transition
- MoEFCC, MNRE, BEE coordination

EXAMPLES & CASE STUDIES

- PM-Surya Ghar Muft Bijli Yojana — 1 crore rooftop solar
- RECLAIM Framework for coal mine closure

- SAIL and Tata Steel hydrogen pilots
- Indian Carbon Market CCTS

MODEL ANSWER

Introduction:

India's updated Nationally Determined Contribution, submitted to UNFCCC in August 2022, commits to 45% reduction in emissions intensity of GDP by 2030 (over 2005), 50% non-fossil electric capacity by 2030, and net-zero by 2070. India's Long-Term Low-Emission Development Strategy (LT-LEDS), tabled at COP-27 in November 2022, sets the structural pathway.

LT-LEDS pillars: Low-carbon electricity (500 GW non-fossil by 2030, MNRE), integrated transport (FAME-III at ₹10,900 crore, PM E-DRIVE 2024-26), urban planning aligned with City Action Plans, hard-to-abate decarbonisation via the Green Hydrogen Mission (₹19,744 crore, 5 MMT by 2030), CO2 removal through afforestation under the Green India Mission, and equitable transition financing of $10 trillion by 2070 (CEEW estimate).

CBAM implications: The EU Carbon Border Adjustment Mechanism, definitive from 1 January 2026, covers steel, aluminium, cement, fertilisers, hydrogen and electricity. Indian exports of $8.5 bn (CRISIL 2024) face a carbon levy of 20-35%; the steel sector alone could see margin erosion of 4-6%. The Carbon Credit Trading Scheme 2023 and Indian Carbon Market under the Energy Conservation Amendment Act 2022 must be CBAM-compatible.

Equity concerns: India's per-capita CO2 (1.9 tonnes) is one-third of the global average. Common But Differentiated Responsibilities and the Paris Article 9.1 climate-finance pledge of $100 bn remain unmet ($83 bn delivered, OECD 2023).

Way forward:

MoEFCC and MNRE should notify ICM Phase-1 by FY27, file WTO disputes on CBAM under Article XX, scale Green Hydrogen capacity to 1 MMT by 2027, and operationalise the Loss-and-Damage Fund commitments agreed at COP-28.

SOURCES

→MoEFCC — LT-LEDS Submission
→Anantam IAS — CBAM and India's Carbon-Trade Reckoning
→Anantam IAS — India's LT-LEDS and Climate Strategy

NDC | LT-LEDS | CBAM | CCTS | net-zero | green hydrogen | just transition | BEE

Q86

India aims for 500 GW non-fossil capacity by 2030. Discuss the progress of the National Green Hydrogen Mission and the integration challenges for renewable energy in India's grid.

10 MARKS | 150 WORDS | 9 MIN | EASY | ENERGY MIX

ANSWER OUTLINE

Introduction: India's non-fossil installed capacity crossed 200 GW in 2024 (MNRE); the National Green Hydrogen Mission targets 5 MMT of green hydrogen by 2030 with an outlay of ₹19,744 crore.

Body: 1) Capacity additions — solar 90+ GW, wind 47 GW. 2) Grid integration — round-the-clock RE, BESS auctions under VGF, Green Energy Open Access Rules 2022. 3) Storage and transmission — PSP pipeline 47 GW, Green Energy Corridor phase II.

Way forward: Scale SIGHT incentives under NGHM; auction 13 GWh BESS under VGF; complete Green Energy Corridor and ISTS waiver extension.

KEY POINTS TO INCLUDE

- Non-fossil installed capacity 200+ GW (MNRE 2024)
- NGHM outlay ₹19,744 crore (Jan 2023)
- SIGHT — Strategic Interventions for Green Hydrogen Transition
- BESS VGF scheme ₹3,760 crore for 13.2 GWh
- Green Energy Open Access Rules 2022
- Solar 90+ GW, wind 47 GW installed
- Pumped Storage Projects pipeline 47 GW

EXAMPLES & CASE STUDIES

- Bhadla Solar Park Rajasthan 2,245 MW
- Khavda Renewable Park Gujarat
- Adani Green Hydrogen Kutch
- Reliance Jamnagar Giga complex

MODEL ANSWER

Introduction: India's installed renewable energy capacity crossed 220 GW in March 2026 (MNRE), 47% of the 500 GW non-fossil target by 2030; solar accounts for 105 GW and wind 48 GW.

Body: The National Green Hydrogen Mission (Cabinet, January 2023, ₹19,744 crore) targets 5 MMT by 2030 and 125 GW associated RE capacity. SIGHT-1 has allocated 4,12,000-tonne electrolyser capacity to Reliance, ACME, Ohmium and L&T. Integration challenges: grid stability with variable RE (CEA Transmission Plan 2032 estimates ₹9.15 lakh crore investment), Battery Energy Storage Systems target of 47 GW (CEA 2024), and DISCOM solvency under RDSS (₹3.03 lakh crore). Green Energy Open Access Rules 2022 cut wheeling barriers, but curtailment risks remain — interstate transmission and AT&C losses (15.4%) limit absorption.

Way forward: MNRE should notify the SECI Pumped Storage Scheme by FY27, scale BESS to 27 GW under the ₹3,760 crore VGF window, and accelerate Green Energy Corridor-II rollout.

SOURCES

→Ministry of New and Renewable Energy — Annual Report
→Anantam IAS — National Green Hydrogen Mission
→Anantam IAS — Solar Energy in India

NGHM | SIGHT | BESS | VGF | ISTS waiver | RTC | PSP

Q87

India's biodiversity governance rests on the Biological Diversity Act 2002 and its 2023 Amendment. Examine how the amendment reshapes access-benefit-sharing and traditional knowledge protection.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | BIODIVERSITY

ANSWER OUTLINE

Introduction: Biological Diversity (Amendment) Act 2023 streamlines ABS, exempts AYUSH practitioners and codified traditional knowledge; India is one of 17 mega-diverse countries hosting 7-8% of global recorded species (NBA Annual Report 2023-24).

Body: 1) Three-tier structure — NBA, SBBs, BMCs and the People's Biodiversity Register. 2) 2023 Amendment — narrower ABS for domestic users, faster IP approvals, Section 36A reforms. 3) Critiques — dilution risk, AYUSH exemption breadth.

Way forward: Strengthen NBA capacity; integrate the Nagoya Protocol; align with WIPO Genetic Resources Treaty 2024.

KEY POINTS TO INCLUDE

- Biological Diversity Act 2002, amended 2023
- NBA, SBB, BMC three-tier structure
- Nagoya Protocol ABS framework
- WIPO Genetic Resources Treaty May 2024
- Section 36A on ABS-IP linkage
- Mega-diverse country — 17 nations
- Traditional Knowledge Digital Library (CSIR-AYUSH)

EXAMPLES & CASE STUDIES

- Turmeric and Neem biopiracy challenges
- Kani tribe Jeevani case Kerala
- PepsiCo potato variety case under PPV&FRA
- Convention on Biological Diversity 1992

MODEL ANSWER

> **Introduction:** The Biological Diversity (Amendment) Act 2023, notified 1 April 2024, modifies the parent Act of 2002 to align with the Kunming-Montreal Global Biodiversity Framework (CBD COP-15, December 2022) and 30×30 conservation.
>
> **Body:** Key changes: AYUSH practitioners and traders of codified Indian systems of medicine are exempted from prior NBA approval; access-and-benefit-sharing (ABS) shifts from approval to intimation for Indian companies; offences are decriminalised through adjudicating officers; and cultivated medicinal plants are recognised. Section 36-A introduces ex-situ conservation centres. Concerns flagged by Parliamentary Standing Committee on Science (2022): dilution of indigenous-community rights under Section 24(2), weaker penalties (₹50 lakh maximum), and IPR-bypass by foreign collaborators through Indian intermediaries. ABS revenue flow to BMCs and 2.7 lakh PBRs needs clarity under the Biological Diversity Rules 2024.
>
> **Way forward:** MoEFCC should notify the Nagoya-aligned ABS Rules under Section 21 by FY27, ring-fencing 20% of ABS proceeds for BMC-led PVTG conservation under FRA convergence.

SOURCES

→MoEFCC — National Biodiversity Authority
→Anantam IAS — Biodiversity Act 2002
→Anantam IAS — WIPO and Genetic Resources Treaty

ABS | NBA | BMC | Nagoya | WIPO GRATK | biopiracy | Section 36A

Q88

Urban heat is emerging as a chronic disaster in Indian cities. Critically analyse the institutional gaps in Heat Action Plans and propose a multi-sectoral response.

10 MARKS | 150 WORDS | 9 MIN | EASY | URBAN CLIMATE

ANSWER OUTLINE

Introduction: India recorded its longest heatwave ever in summer 2024 with 536 heatwave days (IMD); over 40 cities now have Heat Action Plans (HAPs), but only 11 are state-level.

Body: 1) Health burden — 11,000+ suspected heat deaths since 2013 (NCDC). 2) HAP gaps — single-season focus, weak cooling-centre network, no labour rules. 3) Disaster Management Act 2005 silence on heat as 'notified disaster'.

Way forward: Notify heatwave under DM Act 2005; mandate cool-roof and white-paint norms via MoHUA; integrate with NDMA Heat Wave Guidelines 2019 and Ayushman Bharat Health and Wellness Centres.

KEY POINTS TO INCLUDE

- 536 heatwave days summer 2024 (IMD)
- 11,000+ suspected heat deaths since 2013 (NCDC)
- 40+ city Heat Action Plans
- Disaster Management Act 2005
- NDMA Heat Wave Guidelines 2019
- Ahmedabad HAP 2013 — first in South Asia
- Cool roof policy Telangana 2023

EXAMPLES & CASE STUDIES

- Ahmedabad Heat Action Plan
- Telangana Cool Roof Policy
- Kerala HAP 2024

- Mahila Housing Trust cool roofs

MODEL ANSWER

Introduction: NDMA recorded 733 heat-stroke deaths in April-June 2024, and IMD logged 536 heatwave days in 2024 — the highest in 14 years; Navi Mumbai's 2023 Bharat Ratna event saw 14 deaths despite a notified Heat Action Plan.

Body: Of 23 heatwave-prone states, only 17 have HAPs (CPR 2023 audit), and most lack vulnerability assessments, ward-level granularity or financing. The Disaster Management Act 2005 does not classify heatwave as a notified disaster, blocking SDRF/NDRF access. Ahmedabad's HAP (2013, IIPH-Gandhinagar) — cool roofs, IMD early-warning, red-flag hospital protocols — remains under-replicated. Surface UHI intensity has risen 2-3°C in metros (IIT-Bhubaneswar 2024); AMRUT 2.0 (₹2.99 lakh crore) and Smart Cities Mission lack heat-resilience earmarks, and outdoor-worker protection under Code on OSH 2020 is silent on temperature.

Way forward: NDMA, with MoHUA and MoHFW, should notify heatwave as a state-specific disaster, mandate ward-level HAPs under AMRUT 2.0, and integrate Cool Roofs with PMAY-U 2.0 by FY27.

SOURCES

→NDMA — Heat Wave Guidelines
→Anantam IAS — Heat Is Now an Urban Governance Test
→Anantam IAS — NDMA Full Form

heatwave | HAP | NDMA | DM Act | cool roof | urban heat island | IMD

Q89

India's updated NDC commits to a 45% reduction in emissions intensity by 2030 and net-zero by 2070. Critically evaluate the LT-LEDS pathway and the role of CBAM in shaping India's transition.

15 MARKS | 250 WORDS | 14 MIN | HARD | CLIMATE CHANGE

ANSWER OUTLINE

Introduction: India submitted updated NDC in August 2022 — 45% emissions-intensity cut by 2030 (vs 2005 baseline) and 50% non-fossil capacity by 2030; LT-LEDS released at COP27 (Sharm El-Sheikh, November 2022); EU CBAM definitive phase from 1 January 2026.

Body: 1) LT-LEDS pillars — low-carbon electricity, transport electrification, urban systems, hard-to-abate sectors, CO2 removal, finance. 2) CBAM impact — covers cement, iron-steel, aluminium, fertilisers, hydrogen, electricity; ~US$8 billion of Indian exports exposed. 3) Domestic instruments — CCTS notified 2023, Green Credit Programme 2023, GH2 mission ₹19,744 crore.

Way forward: Operationalise CCTS compliance phase; negotiate CBAM equivalence via India-EU FTA; scale GH2 to 5 MMT by 2030; ramp climate finance flows; assert CBDR-RC at COP31.

KEY POINTS TO INCLUDE

- Updated NDC 45% emissions-intensity reduction by 2030 (Aug 2022)
- 50% non-fossil capacity by 2030; net-zero by 2070
- LT-LEDS released at COP27 Nov 2022
- EU CBAM definitive phase 1 Jan 2026
- ~US$8 billion Indian exports exposed to CBAM
- Carbon Credit Trading Scheme notified 28 June 2023
- Green Credit Programme Rules notified October 2023
- National Green Hydrogen Mission ₹19,744 crore (Jan 2023)

EXAMPLES & CASE STUDIES

- Paris Agreement Article 6.2 ITMO transactions
- PAT scheme under PIM 2008
- India-EU TTC dialogue on CBAM

MODEL ANSWER

> **Introduction:**
>
> India submitted its updated Nationally Determined Contribution in August 2022 — a 45% reduction in emissions intensity of GDP by 2030 over 2005, 50% non-fossil installed capacity by 2030, and net-zero by 2070; the Long-Term Low Emission Development Strategy was released at COP27 (Sharm El-Sheikh, November 2022); the EU Carbon Border Adjustment Mechanism enters its definitive phase from 1 January 2026.
>
> **LT-LEDS pillars:**
>
> The LT-LEDS rests on six pillars — low-carbon electricity expansion, transport electrification, urban systems transition, hard-to-abate industry decarbonisation, CO2

removal pathways, and climate-finance mobilisation. It rejects sector-specific net-zero pathways but signals technology-neutral trajectories anchored in equity.

CBAM impact:

CBAM covers cement, iron and steel, aluminium, fertilisers, hydrogen, and electricity — with ~US$8 billion of Indian exports exposed. CBAM levies a carbon price at the EU border equivalent to ETS, eroding the cost advantage of carbon-intensive Indian exports and pushing decarbonisation timelines forward.

Domestic instruments:

The Carbon Credit Trading Scheme was notified on 28 June 2023, transitioning India from PAT to a cap-and-trade architecture. The Green Credit Programme Rules (October 2023) reward voluntary environmental action. The National Green Hydrogen Mission (₹19,744 crore, January 2023) targets 5 MMT by 2030. Article 6.2 ITMO transactions under Paris remain a financing lever.

Way forward / Conclusion:

Operationalise the CCTS compliance phase by 2026, negotiate CBAM equivalence via the India-EU FTA, scale Green Hydrogen production, and reaffirm CBDR-RC at COP31 to defend developmental space under MoEFCC.

SOURCES

- →MoEFCC — India's Long-Term LEDS
- →Anantam IAS — CBAM and India's Carbon-Trade Reckoning
- →Anantam IAS — India's LT-LEDS and Climate Strategy

NDC | LT-LEDS | CBAM | net-zero | CCTS | Green Credit | CBDR-RC

Q90

The National Green Hydrogen Mission targets 5 MMT of annual green hydrogen production by 2030. Examine the SIGHT incentives, the cost competitiveness challenge, and the demand-creation strategy.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | CLIMATE AND ENERGY MIX

ANSWER OUTLINE

Introduction: Cabinet approved National Green Hydrogen Mission on 4 January 2023 with ₹19,744 crore outlay (FY24-30); target 5 MMT GH2 by 2030; SIGHT (Strategic Interventions for Green Hydrogen Transition) is the financing arm with ₹17,490 crore.

Body: 1) Cost gap — green H2 at ~US$5-6/kg vs grey H2 at US$1.5-2/kg; SIGHT bridges via electrolyser and hydrogen-production tranches. 2) Demand creation — refineries, fertilisers, steel given green H2 obligations; pilot in shipping and heavy mobility. 3) Bottlenecks — electrolyser imports, water consumption (~9 kg per kg H2), grid integration.

Way forward: Accelerate domestic electrolyser PLI; mandate green-H2 purchase obligations on PSUs; integrate with renewable capacity tenders; finalise certification standards.

KEY POINTS TO INCLUDE

- NGHM outlay ₹19,744 crore (Cabinet, 4 January 2023)
- 5 MMT green hydrogen target by 2030
- SIGHT scheme ₹17,490 crore
- Green H2 cost ~US$5-6/kg vs grey US$1.5-2/kg
- Refineries, fertilisers, steel — anchor demand sectors
- Indian Green Hydrogen Certification notified 2024
- Pilot under hydrogen valley clusters
- Target 125 GW additional RE for GH2

EXAMPLES & CASE STUDIES

- Reliance Jamnagar GH2 gigafactory plans
- Adani New Industries Kutch plant
- NTPC GH2 bus at Leh
- ONGC green hydrogen pilot at Mangalore

MODEL ANSWER

> **Introduction**:
>
> The Cabinet approved the National Green Hydrogen Mission on 4 January 2023 with a ₹19,744 crore outlay covering FY24-30; the target is 5 MMT of green hydrogen production annually by 2030, supported by 125 GW of additional renewable capacity. SIGHT — Strategic Interventions for Green Hydrogen Transition — is the financing arm with ₹17,490 crore.
>
> **SIGHT incentives**:
>
> SIGHT operates two tranches — for electrolyser manufacturing and for green-hydrogen production. The first awarded tranches (2023-24) created an indigenous

electrolyser pipeline. The Indian Green Hydrogen Certification, notified in 2024, anchors a domestic standards regime aligned with CBAM-equivalence considerations.

Cost competitiveness challenge:

Green hydrogen costs ~US$5-6/kg compared with grey hydrogen at US$1.5-2/kg from natural gas. The cost gap is driven by electrolyser capital cost, RE LCOE, and water-treatment expenses (~9 kg water per kg H2). SIGHT bridges this through capex-linked support; ALMM-style domestic content rules deepen indigenisation.

Demand creation strategy:

Refineries, fertilisers, and steel are designated anchor demand sectors with phased green-H2 purchase obligations. Pilot programmes cover shipping, heavy mobility (NTPC GH2 bus at Leh), and green-steel routes. Reliance Jamnagar and Adani Kutch gigafactory plans build commercial scale; ONGC Mangalore runs a green-H2 pilot. Hydrogen valley clusters anchor regional offtake ecosystems.

Way forward / Conclusion:

Accelerate the domestic electrolyser PLI, mandate green-H2 purchase obligations on PSUs, integrate the mission with renewable capacity tenders, and finalise certification interoperable with EU CBAM by 2027 under MNRE for export competitiveness.

SOURCES

→MNRE — National Green Hydrogen Mission
→Anantam IAS — National Green Hydrogen Mission
→Anantam IAS — Solar Energy in India

green hydrogen | SIGHT | electrolyser | NGHM | grey hydrogen | PLI | RE integration

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Q91

COP28 in Dubai produced the first "transitioning away from fossil fuels" outcome and the operationalisation of the Loss and Damage Fund. Discuss India's positioning and the implementation deficits flagged at COP29 Baku.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | CLIMATE DIPLOMACY

ANSWER OUTLINE

Introduction: COP28 UAE Consensus (13 December 2023) called for "transitioning away from fossil fuels in energy systems" and tripled renewables target; Loss and Damage Fund operationalised under World Bank; COP29 Baku (Nov 2024) agreed New Collective Quantified Goal of US$300 billion/year by 2035.

Body: 1) India's stand — defended developmental space, opposed phase-out language; CBDR-RC principle. 2) Finance gap — NCQG US$300 billion vs developing-country need of US$1.3 trillion. 3) Just Energy Transition Partnerships excluded India.

Way forward: Demand mobilisation roadmap by 2026; push for Article 9 grants vs loans; advocate fossil-fuel subsidy reform with carve-outs for developing countries.

KEY POINTS TO INCLUDE

- COP28 UAE Consensus 13 December 2023
- Loss and Damage Fund operationalised at COP28
- COP29 NCQG US$300 billion/year by 2035
- India's CBDR-RC and equity stand
- Global Stocktake first cycle concluded COP28
- Tripling renewables target by 2030

EXAMPLES & CASE STUDIES

- COP26 Glasgow Net Zero pledge 2070
- Article 9 finance under Paris Agreement
- Loss and Damage Fund pledges ~US$700 million

MODEL ANSWER

> **Introduction:** COP28 produced the UAE Consensus on 13 December 2023, calling for "transitioning away from fossil fuels in energy systems" and tripling renewables by 2030; the Loss and Damage Fund was operationalised under World Bank trusteeship at COP28; COP29 Baku (November 2024) agreed a New Collective Quantified Goal of US$300 billion/year by 2035.
>
> **Body:** First, India's positioning — defended developmental space, opposed phase-out language, anchored on CBDR-RC and equity; coordinated through LMDC and BASIC groups. Second, finance gap — NCQG of US$300 billion versus developing-country needs of US$1.3 trillion estimated by SCF; Loss and Damage Fund pledges remain only ~US$700 million. Third, Just Energy Transition Partnerships excluded India even as Indonesia, Vietnam, and South Africa secured deals.
>
> **Way forward:** Demand a mobilisation roadmap by 2026 under UNFCCC, push Article 9 grants over loans, and advocate fossil-fuel subsidy reform with developing-country carve-outs at COP31 under MoEFCC.

SOURCES

→UNFCCC — COP28 and COP29 outcomes
→Anantam IAS — Paris Agreement 2015
→Anantam IAS — UNFCCC

COP28 | COP29 | Loss and Damage | NCQG | CBDR-RC | Global Stocktake | Paris Agreement

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Q92

India's Environment Impact Assessment regime has been amended through draft notifications and project-specific exemptions since 2020. Examine the institutional design under EIA 2006 and the dilution concerns flagged by the Supreme Court.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | EIA

ANSWER OUTLINE

Introduction: EIA Notification 2006 issued under Section 3 of Environment Protection Act 1986; SC in Vanashakti vs Union of India (May 2025) struck down post-facto environmental clearances; draft EIA 2020 still not finalised.

Body: 1) Process — screening, scoping, public consultation, appraisal by EAC/SEIAA. 2) Dilution concerns — exemptions for B2 category projects under 2020 draft; post-facto clearances offered via 2017 and 2021 OMs (struck down). 3) Capacity gap — under-resourced SEIAAs; opaque public hearings.

Way forward: Finalise EIA notification with broader public consultation timelines; statutory EAC mandates; geo-tagged compliance dashboard; ban on post-facto clearances codified.

KEY POINTS TO INCLUDE

- EIA Notification 2006 under Section 3 EPA 1986
- Vanashakti vs Union of India (SC, May 2025) on post-facto EC
- Draft EIA 2020 yet to be finalised
- Category A — Centre (EAC); Category B — State (SEIAA)
- Public consultation under Para 7 of EIA 2006
- PRAVAH portal for online EC tracking
- Common HVPN Vanashakti judgment cited Lalit Miglani precedent
- NGT Act 2010 — Section 16 appeals

EXAMPLES & CASE STUDIES

- Sterlite Tuticorin closure 2018
- Vedanta Bauxite Niyamgiri 2013 SC
- Hubballi-Ankola railway line EAC reversal 2024

MODEL ANSWER

Introduction:

The Environment Impact Assessment Notification 2006 was issued under Section 3 of the Environment Protection Act 1986; the Supreme Court in Vanashakti vs Union of India (May 2025) struck down post-facto environmental clearances; the draft EIA 2020 remains unfinalised, leaving the regulatory regime in flux and inviting recurring litigation.

Institutional design under EIA 2006:

The process moves through screening, scoping, public consultation, and appraisal. Category A projects are appraised by the Expert Appraisal Committee at Centre; Category B by SEIAA/SEAC at state level. Public consultation under Para 7 mandates hearings and written objections. NGT Act 2010 Section 16 enables judicial review of clearances.

Dilution concerns:

The 2020 draft expanded exemptions for B2 projects and shortened public-consultation periods. Office memoranda of 2017 and 2021 enabled post-facto clearances — both struck down by SC in Vanashakti, which cited Common Cause and Lalit Miglani precedents. Border-area and strategic exemptions weaken accountability; the Hubballi-Ankola railway and Great Nicobar mega-project clearances illustrate the trend.

Capacity gaps:

SEIAAs are under-resourced, EAC sittings are opaque, and the PRAVAH portal still lacks real-time compliance dashboards. Project violations rarely trigger withdrawal of clearance, encouraging fait accompli construction; Sterlite Tuticorin (2018) exposed how delayed enforcement creates social conflict.

Way forward / Conclusion:

> Finalise the EIA notification with broader public-consultation timelines, statutorily mandate EAC composition, deploy a geo-tagged compliance dashboard, and codify the SC's ban on post-facto clearances under MoEFCC by 2027.

SOURCES

→MoEFCC — EIA Notification 2006
→Anantam IAS — Environment Impact Assessment
→Anantam IAS — Environment Protection Act 1986

EIA | EPA 1986 | EAC | SEIAA | post-facto EC | public hearing | NGT

Q93

The Forest (Conservation) Amendment Act 2023 has redefined the scope of "forest land." Discuss the changes, the constitutional challenges and the implications for India's NDC sink target.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | EIA AND FORESTS

ANSWER OUTLINE

Introduction: Van (Sanrakshan Evam Samvardhan) Adhiniyam 2023 notified December 2023; India's updated NDC commits to an additional carbon sink of 2.5-3 billion tonnes CO2e by 2030.

Body: 1) Key changes — exemption for security infrastructure within 100 km of borders, linear projects up to 10 ha, eco-tourism. 2) Judicial review — SC interim order in Ashok Kumar Sharma vs Union (Feb 2024) applied Godavarman "dictionary meaning" of forest. 3) Carbon-sink impact — risk of denotifying deemed forests reduces sink target.

Way forward: Notify rules implementing SC "dictionary meaning" definition; state-wise deemed-forest inventory in 6 months; mandatory compensatory afforestation audits under CAMPA Act 2016; align with NDC.

KEY POINTS TO INCLUDE

- Forest Conservation Amendment Act 2023 (Van Adhiniyam) notified Dec 2023
- Exemption for security infra within 100 km of borders
- Linear projects up to 10 ha exempt
- Godavarman 1996 'dictionary meaning' restored by SC interim 2024
- NDC additional sink 2.5-3 billion tonnes CO2e by 2030
- CAMPA Act 2016 — compensatory afforestation
- ISFR 2023 records forest cover 25.17% of geographic area

- FRA 2006 — community forest rights

EXAMPLES & CASE STUDIES

- Hasdeo Arand coal bloc litigation
- Nicobar Great Nicobar mega project clearances
- Buxa Tiger Reserve diversion controversy

MODEL ANSWER

Introduction: The Van (Sanrakshan Evam Samvardhan) Adhiniyam 2023 was notified in December 2023; India's updated NDC commits to an additional carbon sink of 2.5-3 billion tonnes CO2-equivalent by 2030 — anchored largely in forest cover at 25.17% per ISFR 2023.

Body: First, key changes — security infrastructure within 100 km of borders, linear projects up to 10 ha, and eco-tourism and zoo facilities are exempt from prior central approval; the definition of "forest" is narrowed to recorded or notified forests. Second, the constitutional challenge — SC interim order in Ashok Kumar Sharma vs Union of India (February 2024) reinstated the Godavarman 1996 "dictionary meaning" of forest pending final adjudication. Third, NDC implications — narrow definitions risk denotifying deemed forests, eroding the sink target and contradicting FRA 2006 community forest-rights commitments.

Way forward: Implement the SC's dictionary-meaning definition, complete state-wise deemed-forest inventory within six months, and audit compensatory afforestation under CAMPA Act 2016 by 2027 under MoEFCC.

SOURCES

→MoEFCC — Forest Conservation Amendment Act 2023
→Anantam IAS — Indian Forest Act 1927
→Anantam IAS — Environment Protection Act 1986

FCA Amendment | Godavarman | CAMPA | compensatory afforestation | ISFR | NDC sink

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Q94

India's solar capacity has crossed 100 GW but PM-Surya Ghar Muft Bijli Yojana is now the lever for rooftop solar. Examine progress, financing and integration challenges.

10 MARKS | 150 WORDS | 9 MIN | EASY | ENERGY AND POLLUTION

ANSWER OUTLINE

Introduction: Installed solar capacity crossed 100 GW in early 2025 (MNRE); PM-Surya Ghar Muft Bijli Yojana approved 29 February 2024 with ₹75,021 crore outlay to install rooftop solar in 1 crore households by FY27.

Body: 1) Mechanics — central financial assistance up to ₹78,000/household; ~300 units/month free. 2) Challenges — DISCOM net-metering caps, vendor onboarding, financing for low-income households. 3) Grid integration — RE round-the-clock tenders, BESS PLI ₹18,100 crore.

Way forward: Mandatory gross-metering above 10 kW; deepen Surya Ghar finance through PSL; co-locate with BESS for evening peak.

KEY POINTS TO INCLUDE

- Installed solar capacity crossed 100 GW (MNRE 2025)
- PM-Surya Ghar Yojana approved 29 February 2024
- Outlay ₹75,021 crore for 1 crore households
- CFA up to ₹78,000 per household
- BESS PLI ₹18,100 crore
- ALMM List I and List II for solar modules

EXAMPLES & CASE STUDIES

- Modhera Sun Temple village solar project
- PM-KUSUM solarisation of pumps
- Bhadla and Pavagada solar parks

MODEL ANSWER

> **Introduction:** India's installed solar capacity crossed 100 GW in early 2025 per MNRE; the PM-Surya Ghar Muft Bijli Yojana was approved on 29 February 2024 with a ₹75,021 crore outlay to install rooftop solar in 1 crore households by FY27, anchoring household-level distributed generation.
>
> **Body:** First, scheme mechanics — Central Financial Assistance of up to ₹78,000 per household, ~300 free units per month, collateral-free loans up to ₹2 lakh at 7%, and DBT-linked subsidy disbursal. Second, challenges — DISCOM net-metering caps, vendor onboarding bottlenecks, and finance access for low-income households remain binding constraints, alongside ALMM List I and II compliance. Third, grid

integration — RE round-the-clock tenders and BESS PLI (₹18,100 crore) address evening-peak mismatch; PM-KUSUM solarises agricultural pumps; Bhadla and Pavagada parks anchor utility scale.

Way forward: Move to gross-metering above 10 kW, route Surya Ghar finance through Priority Sector Lending, co-locate rooftop solar with BESS, and finalise net-metering harmonisation under MNRE by 2027.

SOURCES

→MNRE — PM Surya Ghar Muft Bijli Yojana
→Anantam IAS — Solar Energy in India
→Anantam IAS — National Green Hydrogen Mission

PM-Surya Ghar | rooftop solar | MNRE | ALMM | net metering | BESS

Q95

The Biological Diversity (Amendment) Act 2023 reshapes India's Access and Benefit Sharing regime aligned with the Kunming-Montreal Global Biodiversity Framework. Discuss the changes and their impact on traditional knowledge.

15 MARKS | 250 WORDS | 14 MIN | MEDIUM | BIODIVERSITY

ANSWER OUTLINE

Introduction: Biological Diversity (Amendment) Act 2023 enacted August 2023; CBD COP15 adopted Kunming-Montreal GBF on 19 December 2022 with 23 targets including the 30×30 conservation target.

Body: 1) Key amendments — exempts codified traditional knowledge from prior NBA approval; AYUSH practitioners exemption; decriminalisation with monetary penalties. 2) Concerns — dilutes consent of Biodiversity Management Committees (BMCs); risk to ABS revenue. 3) GBF alignment — National Biodiversity Strategy and Action Plan (updated 2024) targets 30×30, restoration of 30% degraded ecosystems.

Way forward: Strengthen BMC role under amended Rules 2024; codify benefit-sharing percentages; align CITES enforcement; Cali Fund participation post-CBD COP16.

KEY POINTS TO INCLUDE

- Biological Diversity Amendment Act 2023 enacted Aug 2023
- Kunming-Montreal GBF adopted 19 December 2022
- 23 GBF targets including 30×30 by 2030

- AYUSH manufacturers and codified TK exempted from NBA approval
- Decriminalisation — penalty Rs 1-50 lakh
- NBSAP updated 2024
- CBD COP16 Cali Fund on digital sequence information (Oct 2024)
- People's Biodiversity Registers via BMCs

EXAMPLES & CASE STUDIES

- Divya Pharmacy case (Uttarakhand HC, 2018)
- Neem patent revocation EPO 2005
- Western Ghats Gadgil-Kasturirangan reports

MODEL ANSWER

Introduction:

The Biological Diversity (Amendment) Act 2023 was enacted in August 2023; the CBD COP15 (Montreal) adopted the Kunming-Montreal Global Biodiversity Framework on 19 December 2022 with 23 targets — including the 30×30 conservation target. India's National Biodiversity Strategy and Action Plan was updated in 2024 to align with the GBF.

Key amendments:

The 2023 Act exempts codified traditional knowledge and AYUSH practitioners using Indian biological resources from prior National Biodiversity Authority approval. It decriminalises offences with monetary penalties of ₹1-50 lakh and rationalises benefit-sharing categories. The Divya Pharmacy (Uttarakhand High Court, 2018) case had earlier upheld AYUSH manufacturer obligations.

Impact on traditional knowledge:

By widening exemptions, the amendment is feared to dilute the consent role of Biodiversity Management Committees and reduce ABS revenue for communities maintaining People's Biodiversity Registers. Critics flag erosion of FPIC standards under the Nagoya Protocol 2010, with the Gadgil-Kasturirangan Western Ghats reports cited as benchmarks.

GBF alignment:

NBSAP (2024) targets 30% of terrestrial, inland water, coastal and marine area under effective conservation by 2030, restoration of 30% of degraded ecosystems, and

equitable benefit sharing. CBD COP16 (Cali, October 2024) operationalised the Cali Fund on Digital Sequence Information for community returns from genetic data.

Way forward / Conclusion:

Strengthen the BMC role under amended Rules 2024, codify benefit-sharing percentages by sector, align CITES enforcement with the Wildlife Protection Amendment 2022, build on neem-patent and Divya Pharmacy precedents, and channel Cali Fund flows to communities under MoEFCC by 2027.

SOURCES

→MoEFCC — Biological Diversity Act notifications
→Anantam IAS — Biodiversity Act 2002
→Anantam IAS — Convention on Biological Diversity

BDA 2023 | GBF | 30x30 | NBA | BMC | ABS | CBD COP16 | DSI

Q96

India hosts 89 Ramsar sites and four biodiversity hotspots but conservation outcomes are uneven. Discuss the role of community-led models such as Khasi Hills REDD+ and Project Tiger.

10 MARKS | 150 WORDS | 9 MIN | EASY | BIODIVERSITY AND CONSERVATION

ANSWER OUTLINE

Introduction: India has 89 Ramsar sites (2025) and four biodiversity hotspots — Himalaya, Indo-Burma, Western Ghats, Sundaland; Khasi Hills REDD+ became India's first Plan Vivo community carbon project; All India Tiger Estimation 2022 reported 3,682 tigers.

Body: 1) Successes — Project Tiger 1973, Project Elephant 1992, MISHTI mangrove scheme. 2) Community model — Khasi Hills REDD+ aggregates 62 villages, generates carbon credits. 3) Gaps — wetland degradation, human-wildlife conflict.

Way forward: Scale community carbon projects; strengthen Wetland Rules 2017; expand Project Cheetah and CAMPA-funded restoration.

KEY POINTS TO INCLUDE

- 89 Ramsar sites in India (2025)
- Four biodiversity hotspots — Himalaya, Indo-Burma, Western Ghats, Sundaland
- AITE 2022 — 3,682 tigers
- Khasi Hills REDD+ first Plan Vivo project in India

- MISHTI mangrove scheme 2023 — 540 sq km target
- Wetlands (Conservation and Management) Rules 2017

EXAMPLES & CASE STUDIES

- Project Tiger 1973 — NTCA
- Project Cheetah Kuno 2022
- Mangrove Alliance for Climate (COP27)

MODEL ANSWER

Introduction: India has 89 Ramsar sites and four biodiversity hotspots — Himalaya, Indo-Burma, Western Ghats, and Sundaland; the Khasi Hills REDD+ project became India's first Plan Vivo community carbon initiative; the All India Tiger Estimation 2022 recorded 3,682 tigers, a global high under Project Tiger.

Body: First, flagship successes — Project Tiger (1973) under NTCA, Project Elephant (1992), Project Cheetah at Kuno (2022), and the Mangrove Initiative for Shoreline Habitats & Tangible Incomes (MISHTI) scheme of 2023 covering 540 sq km. Second, community model — Khasi Hills REDD+ aggregates 62 villages in Meghalaya, generating carbon revenue tied to forest conservation. Third, gaps — wetland degradation, human-wildlife conflict, and uneven Wetland Rules 2017 enforcement; the Mangrove Alliance for Climate (COP27) anchors coastal action.

Way forward: Scale community carbon projects through the Green Credit Programme, strengthen Wetland Rules 2017 enforcement, and expand CAMPA-funded restoration under MoEFCC by 2030.

SOURCES

→MoEFCC — Ramsar Sites India
→Anantam IAS — Khasi Hills REDD+
→Anantam IAS — Ramsar Sites in India

Ramsar | REDD+ | Project Tiger | MISHTI | biodiversity hotspot | Plan Vivo | NTCA

Q97

Delhi-NCR continues to record "severe" air-quality episodes every winter. Critically evaluate the National Clean Air Programme and the airshed approach under CAQM.

15 MARKS | 250 WORDS | 14 MIN | HARD | POLLUTION CONTROL

ANSWER OUTLINE

Introduction: National Clean Air Programme launched January 2019, revised target of 40% reduction in PM2.5/PM10 by 2025-26 over 2017 baseline; CAQM Act 2021 created the Commission for Air Quality Management for NCR and adjoining areas; CPCB AQI 2025 records winter PM2.5 in Delhi at 250-400 µg/m³ against WHO 5 µg/m³ annual.

Body: 1) NCAP — 131 non-attainment cities; ₹10,000+ crore disbursed via 15th FC grants. 2) Airshed governance — CAQM Act covers 5 states; GRAP stages I-IV. 3) Gaps — stubble burning, ULBs under-resourced, slow source-apportionment science.

Way forward: Statutory airshed plans for IGP; expand SAFAR-style real-time monitoring; mandatory crop-residue management with PUSA decomposer; phase out unfit BS-IV trucks.

KEY POINTS TO INCLUDE

- NCAP launched January 2019, MoEFCC
- Revised target 40% PM reduction by 2025-26
- 131 non-attainment cities under NCAP
- ₹10,000+ crore disbursed via 15th FC air-quality grants
- CAQM Act 2021 — Commission with statutory powers
- GRAP stages I-IV trigger by AQI
- WHO 2021 guidelines PM2.5 5 µg/m³ annual
- Stubble fires Punjab-Haryana ~30% Delhi winter PM2.5

EXAMPLES & CASE STUDIES

- Odd-even Delhi 2016 and 2019
- Connaught Place smog tower 2021
- PUSA bio-decomposer trials

MODEL ANSWER

> **Introduction**:
>
> The National Clean Air Programme was launched in January 2019 with a revised target of 40% reduction in PM2.5/PM10 by 2025-26 over the 2017 baseline; the CAQM Act 2021 created a statutory Commission for Air Quality Management for the NCR and adjoining airshed; CPCB AQI records put winter PM2.5 in Delhi at 250-400 µg/m³ against the WHO 2021 guideline of 5 µg/m³ annual.

NCAP architecture and scorecard:

NCAP covers 131 non-attainment cities; over ₹10,000 crore has been disbursed via 15th Finance Commission air-quality grants to million-plus cities. Action plans rely on city-level source apportionment, dust control, public-transport electrification, and industrial relocation. Outcomes remain mixed — only a few cities like Indore and Surat show sustained PM10 decline.

Airshed approach under CAQM:

The CAQM has statutory powers across Delhi, Haryana, Punjab, UP, and Rajasthan within NCR. GRAP Stages I-IV trigger sequenced restrictions by AQI. The shift from city-administrative to airshed governance is a structural advance. Yet ULBs remain under-resourced, and stubble-burning in Punjab-Haryana — estimated to contribute ~30% of Delhi's winter PM2.5 — persists despite PUSA bio-decomposer subsidies and the Connaught Place smog tower (2021).

Gaps:

Source-apportionment science is slow, BS-IV trucks still ply, and inter-state coordination on power-sector emissions remains thin; odd-even experiments (2016, 2019) have only short-run effects.

Way forward / Conclusion:

Notify statutory airshed plans for the Indo-Gangetic Plain, expand SAFAR-style real-time monitoring nationwide, mandate crop-residue management with PUSA decomposer, and phase out unfit BS-IV trucks by 2027 under MoEFCC.

SOURCES

- →CPCB — NCAP and AQI
- →Anantam IAS — Air Pollution in India
- →Anantam IAS — Air Act 1981

NCAP | CAQM | GRAP | PM2.5 | airshed | CPCB | stubble burning

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Q98

Plastic Waste Management Rules and EPR are now central to India's circular-economy push. Examine the single-use plastic ban, the EPR portal and the e-waste regime.

10 MARKS | 150 WORDS | 9 MIN | EASY | POLLUTION CONTROL

ANSWER OUTLINE

Introduction: Plastic Waste Management Amendment Rules 2022 banned 19 single-use plastic items from 1 July 2022; CPCB EPR Portal operationalised 2022 covers plastic, e-waste, battery, tyre, used oil; India generated 4.13 million tonnes plastic waste in 2020-21 (CPCB Annual Report).

Body: 1) EPR mechanics — registration, credit certificates, audit. 2) E-waste Rules 2022 — producer responsibility, refurbisher registration; 1.6 million tonnes generated FY22. 3) Battery Waste Rules 2022 cover EV batteries.

Way forward: Strengthen state-level enforcement; mandatory eco-modulation of EPR fees; expand EPR to glass and textiles; UN Global Plastics Treaty ratification.

KEY POINTS TO INCLUDE

- PWM Amendment Rules 2022 banned 19 SUP items from 1 July 2022
- CPCB EPR Portal launched 2022
- Plastic waste 4.13 million tonnes (2020-21)
- E-Waste Rules 2022 with EPR registration
- Battery Waste Rules 2022 for EV batteries
- Global Plastics Treaty INC negotiations 2024-25

EXAMPLES & CASE STUDIES

- Single-use plastic ban implementation 1 July 2022
- Swachh Bharat Mission urban waste segregation
- Carbide-Rhodamine food adulteration cases

MODEL ANSWER

> **Introduction:** The Plastic Waste Management (Amendment) Rules 2022 banned 19 single-use plastic items from 1 July 2022; the CPCB EPR Portal, operationalised in 2022, covers plastic, e-waste, battery, tyre, and used oil; CPCB recorded 4.13 million tonnes of plastic waste in 2020-21, with informal recyclers handling much of the flow.
>
> **Body:** First, EPR mechanics — producers register, file annual returns, and acquire EPR certificates; CPCB audits and de-registers defaulters who fail collection targets. Second, the E-Waste Rules 2022 mandate registration of producers, refurbishers, and recyclers, with 1.6 million tonnes of e-waste generated in FY22 against weak formal-sector capacity. Third, the Battery Waste Rules 2022 cover EV and consumer batteries,

building circular value chains, with Swachh Bharat segregation as the upstream anchor.

Way forward: Strengthen state-level enforcement, introduce eco-modulated EPR fees, extend EPR to glass and textiles, and ratify the UN Global Plastics Treaty post-INC negotiations by 2027 under MoEFCC.

SOURCES

→CPCB — EPR Portal
→Anantam IAS — Single-Use Plastic Ban in India
→Anantam IAS — E-Waste Management in India

EPR | SUP | PWM Rules | e-waste | battery waste | CPCB | Global Plastics Treaty

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Q99

Microplastics have entered drinking water, agricultural soil and human placenta. Discuss the science, the Indian regulatory gap, and the role of the UN Global Plastics Treaty.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | POLLUTION CONTROL

ANSWER OUTLINE

Introduction: WHO and UNEP define microplastics as plastic particles <5 mm; UNEA-5.2 (March 2022) mandated an Intergovernmental Negotiating Committee (INC) to draft a legally binding instrument by end-2024 (Busan INC-5 inconclusive Nov 2024); India generates ~4.13 million tonnes plastic waste/year (CPCB).

Body: 1) Health impacts — endocrine disruption, cardiovascular risk (Marfella study 2024, NEJM). 2) Indian regulatory gap — no microplastic-specific Rule; BIS pending standard. 3) Pathways — primary (cosmetics, pellets) and secondary (degradation).

Way forward: BIS microplastic monitoring standard; ban primary microbeads in cosmetics; ratify Global Plastics Treaty; mandate filters in washing machines.

KEY POINTS TO INCLUDE

- Microplastics
- Plastic waste 4.13 million tonnes/year India
- UNEA-5.2 mandate March 2022
- Busan INC-5 outcome inconclusive Nov 2024
- Marfella et al NEJM 2024 — microplastics in carotid plaques
- BIS microplastic standard pending

EXAMPLES & CASE STUDIES

- Ganga microplastic survey IIT-K 2021
- Single-use plastic ban 2022
- Nestle's microplastic disclosures 2024

MODEL ANSWER

Introduction: WHO and UNEP define microplastics as plastic particles smaller than 5 mm; UNEA-5.2 (March 2022) mandated an Intergovernmental Negotiating Committee to draft a legally binding instrument, with the Busan INC-5 (November 2024) ending inconclusively; India generates ~4.13 million tonnes of plastic waste annually per CPCB.

Body: First, the science — microplastics enter through primary (cosmetics, pellets) and secondary (degradation of macro-plastics) pathways; Marfella et al (NEJM 2024) found microplastics in carotid plaques, linking exposure to cardiovascular risk and endocrine disruption. Second, the Indian gap — no microplastic-specific Rule; BIS standard for monitoring is pending; FSSAI guidance is limited; an IIT-Kanpur 2021 survey revealed microplastics in the Ganga. Third, the global response — Plastic Waste Management Rules 2022 ban single-use plastics; the Global Plastics Treaty remains under negotiation post-Busan.

Way forward: Notify a BIS microplastic monitoring standard, ban primary microbeads in cosmetics, ratify the Global Plastics Treaty, and mandate filters in washing machines by 2028 under MoEFCC.

SOURCES

→UNEP — Global Plastics Treaty
→Anantam IAS — Microplastics
→Anantam IAS — Plastics Recycling in India

microplastics | Global Plastics Treaty | UNEA | INC | CPCB | BIS

Q100

Urban heat is emerging as a chronic disaster across Indian cities. Examine the institutional architecture of Heat Action Plans and propose reforms.

15 MARKS | 250 WORDS | 14 MIN | HARD | CONSERVATION AND POLLUTION

ANSWER OUTLINE

Introduction: IMD recorded 536 heatwave days across India in summer 2024 — highest in 14 years; ~46% of Indian cities have a Heat Action Plan (Centre for Policy Research 2023); NDMA released revised guidelines on heatwave management in 2019.

Body: 1) HAP architecture — IMD forecasts, state DM Departments, municipal cooling centres, ASHA mobilisation. 2) Gaps — most HAPs lack funding, vulnerability mapping, and accountability; informal-sector workers excluded. 3) Notification gap — heatwave not yet a 'notified disaster' under SDRF for compensation.

Way forward: Notify heatwave under DM Act 2005 categories; bind HAPs to ULB budgets; cool-roof retrofitting under PMAY-U 2.0; ESI/EPF heat-relief payouts.

KEY POINTS TO INCLUDE

- IMD recorded 536 heatwave days summer 2024
- ~46% of Indian cities have a HAP (CPR 2023)
- NDMA Revised Guidelines on Heatwave Management 2019
- Heatwave not yet notified under SDRF list
- Ahmedabad HAP 2013 — first city plan
- PMAY-U 2.0 envisages cool-roof retrofitting
- Mission LiFE behavioural component

EXAMPLES & CASE STUDIES

- Ahmedabad HAP 2013 (after 2010 deaths)
- Telangana May 2015 heat deaths
- ISRO TRISHNA mission for urban heat-island mapping

MODEL ANSWER

> **Introduction**:
>
> The IMD recorded 536 heatwave days across India during summer 2024 — the highest in 14 years; the Centre for Policy Research (2023) finds only ~46% of Indian cities have a Heat Action Plan (HAP). NDMA released revised Guidelines on Heatwave Management in 2019, but heat remains unnotified under the disaster-relief list.
>
> **Institutional architecture**:

The HAP architecture rests on IMD seasonal and short-range forecasts, State Disaster Management Departments, district administration, municipal cooling centres, water-supply augmentation, and ASHA-led community mobilisation. Ahmedabad pioneered India's first HAP in 2013 after the 2010 heat deaths, becoming a global model now replicated by 100+ Indian cities.

Persistent gaps:

Most HAPs lack dedicated funding, fine-grained vulnerability mapping, and accountability structures. Informal-sector workers — construction, street vending, gig delivery — are invisible to municipal interventions. The Telangana heat deaths of May 2015 demonstrated that workplace heat regulation under labour laws is underdeveloped, while Mission LiFE's behavioural component remains under-utilised.

Notification gap:

Heatwave is not among the 12 notified disasters under SDRF, so compensation, livelihood relief, and ex-gratia for heat deaths are discretionary. The DM (Amendment) Act 2024 created scope for an Urban Disaster Management Authority but no clear heat mandate; ISRO's TRISHNA mission promises urban heat-island mapping.

Way forward / Conclusion:

Notify heatwave under the DM Act 2005 SDRF list, bind HAPs to ULB budgets through 16th FC grants, mandate cool-roof retrofitting under PMAY-U 2.0, and pilot ESI/EPF heat-relief payouts for outdoor workers by 2027 under NDMA.

SOURCES

- →NDMA — Heatwave Guidelines
- →Anantam IAS — TRISHNA Mission
- →Anantam IAS — India's LT-LEDS and Climate Strategy

heat action plan | heatwave | NDMA | DM Act | urban heat island | SDRF | ULB

GS PAPER 3

Disaster Management

15 practice questions

Q101

How important are vulnerability and risk assessment for pre-disaster management? As an administrator, what key areas would you focus on in a disaster management setup?

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | RISK ASSESSMENT & ADMINISTRATIVE PREPAREDNESS | 2013

ANSWER OUTLINE

Introduction: Define vulnerability and risk assessment; frame the Disaster Management Act, 2005 shift from relief to prevention.

Body Part A — importance: targeting, prioritising resources, hazard zoning, early warning, insurance. **Part B — administrator's focus areas:** institutional (DDMA), planning, capacity-building, response systems, recovery.

Conclusion: Risk assessment converts preparedness into measurable, equity-sensitive action.

KEY POINTS TO INCLUDE

- Risk = Hazard × Exposure × Vulnerability; vulnerability assessment identifies who is most exposed and least able to cope
- Disaster Management Act, 2005 shifted governance from relief-centric to prevention and mitigation-centric
- Assessment enables targeted resource allocation, hazard zonation and calibrated early-warning thresholds
- Risk transfer tools: crop insurance and parametric insurance informed by assessment
- Administrator's institutional focus: functional DDMA, updated district disaster management plan, incident command system
- Mitigation/preparedness: building-code enforcement, retrofitting lifeline buildings, mock drills, pre-positioned relief stocks
- Early warning: last-mile dissemination via sirens, SMS and community networks
- Capacity-building of Aapda Mitra volunteers and protection of vulnerable groups (women, elderly, persons with disabilities)
- Response and recovery: coordination with NDRF and build-back-better reconstruction

EXAMPLES & CASE STUDIES

- District Disaster Management Authority headed by the District Collector under the DM Act 2005
- Aapda Mitra community volunteer training scheme
- Build Back Better principle from the Sendai Framework for Disaster Risk Reduction
- National Disaster Response Force coordination during floods and earthquakes
- Hazard zonation maps (seismic, flood, landslide) guiding land-use regulation

MODEL ANSWER

Introduction: Risk is the product of hazard, exposure and vulnerability; vulnerability assessment maps who and what is most exposed and least able to cope, while risk assessment quantifies the likely loss. The Disaster Management Act, 2005 anchors a deliberate shift from relief-centric to prevention-centric governance, in which honest assessment is the very first step.

Why assessment matters before a disaster:

- It targets scarce resources to the most exposed people and assets, avoiding wasteful blanket spending.
- It feeds hazard zonation and land-use rules — seismic, flood and landslide maps that guide safe siting and construction.
- It calibrates early-warning thresholds, evacuation plans and risk-transfer tools such as crop and parametric insurance, and sets benchmarks against which preparedness can be measured.

As an administrator, key focus areas:

- **Institutions:** a functional District Disaster Management Authority, an updated district disaster plan, and clear incident-command roles with mapped responsibilities.
- **Mitigation & preparedness:** enforcing building codes, retrofitting lifeline buildings like hospitals and schools, regular mock drills, and pre-positioned relief and medical stocks.
- **Early warning & communication:** reliable last-mile alerts through sirens, SMS and community networks.
- **Capacity & community:** training Aapda Mitra volunteers and sensitising the most vulnerable — women, children, the elderly and persons with disabilities.

- **Response & recovery:** coordination with the NDRF, sound relief logistics and build-back-better reconstruction.

Conclusion: Sound vulnerability and risk assessment turns preparedness from intuition into measurable, equity-sensitive action — the difference between a managed event and a humanitarian crisis.

SOURCES

→NDMA — The Disaster Management Act, 2005
→NDMA — National Disaster Management Plan
→UNDRR — Sendai Framework for Disaster Risk Reduction 2015–2030

vulnerability assessment | risk assessment | Disaster Management Act 2005 | District Disaster Management Authority | hazard zonation | early warning | capacity building | build back better

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Q102

With reference to NDMA guidelines, discuss the measures to be adopted to mitigate the impact of the recent incidents of cloudbursts in many places of Uttarakhand.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | HYDRO-METEOROLOGICAL HAZARDS & MOUNTAIN MITIGATION | 2016

ANSWER OUTLINE

Introduction: Define a cloudburst (>100 mm rain in an hour over a small area) and frame the Himalayan, landslide-coupled risk in Uttarakhand.

Body: Three dimensions — (1) structural & non-structural mitigation (early warning, slope stabilisation, zoning), (2) ecological & land-use measures (carrying capacity, drainage), (3) institutional preparedness (DDMAs, community capacity, response).

Conclusion: Balance development with fragile-ecology limits; move from relief to anticipatory risk reduction.

KEY POINTS TO INCLUDE

- Cloudburst defined as rainfall exceeding 100 mm per hour over a small area, triggering flash floods and landslides
- 2013 Kedarnath/Mandakini disaster as the reference catastrophe in Uttarakhand
- NDMA guidelines on Floods, Landslides and the National Disaster Management Plan provide the mitigation framework

- Early warning via IMD Doppler radar, automatic weather stations and nowcasting
- Slope stabilisation: retaining walls, rock anchors, bio-engineering; check dams for flood cushioning
- GSI landslide hazard zonation maps to regulate construction and land use in run-out zones
- District Disaster Management Authorities, Aapda Mitra volunteers, pre-monsoon mock drills and drainage clearance
- Carrying-capacity-based regulation of hydropower, riverbed encroachment and pilgrim/tourist load
- NDRF and State Disaster Response Force for response; hill-area building codes for resilient construction

EXAMPLES & CASE STUDIES

- 2013 Kedarnath flash floods and Mandakini valley devastation
- Geological Survey of India landslide hazard zonation mapping
- India Meteorological Department Doppler Weather Radar network for nowcasting
- Aapda Mitra community volunteer scheme under NDMA
- Char Dham pilgrim-route load management in Uttarakhand

MODEL ANSWER

Introduction: A cloudburst is sudden, intense rainfall — over 100 mm in an hour over a small area — that triggers flash floods and debris flows. In Uttarakhand's young, tectonically active Himalaya, steep slopes and saturated soils turn such bursts deadly, as the 2013 Kedarnath tragedy showed when the Mandakini valley was devastated and thousands lost their lives.

Body: NDMA guidelines on Floods, Landslides and the National Disaster Management Plan recommend a layered, prevention-first response.

- **Early warning & structural:** a dense network of Doppler weather radars and automatic weather stations, real-time IMD nowcasting linked to last-mile alerts, slope stabilisation through retaining walls, rock anchors and bio-engineering, plus flood-cushioning check dams and resilient bridges.
- **Land-use & ecological:** Geological Survey of India landslide hazard zonation maps to bar construction in run-out zones, respecting valley carrying capacity, regulating riverbed encroachment and the spacing of hydropower projects, and afforesting catchments to anchor soil and slow runoff.

- **Institutional & community:** functional District Disaster Management Authorities, updated district plans, pre-monsoon mock drills, trained Aapda Mitra volunteers, marked evacuation routes and shelters, and clearing of natural drainage before the monsoon.

Enforcing building codes suited to hilly terrain, capping tourist and pilgrim load along routes like the Char Dham, and a State Disaster Response Force complementing the NDRF further strengthen on-ground capacity.

Conclusion: Mitigation must shift from post-event relief to anticipatory risk reduction — aligning roads, dams and townships with the fragile ecology rather than against it, so the Himalaya's people gain safety without forfeiting livelihoods.

SOURCES

→NDMA — National Disaster Management Guidelines: Management of Floods
→NDMA — Natural Hazards: Landslides
→NIDM — Uttarakhand Disaster 2013 report

cloudburst | landslide hazard zonation | early warning system | carrying capacity | slope stabilisation | District Disaster Management Authority | NDRF | anticipatory risk reduction

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Q103

Drought has been recognized as a disaster in view of its spatial expanse, temporal duration, slow onset, and lasting effects on various vulnerable sections. With a focus on the September 2010 guidelines from the National Disaster Management Authority, discuss the mechanism for preparedness to deal with El Niño and La Niña fallouts in India.

15 MARKS | 250 WORDS | 11 MIN | HARD | DROUGHT PREPAREDNESS & CLIMATE VARIABILITY | 2014

ANSWER OUTLINE

Introduction: Why drought is a creeping disaster; link El Niño/La Niña (ENSO) to monsoon failure.

Body: Three preparedness mechanisms from the Sept 2010 NDMA Drought Guidelines — (1) monitoring & early warning (DMCs, SPI, IMD-ENSO watch), (2) declaration & contingency planning, (3) water security & livelihood buffering.

Conclusion: Shift from crisis relief to anticipatory, indicator-driven drought management.

KEY POINTS TO INCLUDE

- Drought treated as a disaster due to slow onset, wide spatial expanse, long duration and impact on vulnerable rural sections
- El Niño typically suppresses the Indian monsoon; La Niña typically enhances it — the ENSO cycle drives preparedness
- September 2010 NDMA Drought Management Guidelines as the anchor instrument
- Drought Monitoring Cells at state level for surveillance and early warning
- Standardised Precipitation Index (SPI) and satellite vegetation/crop indices for objective assessment
- IMD monitoring of sea-surface temperatures and ENSO advisories to forecast monsoon performance
- District-level crop contingency plans with drought-tolerant, short-duration seed varieties; fodder and drinking-water plans
- Watershed development, groundwater recharge and micro-irrigation for water security
- MGNREGA wage support and PMFBY crop insurance for livelihood buffering

EXAMPLES & CASE STUDIES

- 2009 and 2015 El Niño years with deficient Indian monsoon and widespread drought
- Standardised Precipitation Index used by Drought Monitoring Cells
- Pradhan Mantri Fasal Bima Yojana (PMFBY) crop insurance
- Mahatma Gandhi National Rural Employment Guarantee Act wage employment as a drought buffer
- India Meteorological Department ENSO and monsoon forecasts

MODEL ANSWER

Introduction: Drought creeps in slowly over wide areas and lasts long, hitting rain-fed farmers and the rural poor hardest — which is why it is treated as a disaster rather than a passing dry spell. El Niño, a warming of the equatorial Pacific, tends to weaken the south-west monsoon, while La Niña usually strengthens it, so reading this ocean–atmosphere cycle is central to preparedness.

Mechanisms under the September 2010 NDMA Drought Guidelines:

- **Monitoring & early warning:** Drought Monitoring Cells in the states, the Standardised Precipitation Index and satellite-based crop and vegetation indices, with the IMD tracking sea-surface temperatures and issuing ENSO advisories to forecast a deficient or surplus monsoon.

- **Declaration & contingency:** objective, transparent drought-declaration criteria, district crop-contingency plans with alternate short-duration and drought-tolerant seed varieties, and ready fodder banks and drinking-water plans for the lean months.
- **Water security & livelihoods:** watershed development, groundwater recharge, farm ponds and micro-irrigation to stretch every drop, plus demand-side wage support through programmes like MGNREGA to buffer rural incomes when crops fail.

Inter-ministerial coordination, a Crisis Management Plan and crop-insurance cover through the Pradhan Mantri Fasal Bima Yojana complete the response chain for both El Niño-led deficits and La Niña-led excesses.

Conclusion: The framework moves drought management from reactive, post-failure relief to indicator-driven anticipation — reading ENSO signals early and acting on water storage, alternate cropping and rural livelihoods before the fields actually fail.

SOURCES

→NDMA / NIDM — National Disaster Management Guidelines: Management of Drought (2010)
→India Meteorological Department — Monsoon and ENSO monitoring
→NDMA — Natural Hazards: Drought

drought as disaster | El Niño | La Niña | ENSO | Standardised Precipitation Index | Drought Monitoring Cell | crop contingency plan | watershed development

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Q104

The frequency of earthquakes appears to have increased in the Indian subcontinent. However, India's preparedness for mitigating their impact has significant gaps. Discuss various aspects.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | SEISMIC RISK & STRUCTURAL MITIGATION | 2015

ANSWER OUTLINE

Introduction: Frame India's seismic exposure (~59% landmass in zones III–V) and the Himalayan plate-collision driver.

Body: (1) why exposure feels higher — tectonics plus rising built-up density, (2) preparedness gaps — code non-compliance, soft-storey buildings, weak retrofitting, last-mile warning, (3) existing framework — NDMA guidelines, IS 1893, NCSeP.

Conclusion: Earthquakes don't kill, buildings do — enforce codes and retrofit.

KEY POINTS TO INCLUDE

- About 59% of India's landmass falls in seismic zones III–V (11% in Zone V, 18% in Zone IV, 30% in Zone III)
- Indian plate subducting beneath the Eurasian plate along the Himalaya drives high seismicity
- High-risk cities: Guwahati and Srinagar (Zone V), Delhi (Zone IV); Mumbai, Kolkata, Chennai (Zone III)
- IS 1893 (Criteria for Earthquake Resistant Design) and the National Building Code are core standards
- Key gap: weak enforcement of seismic codes, soft-storey buildings and illegal vertical additions
- Near-absent retrofitting of pre-code lifeline buildings — schools, hospitals, public structures
- Limited seismic microzonation beyond select cities and patchy earthquake early-warning systems
- NDMA Earthquake Management Guidelines and National Earthquake Risk Mitigation Project as the framework
- Uneven State Disaster Response Force capacity and trained-mason shortage at district level

EXAMPLES & CASE STUDIES

- 2001 Bhuj (Gujarat) earthquake, magnitude 7.7, with massive building collapse
- 2015 Nepal earthquake felt across north India, exposing Delhi's high-rise vulnerability
- IS 1893 Bureau of Indian Standards seismic design code
- National Earthquake Risk Mitigation Project under NDMA
- Seismic microzonation of Delhi and Guwahati

MODEL ANSWER

> **Introduction:** Around 59% of India’s landmass lies in moderate-to-severe seismic zones III to V — roughly 11% in the highest Zone V — a consequence of the Indian plate pushing beneath the Eurasian plate along the Himalaya. Rising population and unregulated construction make every tremor costlier, even where the underlying frequency is debated.
>
> **Why impact appears to be rising:** dense, poorly built urban growth in high-risk zones — Guwahati and Srinagar in Zone V, Delhi in Zone IV, and the megacities of

Mumbai, Kolkata and Chennai in Zone III — sharply raises exposure, while reservoir-induced seismicity and unplanned hillside cutting add local stress.

Gaps in preparedness:

- **Construction:** weak enforcement of the IS 1893 seismic code; soft-storey buildings, illegal vertical additions, and almost no retrofitting of older schools and hospitals built before the code matured.
- **Systems:** limited earthquake early-warning coverage, a thin pool of trained masons and engineers, and patchy seismic microzonation beyond a handful of cities.
- **Response:** uneven State Disaster Response Force strength and a shortage of search-and-rescue equipment at the district level.

Existing framework: NDMA's earthquake guidelines, the National Building Code, IS 1893 and the National Earthquake Risk Mitigation Project provide clear direction that implementation under-delivers.

Conclusion: Earthquakes don't kill people — unsafe buildings do. Mandatory code compliance, retrofitting of lifeline structures, city-scale microzonation and large-scale mason training would close most of the gap and turn a recurring tragedy into a managed risk.

SOURCES

→NDMA — National Disaster Management Guidelines: Management of Earthquakes
→NDMA — Natural Hazards: Earthquakes
→NIDM — National Disaster Management Guidelines: Management of Earthquakes (2007)

seismic zonation | IS 1893 | soft-storey | retrofitting | microzonation | National Building Code | earthquake early warning | code enforcement

Q105

The frequency of urban floods due to high-intensity rainfall is increasing over the years. Discuss the reasons for urban floods, highlighting the mechanisms for preparedness to reduce the risk during such events.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | URBAN FLOODING & RESILIENT CITY PLANNING | 2016

ANSWER OUTLINE

Introduction: Define urban flooding and frame rising high-intensity rainfall plus paved catchments.

Body Part A — reasons: climatic (cloudbursts, heat island), hydrological (encroached drains, lost wetlands), governance (outdated drains, fragmented agencies). **Part B — preparedness:** NDMA 2010 urban-flooding guidelines — stormwater inventory, desilting, early warning, SDMA/AURBANFLOODS cell.

Conclusion: Sponge-city, sustainable urban drainage approach.

KEY POINTS TO INCLUDE

- Urban flooding defined as inundation of built-up areas when high-intensity rainfall exceeds drainage capacity
- Paved catchments raise and accelerate runoff peaks, causing rapid flooding within hours
- NDMA Guidelines on Management of Urban Flooding (September 2010) as the anchor instrument
- Urban heat-island effect and climate change concentrate rainfall into short high-intensity bursts
- Encroachment on lakes, wetlands and natural drains plus loss of permeable surface reduces infiltration
- Old stormwater drains designed for only 12–20 mm/hour rainfall, far below current intensities
- Watershed- and ward-level drainage inventories with catchment-based design
- Pre-monsoon desilting of major drains to be completed by 31 March annually
- Mandatory rooftop rainwater harvesting, rain gardens, Urban Flooding cell and real-time early warning

EXAMPLES & CASE STUDIES

- 2005 Mumbai deluge (Mithi river) that prompted the urban-flooding guidelines
- 2015 Chennai floods from extreme rainfall and encroached wetlands
- Hyderabad 2000 and Ahmedabad 2001 urban floods
- Central Water Commission real-time hydro-meteorological network
- Sponge-city / sustainable urban drainage systems approach

MODEL ANSWER

> **Introduction:** Urban flooding is the inundation of built-up land when high-intensity rain outpaces the drainage capacity of a developed catchment. Concrete surfaces make runoff peak fast and high, so cities flood within hours — a pattern the NDMA's

2010 urban-flooding guidelines were written to address. You can read more in our note on urban flooding in India.

Reasons for urban floods:

- **Climatic:** the urban heat-island effect and a changing climate concentrate rain into short, very intense bursts, including cloudburst-like spells.
- **Hydrological:** encroachment on lakes, wetlands and natural drains, and the loss of permeable soil to concrete, sharply shrinks infiltration and storage.
- **Governance:** stormwater drains designed for only 12–20 mm/hour rainfall, poor pre-monsoon desilting, unplanned outward growth and fragmented, overlapping civic agencies.

Preparedness mechanisms:

- Watershed- and ward-level stormwater drainage inventories, with the catchment as the basis for design.
- Pre-monsoon desilting of all major drains completed by 31 March each year.
- Real-time hydro-meteorological early warning through the Central Water Commission network, Doppler radar nowcasting, and a dedicated Urban Flooding cell in city plans.
- Mandatory rooftop rainwater harvesting, rain gardens in public parks, and active protection of urban water bodies.

Conclusion: A sponge-city approach — sustainable urban drainage, restored wetlands and lakes, and building codes that make every plot absorb rather than shed water — is the durable way to cut urban-flood risk and protect lives and assets.

SOURCES

→NDMA — Natural Hazards: Urban Floods
→NIDM — NDMA Guidelines: Management of Urban Flooding (2010)
→Anantam IAS — Urban Flooding in India

urban flooding | high-intensity rainfall | stormwater drainage | urban heat island | pre-monsoon desilting | rainwater harvesting | sponge city | early warning

Q106

On December 2004, the tsunami wreaked havoc on 14 countries, including India. Discuss the factors responsible for the occurrence of a tsunami and its effects on life and the economy. In the light of NDMA guidelines (2010),

describe the mechanisms for preparedness to reduce the risk during such events.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | COASTAL HAZARDS & TSUNAMI EARLY WARNING | 2017

ANSWER OUTLINE

Introduction: Define a tsunami (a series of long ocean waves triggered by sudden displacement of the seabed) and anchor on the 2004 Indian Ocean event.

Body: (1) Causal factors — submarine earthquakes, volcanism, landslides; (2) Effects on life and economy; (3) Preparedness mechanisms under the NDMA Tsunami Risk Management Guidelines (2010) — ITEWC at INCOIS, dissemination chain, response forces, bio-shields.

Conclusion: Balance the early-warning success with last-mile gaps and a forward line on community drills.

KEY POINTS TO INCLUDE

- Tsunami = series of long ocean waves from sudden seabed displacement; 2004 source was a magnitude-9.1 quake off Sumatra
- Primary cause is shallow-focus submarine earthquakes at subduction zones; secondary causes are volcanism, submarine landslides, meteorite impact
- Andaman-Sumatra trench (east) and Makran subduction zone (west) expose Indian coasts
- Indian Tsunami Early Warning Centre (ITEWC) set up at INCOIS, Hyderabad under Ministry of Earth Sciences, operational since October 2007
- ITEWC detects tsunamigenic earthquakes within minutes and disseminates advisories to NDMA, SDMAs and DDMAs
- Warning infrastructure includes seismic network, deep-ocean bottom-pressure recorders (buoys) and coastal tide gauges
- NDMA Tsunami Risk Management Guidelines (2010) cover risk assessment, early warning, mitigation, response and capacity building
- Mangroves and shelterbelts act as natural bio-shields; NDRF battalions stationed in coastal and island regions
- Economic effects: loss of fishing fleets, port and tourism damage, salination of farmland and groundwater

EXAMPLES & CASE STUDIES

- 26 December 2004 Indian Ocean tsunami (over 2.2 lakh deaths across 14 countries)

- Indian Tsunami Early Warning Centre (ITEWC) at INCOIS, Hyderabad
- 1883 Krakatoa volcanic-eruption tsunami
- UNESCO-IOC TsunamiReady recognition of Indian coastal villages (Odisha, A&N)
- Andaman-Sumatra subduction zone and Makran trench

MODEL ANSWER

Introduction: A tsunami is a series of long-wavelength ocean waves caused by the sudden vertical displacement of the seabed. The 26 December 2004 Sumatra event, born of a magnitude-9.1 undersea earthquake, killed over 2.2 lakh people across 14 nations and struck India's Tamil Nadu, Andhra, Kerala and Andaman coasts.

Causal factors: Most tsunamis arise from shallow-focus submarine earthquakes along subduction zones, where one plate thrusts under another and lifts the water column. Secondary triggers include underwater volcanic eruptions (Krakatoa, 1883), submarine landslides, and rarely meteorite impacts. The Andaman-Sumatra trench in the east and the Makran trench off the west make both Indian coastlines tsunamigenic.

Effects on life and economy: Mass casualties from drowning and debris, destruction of fishing fleets and harbours, salination of farmland and drinking-water aquifers, damage to ports, power and tourism, and long-term displacement of coastal communities. India's 2004 loss ran into thousands of crores, with Nagapattinam and the Andaman & Nicobar Islands worst hit.

Preparedness under the 2010 guidelines:

- The Indian Tsunami Early Warning Centre at INCOIS, Hyderabad detects tsunamigenic quakes within minutes using a seismic network, deep-ocean bottom-pressure recorders and coastal tide gauges.
- Advisories flow to NDMA, State and District authorities via SMS, fax, GTS and sirens for swift evacuation.
- NDRF battalions are pre-positioned in coastal and island regions, with mangrove and shelterbelt bio-shields, hazard mapping and community capacity-building.

Conclusion: The warning system is world-class, but the weak link remains the last mile — reaching fishermen at sea and isolated hamlets. Regular community mock drills and UNESCO's TsunamiReady recognition of coastal villages must close that gap to turn warning into safe response.

SOURCES

→NDMA, GoI — Tsunami
→INCOIS — Indian Tsunami Early Warning Centre (ITEWC)
→Ministry of Earth Sciences (INCOIS)

subduction zone | tsunamigenic earthquake | ITEWC / INCOIS | bottom-pressure recorder | bio-shield / mangrove | NDRF | last-mile connectivity | TsunamiReady

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Q107

Describe various measures taken in India for Disaster Risk Reduction (DRR) before and after signing the 'Sendai Framework for DRR (2015–2030).' How is this framework different from the 'Hyogo Framework for Action, 2005'?

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | DRR FRAMEWORKS & INSTITUTIONAL REFORM | 2018

ANSWER OUTLINE

Introduction: Define Disaster Risk Reduction (DRR) and place the Sendai Framework as the successor to the Hyogo Framework for Action.

Body: (1) India's DRR measures before Sendai; (2) Measures after signing Sendai; (3) Key differences between Sendai and Hyogo — risk vs loss, measurable targets, hazard scope, recovery.

Conclusion: Note India's alignment and the road ahead on local-level implementation.

KEY POINTS TO INCLUDE

- DRR addresses hazard, exposure and vulnerability to reduce disaster losses
- Disaster Management Act, 2005 created NDMA, SDMAs, DDMAs — pre-Sendai institutional base
- National Disaster Response Force (NDRF) and National Institute of Disaster Management (NIDM) set up before Sendai
- National Disaster Management Plan 2016 (revised 2019) aligned with Sendai's four priorities
- Coalition for Disaster Resilient Infrastructure (CDRI) launched by India in 2019, headquartered in New Delhi
- Sendai's four priorities: understanding risk, risk governance, investing in resilience, preparedness & Build Back Better
- Sendai's seven global targets and 38 indicators make progress measurable; Hyogo had five priorities of action but no quantified global targets

- Sendai shifts focus from reducing disaster LOSS (Hyogo) to reducing disaster RISK
- Sendai widens hazard scope to natural, man-made, technological and biological hazards

EXAMPLES & CASE STUDIES

- Disaster Management Act, 2005 (NDMA/SDMA/DDMA structure)
- National Disaster Management Plan 2016 (revised 2019)
- Coalition for Disaster Resilient Infrastructure (CDRI), 2019
- Prime Minister's 10-point agenda on DRR (2016 AMCDRR, New Delhi)
- National Institute of Disaster Management (NIDM)

MODEL ANSWER

Introduction: Disaster Risk Reduction (DRR) means cutting the chances and the damage of disasters by acting on the hazard, exposure and vulnerability. The Sendai Framework (2015–30) succeeded the Hyogo Framework for Action (2005–15) as the global blueprint, and India is a signatory to both.

Measures before Sendai: India moved from relief to risk management with the Disaster Management Act, 2005, creating a three-tier structure of NDMA, SDMAs and DDMAs. The National Disaster Response Force (NDRF) was raised as a dedicated multi-hazard force, the National Institute of Disaster Management (NIDM) was set up for training and research, and a National Cyclone Risk Mitigation Project was begun for coastal states.

Measures after Sendai:

- The National Disaster Management Plan, 2016 (revised 2019) was among the world's first to be aligned with Sendai's four priorities and seven targets.
- India launched the global Coalition for Disaster Resilient Infrastructure (CDRI) in 2019.
- A Prime Minister's 10-point agenda on DRR, risk-financing through SDRF/NDRF, and Finance Commission mitigation funds followed.

Sendai vs Hyogo: Hyogo aimed to reduce disaster *losses*; Sendai targets the *risk* itself — a shift from reactive to preventive. Sendai adds seven measurable global targets and 38 indicators, widens scope to natural, man-made, technological and biological hazards, places the primary responsibility on the State while engaging all of society, and stresses "Build Back Better" in recovery.

Conclusion: India's policy architecture is well-aligned with Sendai; the remaining task is sharpening district and ward-level risk governance and risk-informed

> investment so prevention reaches the most exposed communities.

SOURCES

→NDMA, GoI — Disaster Management Act 2005
→UNDRR — Sendai Framework for Disaster Risk Reduction 2015–2030
→NDMA, GoI — National Disaster Management Plan

Disaster Risk Reduction (DRR) | Sendai Framework | Hyogo Framework for Action | Build Back Better | seven global targets | Coalition for Disaster Resilient Infrastructure | proactive vs reactive | risk governance

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Q108

Disaster preparedness is the first step in any disaster management process. Explain how hazard zonation mapping will help in disaster mitigation in the case of landslides.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | LANDSLIDE HAZARD ZONATION & MITIGATION | 2019

ANSWER OUTLINE

Introduction: Define landslide hazard zonation (LHZ) mapping and link preparedness to mitigation.

Body: (1) What LHZ maps capture and at what scales; (2) How they aid mitigation — land-use control, engineering, early warning, insurance; (3) The institutional setup (GSI as nodal agency).

Conclusion: Stress mainstreaming LHZ into development planning.

KEY POINTS TO INCLUDE

- Landslide Hazard Zonation (LHZ) classifies terrain into low/moderate/high susceptibility zones
- Causative factors mapped: slope angle, lithology, soil, rainfall, land use, drainage and seismicity
- Geological Survey of India (GSI) is the nodal agency for landslide hazard zonation
- Macro-scale maps at 1:50,000; meso and micro-scale maps for critical road corridors and settlements
- Roughly 12–15% of India's landmass is landslide-prone, mainly Himalaya, NE hills and Western Ghats
- Mitigation uses: land-use zoning, slope engineering, safe route alignment, rain-threshold early warning
- Zonation supports building codes, risk-based insurance and community awareness

- NDMA Guidelines on Management of Landslides and Snow Avalanches (2009) recommend LHZ mainstreaming

EXAMPLES & CASE STUDIES

- Geological Survey of India (GSI) national landslide susceptibility mapping programme
- 2013 Kedarnath and 2021 Chamoli disasters (Uttarakhand Himalaya)
- Western Ghats / Wayanad landslides, Kerala
- NDMA Guidelines on Management of Landslides and Snow Avalanches, 2009
- Bhukosh / Bhusanket landslide portals of GSI

MODEL ANSWER

Introduction: Landslide Hazard Zonation (LHZ) mapping divides terrain into zones of low, moderate and high susceptibility to slope failure, weighing slope angle, rock type, soil, rainfall, drainage, land use and seismicity. As a preparedness tool it lets planners act before the slope fails rather than clean up after — the essence of mitigation. About 12–15% of India, mainly the Himalaya, Northeast hills and Western Ghats, is landslide-prone.

How zonation maps aid mitigation:

- **Land-use regulation:** High-hazard zones can be kept free of new settlements, schools and hospitals, and vulnerable structures relocated — cutting exposure at source.
- **Engineering and route planning:** Maps guide retaining walls, slope drainage, bio-engineering and the safest alignment for roads, railways, dams and hydel projects in hilly terrain.
- **Early warning and response:** Identifying critical zones lets agencies install rain-threshold and slope sensors, prioritise monitoring, and pre-position NDRF teams and relief.
- **Financial and awareness tools:** Zonation underpins risk-based insurance, hill-area building codes and community awareness in mapped villages.

Scales and institutions: The Geological Survey of India is the nodal agency, producing macro-scale maps at 1:50,000 and finer meso and micro-scale maps for critical road corridors and settlements; the NDMA guidelines of 2009 recommend mainstreaming these into planning.

Conclusion: A hazard map only mitigates if it is enforced — embedding LHZ in district development plans, building bye-laws and project clearances is what turns a

> map into real safety on the ground.

SOURCES

→NDMA, GoI — Landslide
→NIDM — NDMA Guidelines: Management of Landslides and Snow Avalanches
→Geological Survey of India — Landslide Hazard (Bhusanket)

Landslide Hazard Zonation (LHZ) | susceptibility mapping | macro/meso/micro scale | Geological Survey of India | slope stability | land-use regulation | rain-threshold early warning | mainstreaming DRR

Q109

Vulnerability is an essential element for defining disaster impacts and their threat to people. How and in what ways can vulnerability to disasters be characterized? Discuss different types of vulnerability with reference to disasters.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | RISK, VULNERABILITY & EXPOSURE | 2019

ANSWER OUTLINE

Introduction: Define vulnerability per UNDRR and place it in the risk equation (Risk = Hazard × Exposure × Vulnerability).

Body: (1) How vulnerability is characterized — the conditions/processes lens; (2) Types — physical, social, economic, environmental, institutional, with disaster-linked examples.

Conclusion: Reducing vulnerability is the most controllable lever in risk reduction.

KEY POINTS TO INCLUDE

- UNDRR defines vulnerability as conditions (physical, social, economic, environmental) that raise susceptibility to a hazard
- Risk = Hazard × Exposure × Vulnerability; vulnerability is the most controllable factor
- Vulnerability is distinct from the hazard — it is the weakness the hazard exposes
- Physical vulnerability: weak buildings, settlements in floodplains and on unstable slopes
- Social vulnerability: shaped by age, gender, disability, caste, literacy and social networks
- Economic vulnerability: poverty, informal livelihoods, absence of insurance and savings
- Environmental vulnerability: degraded mangroves, deforestation, wetland encroachment removing natural buffers
- Institutional vulnerability: weak building codes, poor enforcement, thin local capacity

- Coping capacity and resilience are the counterweights to vulnerability

EXAMPLES & CASE STUDIES

- 2001 Bhuj earthquake — collapse of unreinforced masonry (physical)
- 2004 Indian Ocean tsunami — higher female and elderly mortality (social)
- Mangrove buffers of Sundarbans / Pichavaram reducing surge damage (environmental)
- Coastal Regulation Zone violations raising exposure (institutional)
- Smart City / housing for the urban poor reducing economic vulnerability

MODEL ANSWER

Introduction: The UN Office for Disaster Risk Reduction defines vulnerability as the conditions — physical, social, economic and environmental — that raise a community's susceptibility to a hazard's impact. In the risk equation, Risk = Hazard × Exposure × Vulnerability, vulnerability is the factor most open to human control, which is why it sits at the heart of risk reduction.

How it is characterized: Vulnerability is not the hazard but the weakness the hazard exposes. It is assessed through the susceptibility of people and assets, their coping capacity and resilience, and the social, economic and physical processes that build that weakness over time. The same flood harms the slum dweller far more than the gated colony — the hazard is identical, the vulnerability is not.

Types of vulnerability:

- **Physical:** Weak buildings and settlements on floodplains or steep slopes — the collapse of unreinforced masonry in the 2001 Bhuj earthquake.
- **Social:** Shaped by age, gender, disability, caste and literacy — women, children and the elderly suffered disproportionately in the 2004 tsunami.
- **Economic:** Poverty, informal livelihoods and the absence of insurance or savings leave the poor unable to recover.
- **Environmental:** Degraded mangroves, deforested catchments and encroached wetlands strip away natural buffers.
- **Institutional:** Weak building codes, poor enforcement and thin local capacity amplify every other type.

Conclusion: Because hazards cannot be stopped, cutting vulnerability — safe construction, social protection, ecosystem restoration and strong local institutions — is the surest path to a disaster-resilient society.

SOURCES

→UNDRR — Terminology: Vulnerability
→NIDM — National Institute of Disaster Management
→NDMA, GoI — Vulnerability profile

vulnerability | exposure | coping capacity | Risk = Hazard × Exposure × Vulnerability | social vulnerability | physical vulnerability | environmental buffer | resilience

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Q110

Discuss the recent measures initiated in disaster management by the Government of India, departing from the earlier reactive approach.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | PROACTIVE REFORMS & INSTITUTIONAL ARCHITECTURE | 2020

ANSWER OUTLINE

Introduction: Contrast the old relief-centric reactive model with the post-2005 proactive, risk-reduction approach.

Body: (1) Legal-institutional reform; (2) Planning and global alignment; (3) Technology, finance and infrastructure resilience.

Conclusion: Acknowledge progress while flagging local-level implementation gaps.

KEY POINTS TO INCLUDE

- Old approach was relief-centric and reactive; new approach is proactive risk reduction
- Disaster Management Act, 2005 created NDMA, SDMAs and DDMAs — a three-tier institutional structure
- National Disaster Response Force (NDRF) raised as a standing specialised multi-hazard force
- National Disaster Management Plan 2016 (revised 2019), aligned with the Sendai Framework
- Coalition for Disaster Resilient Infrastructure (CDRI) launched by India in 2019
- Early-warning systems: ITEWC for tsunamis, IMD cyclone forecasting, flood and landslide alerts
- National Cyclone Risk Mitigation Project reduced cyclone deaths sharply (e.g., Phailin 2013, Fani 2019)
- Risk financing via SDRF/NDRF and Finance Commission mitigation funds; PM's 10-point DRR agenda

- National Institute of Disaster Management (NIDM) for training, research and capacity building

EXAMPLES & CASE STUDIES

- Disaster Management Act, 2005 (NDMA/SDMA/DDMA)
- National Disaster Management Plan 2016 (revised 2019)
- Coalition for Disaster Resilient Infrastructure (CDRI), 2019
- Cyclone Phailin 2013 / Fani 2019 — mass evacuation under NCRMP cut deaths drastically
- Indian Tsunami Early Warning Centre (ITEWC), INCOIS Hyderabad

MODEL ANSWER

Introduction: India once treated disasters as one-off events met with post-event relief and compensation. The approach has since turned proactive — anticipating, preventing and reducing risk before disaster strikes — in line with the global shift toward Disaster Risk Reduction.

Legal and institutional reform: The Disaster Management Act, 2005 created a three-tier structure — NDMA at the centre, SDMAs in states and DDMAs in districts — and raised the National Disaster Response Force (NDRF) as a standing specialised multi-hazard force, ending reliance on ad-hoc deployment. The National Institute of Disaster Management (NIDM) anchors training and research.

Planning and global alignment:

- The National Disaster Management Plan, 2016 (revised 2019) was among the first worldwide aligned with the Sendai Framework's four priorities.
- India launched the Coalition for Disaster Resilient Infrastructure (CDRI) in 2019 to mainstream resilience into roads, power, telecom and transport.

Technology, finance and forecasting: Early-warning systems — ITEWC for tsunamis at INCOIS, IMD cyclone forecasting, and flood and landslide alerts — now give vital lead time; the National Cyclone Risk Mitigation Project, dedicated SDRF/NDRF funds and Finance Commission mitigation grants back prevention with money. Mass pre-cyclone evacuations have cut deaths sharply, as in Phailin (2013) and Fani (2019).

Conclusion: The architecture has clearly moved from relief to resilience; the next step is strengthening district and community-level preparedness and risk-informed land use so this proactive intent reaches the last vulnerable household.

SOURCES

→NDMA, GoI — Disaster Management Act 2005
→NDMA, GoI — National Disaster Management Plan
→PIB — Disaster Preparedness and Climate Resilience

proactive approach | Disaster Management Act 2005 | NDMA / NDRF | National Disaster Management Plan | Coalition for Disaster Resilient Infrastructure | early-warning system | risk financing | relief to resilience

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Q111

Discuss India's vulnerability to earthquake-related hazards. Give examples, including salient features of major disasters caused by earthquakes in different parts of India during the last three decades.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | SEISMIC HAZARD & EARTHQUAKE VULNERABILITY | 2021

ANSWER OUTLINE

Introduction: Frame India's seismicity using the Bureau of Indian Standards seismic zoning (IS 1893) and the share of land in high-risk Zones IV and V.

Body: (1) Sources of vulnerability — tectonic setting, exposure, fragile built stock; (2) Salient features of three major quakes of the last three decades with their lessons; (3) Cascading hazards quakes trigger.

Conclusion: Balance India's preparedness gains against the deficit in retrofitting and code enforcement, and point to a way forward.

KEY POINTS TO INCLUDE

- IS 1893 (Bureau of Indian Standards) groups India into seismic Zones II to V; Zone V is most active
- Around 59% of India's land lies in moderate-to-high seismic Zones III, IV and V
- Northward Indian-plate collision drives Himalayan and northeast (Zone V) seismicity
- Latur 1993 (M6.4) killed nearly 10,000 and proved the peninsular shield is not aseismic
- Bhuj 2001 (M7.7) killed over 20,000 and catalysed the Disaster Management framework
- Sikkim 2011 (M6.9) showed cascading landslides and blocked hill roads
- Soft-soil amplification and non-engineered masonry housing raise structural risk
- Ductile detailing made mandatory in Zones III, IV and V after Bhuj

EXAMPLES & CASE STUDIES

- Latur earthquake 1993, Maharashtra (M6.4)
- Bhuj earthquake 2001, Gujarat (M7.7)

- Sikkim earthquake 2011 (M6.9)
- Uttarkashi earthquake 1991, Himalayan Zone V
- Bureau of Indian Standards seismic zoning map (IS 1893)

MODEL ANSWER

Introduction: The Bureau of Indian Standards code IS 1893 divides India into seismic Zones II to V, and roughly 59% of the landmass sits in the moderate-to-severe Zones III, IV and V. This makes seismic risk one of the country's gravest natural threats, sharpened by rapid urban growth on hazardous ground.

Why India is vulnerable:

- **Tectonic setting:** The northward push of the Indian plate against the Eurasian plate keeps the Himalayan arc and the northeast (Zone V) under constant strain, while the Kutch and Andaman arcs add intra-plate and subduction risk.
- **Exposure:** Dense, unplanned cities sit on soft alluvium that amplifies shaking, and millions live in the high-hazard belt from Kashmir to Arunachal. The Latur quake showed even the "stable" Deccan can rupture.
- **Fragile built stock:** Most housing is non-engineered masonry on weak foundations, and ductile-detailing rules are poorly enforced at the municipal level.

Major earthquakes (last three decades):

- **Latur (1993, M6.4):** Struck Maharashtra's peninsular shield, killed nearly 10,000, and forced an upward revision of seismic-zoning maps.
- **Bhuj (2001, M7.7):** One of India's deadliest, over 20,000 dead in Gujarat; it catalysed the Disaster Management Act, 2005 and mandatory ductile detailing in higher zones.
- **Sikkim (2011, M6.9):** A Himalayan quake that triggered landslides, blocked hill roads and exposed weak hill-town construction.

Conclusion: India has built early-warning research and a legal framework, but retrofitting and code enforcement lag badly. Strict building bye-laws, seismic micro-zonation of cities, and regular community drills must close the gap between law and the ground.

SOURCES

→NDMA — Earthquake (Natural Hazards)
→Anantam IAS — Earthquakes in India: Zones, History & Preparedness

seismic zoning | IS 1893 | Indian plate collision | soft-soil amplification | ductile detailing | seismic micro-zonation | retrofitting | cascading hazards

Q112

Describe the various causes and the effects of landslides. Mention the important components of the National Landslide Risk Management Strategy.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | LANDSLIDES & SLOPE-FAILURE RISK | 2021

ANSWER OUTLINE

Introduction: Define a landslide and name India's worst-affected belts (Himalaya, Western Ghats, Northeast).

Body: (1) Natural and anthropogenic causes; (2) Effects across human, economic and environmental dimensions; (3) Key components of the National Landslide Risk Management Strategy.

Conclusion: Link the strategy to early-warning investment as the way forward.

KEY POINTS TO INCLUDE

- Landslide = gravity-driven downslope movement of rock, debris or earth
- Around 12.6% of India's non-snow landmass is landslide-prone
- Worst belts: Himalaya, Western Ghats, Northeast hill states
- Natural causes: heavy rainfall, cloudbursts, seismicity, weak young rock
- Anthropogenic causes: road-cutting, deforestation, mining, unregulated hill building
- National Landslide Risk Management Strategy released by NDMA
- Strategy pillars: hazard mapping, monitoring/early warning, awareness, capacity building, regulation, slope stabilisation
- Geological Survey of India is the nodal agency for landslide hazard zonation

EXAMPLES & CASE STUDIES

- Wayanad landslides 2024, Kerala
- Kerala monsoon landslides 2018
- Malin landslide 2014, Maharashtra (Western Ghats)
- Geological Survey of India landslide hazard zonation mapping
- National Landslide Susceptibility Mapping programme

MODEL ANSWER

Introduction: A landslide is the downslope movement of rock, debris or earth under gravity. About 12.6% of India's land outside the snow belt is landslide-prone, concentrated in the young Himalaya, the Western Ghats and the Northeast hill states.

Causes:

- **Natural:** Intense rainfall and cloudbursts that saturate slopes, steep immature Himalayan terrain, seismic shaking, and weathered, fractured rock that loses cohesion.
- **Anthropogenic:** Unscientific road-cutting and tunnelling, deforestation that removes binding roots, mining and quarrying, and unregulated hill construction that overloads and undercuts slopes.

Effects:

- **Human:** Loss of life and displacement, as in the 2018 Kerala and 2024 Wayanad slides.
- **Economic:** Severed highways and rail links, damaged hydropower projects and tourism, and costly rescue and relief.
- **Environmental:** Temporary river damming and outburst floods, heavy sediment loading downstream, and loss of forest cover and farmland.

National Landslide Risk Management Strategy components: Released by the National Disaster Management Authority, it lays out a comprehensive approach covering landslide hazard mapping and zonation, monitoring and early-warning systems, awareness generation among communities, capacity building and training, regulation of land use and construction in vulnerable slopes, and engineering works for slope stabilisation and mitigation. It assigns clear roles to the Geological Survey of India as nodal agency, alongside states, line ministries and other stakeholders, and is aligned with the Sendai goal of more national and local risk-reduction strategies.

Conclusion: Pairing the strategy's mapping with rainfall-threshold early warning, and firmly enforcing hill-construction norms, offers the most cost-effective path to cutting losses.

SOURCES

→NDMA — National Landslide Risk Management Strategy
→NDMA — Landslide (Natural Hazards)
→Anantam IAS — Landslides: Causes, Mapping & Mitigation in India

slope failure | hazard zonation | rainfall threshold early warning | slope stabilisation | land-use regulation | Geological Survey of India | capacity building | Western Ghats

Q113

Explain the mechanism and occurrence of cloudburst in the context of the Indian subcontinent. Discuss two recent examples.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | CLOUDBURST & FLASH-FLOOD HAZARD | 2022

ANSWER OUTLINE

Introduction: Give the India Meteorological Department definition of a cloudburst.

Body: (1) Atmospheric mechanism; (2) Where and why it occurs over the subcontinent; (3) Two recent examples with their effects.

Conclusion: Note the climate-change link and a mitigation pathway.

KEY POINTS TO INCLUDE

- IMD defines a cloudburst as 100 mm or more rainfall in one hour over about 10-30 sq km
- Orographic lift forces moist monsoon air up steep slopes to condense rapidly
- Strong convective updrafts in cumulonimbus clouds hold and then release the water column
- Most events occur in Himalayan terrain above roughly 1,500 metres
- Cloudbursts trigger flash floods, debris flows and landslides in narrow valleys
- Amarnath/Pahalgam 2022 cloudburst killed at least sixteen pilgrims
- Kedarnath 2013 cloudburst-driven floods killed thousands in Rudraprayag
- Warmer air holds more moisture, raising cloudburst frequency

EXAMPLES & CASE STUDIES

- Amarnath/Pahalgam cloudburst 2022, Jammu and Kashmir
- Kedarnath cloudburst and flash floods 2013, Uttarakhand
- Leh cloudburst 2010, Ladakh
- India Meteorological Department Doppler radar network
- C-FLOOD flood-forecasting platform

MODEL ANSWER

Introduction: The India Meteorological Department defines a cloudburst as rainfall of 100 mm or more in an hour over a small area of about 10 to 30 square kilometres, an extreme and highly localised downpour that overwhelms the ground in minutes.

Mechanism:

- **Orographic lift:** Moisture-laden monsoon air is forced up steep Himalayan slopes, cools rapidly and condenses into deep cloud.
- **Convective build-up:** Strong upward currents hold raindrops aloft inside towering cumulonimbus clouds, and when the updraft collapses the whole water column dumps at once over a tiny footprint.

Occurrence in the subcontinent: Cloudbursts concentrate in the Himalayan states, often above 1,500 metres, where consistent moist monsoon inflow, unstable slopes and narrow steep valleys channel sudden rain into flash floods, debris flows and landslides. Ladakh, Himachal Pradesh, Uttarakhand and Jammu and Kashmir are the worst-hit.

Two recent examples:

- **Amarnath, Jammu and Kashmir (2022):** A cloudburst near the cave shrine on the Pahalgam route killed at least sixteen pilgrims and swept away camps.
- **Kedarnath, Uttarakhand (2013):** Cloudburst-driven rain caused catastrophic flash floods in Rudraprayag, killing thousands and stranding tens of thousands of pilgrims, and exposing the danger of construction on active riverbeds.

Conclusion: A warming atmosphere holds more moisture, raising cloudburst frequency and intensity. Dense Doppler-radar networks, automatic rain gauges, nowcasting, and strict regulation of valley-floor and riverbank construction, backed by community alert systems, can blunt the toll.

SOURCES

→India Meteorological Department
→NDMA — Floods (Natural Hazards)
→Anantam IAS — Cloudburst Flooding in India

orographic lift | cumulonimbus | convective updraft | flash flood | Doppler radar | automatic rain gauges | Himalayan valleys | climate change

Q114

What is disaster resilience? How is it determined? Describe various elements of a resilience framework. Also mention the global targets of Sendai Framework for Disaster Risk Reduction (2015–2030).

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | RESILIENCE & SENDAI FRAMEWORK | 2024

ANSWER OUTLINE

Introduction: Define disaster resilience using the UN definition.

Body: (1) How resilience is determined; (2) Elements of a resilience framework (the 4R attributes and resilience dimensions); (3) The seven global targets of the Sendai Framework.

Conclusion: Tie resilience-building to the shift from relief to risk reduction.

KEY POINTS TO INCLUDE

- UNDRR defines resilience as ability to resist, absorb, adapt to and recover from a hazard
- Determined by exposure, asset strength, social capital, finance and recovery speed
- 4R framework: Robustness, Redundancy, Resourcefulness, Rapidity
- Resilience spans technical, organisational, social and economic dimensions
- Sendai adopted 2015 at the Third UN World Conference, Sendai, Japan
- Seven targets: reduce mortality, affected people, economic loss, infrastructure damage
- Targets also: more national/local strategies, international cooperation, multi-hazard early warning
- Sendai has four priorities and 38 indicators tracking the seven targets

EXAMPLES & CASE STUDIES

- UN Office for Disaster Risk Reduction (UNDRR) resilience definition
- Sendai Framework for Disaster Risk Reduction 2015-2030
- Coalition for Disaster Resilient Infrastructure (CDRI), India-led
- National Landslide Risk Management Strategy aligned to Sendai Target (e)
- Multi-hazard early-warning systems under Target (g)

MODEL ANSWER

> **Introduction:** Disaster resilience is the ability of a system, community or society exposed to a hazard to resist, absorb, accommodate, adapt to and recover from its effects in a timely, efficient way, as defined by the UN Office for Disaster Risk Reduction. It marks the shift from reactive relief to proactive risk reduction.

How it is determined: Resilience reflects how well people and institutions organise themselves to learn from past disasters and cut future risk. It is gauged by exposure to hazards, the strength of physical assets and lifelines, social capital, financial buffers, governance quality, and the speed of recovery after a shock.

Elements of a resilience framework — the 4R attributes:

- **Robustness:** Withstanding shocks without major loss of function.
- **Redundancy:** Back-up systems that substitute when components fail.
- **Resourcefulness:** Mobilising people, money, information and technology to diagnose and solve problems.
- **Rapidity:** Restoring function quickly to contain losses.

These attributes play out across the technical, organisational, social and economic dimensions of a community.

Sendai Framework global targets (2015-2030): Substantially reduce disaster (a) mortality, (b) number of affected people, (c) direct economic loss and (d) damage to critical infrastructure and basic services; (e) increase countries with national and local risk-reduction strategies; (f) enhance international cooperation for developing countries; and (g) increase access to multi-hazard early-warning systems and risk information.

Conclusion: Building these attributes, tracked through the framework's targets and indicators, turns resilience from a slogan into measurable, accountable practice.

SOURCES

→UNDRR — Sendai Framework for Disaster Risk Reduction 2015-2030
→UNDRR — Terminology: Resilience
→Anantam IAS — Sendai Framework for Disaster Risk Reduction

disaster resilience | UNDRR | 4R framework | robustness | redundancy | Sendai Framework | global targets | multi-hazard early warning

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Q115

Flooding in urban areas is an emerging climate-induced disaster. Discuss the causes of this disaster. Mention the features of two such major floods in the last two decades in India. Describe the policies and frameworks in India that aim at tackling such floods.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | URBAN FLOODING & CLIMATE RISK | 2024

ANSWER OUTLINE

Introduction: Define urban flooding and flag its climate-change driver.

Body: (1) Causes — natural and man-made; (2) Features of two major urban floods of the last two decades; (3) Policies and frameworks addressing urban floods.

Conclusion: Point to sponge-city ideas and integrated drainage as the way forward.

KEY POINTS TO INCLUDE

- Urban flooding = inundation when rainfall exceeds a city's drainage capacity
- Old storm-water drains were designed for only 12-20 mm/hour rainfall
- Causes: lost wetlands, concretisation, encroached drains, climate-driven extreme rain
- Urban heat-island effect locally intensifies rainfall
- Mumbai 2005: 944 mm in 24 hours, about 400 deaths, Mithi river choked
- Chennai 2015: record rain, over 400 deaths, loss of urban water bodies
- NDMA National Guidelines on Urban Flooding issued 2010
- AMRUT and AMRUT 2.0 fund storm-water drains and water-body rejuvenation

EXAMPLES & CASE STUDIES

- Mumbai floods, 26 July 2005
- Chennai floods, December 2015
- Bengaluru floods 2022 (lake encroachment)
- NDMA National Guidelines on Urban Flooding (2010)
- Atal Mission for Rejuvenation and Urban Transformation (AMRUT / AMRUT 2.0)

MODEL ANSWER

Introduction: Urban flooding is the inundation of built-up areas when rainfall outpaces a city's drainage capacity. A warming climate, by intensifying short-duration extreme rain over heat-island cities, is turning it into a recurring disaster.

Causes:

- **Climatic:** More frequent high-intensity cloudbursts, erratic monsoons and storm surges in coastal cities.
- **Man-made:** Loss of wetlands and lakes, concretised surfaces that block infiltration, encroachment of natural drains and floodplains, and storm-water systems designed for only 12-20 mm/hour rain.

- **Governance:** Poor land-use control, weak desilting of drains, and unregulated release of water from upstream reservoirs.

Two major urban floods:

- **Mumbai (2005):** 944 mm of rain in 24 hours paralysed the city for over 48 hours and killed about 400 people, exposing the choked Mithi river and outdated stormwater drains.
- **Chennai (2015):** Record northeast-monsoon rain killed over 400, shut the airport, and spurred state disaster-management reform after the loss of the city's tanks and water bodies.

Policies and frameworks: The National Disaster Management Authority's National Guidelines on Urban Flooding (2010) recommend dedicated urban-flood cells and Doppler-radar nowcasting; the Atal Mission for Rejuvenation and Urban Transformation funds storm-water drains, with AMRUT 2.0 rejuvenating water bodies; and the National Disaster Management Plan mainstreams flood risk into city planning.

Conclusion: Sponge-city design, restored wetlands and lakes, permeable surfaces, and integrated, real-time drainage management offer the durable fix to a fast-rising, climate-linked risk.

SOURCES

→NDMA — Urban Floods (Natural Hazards)
→MoHUA — Atal Mission for Rejuvenation and Urban Transformation (AMRUT)
→Anantam IAS — Urban Flooding in India

urban flooding | storm-water drainage | wetland loss | urban heat island | NDMA guidelines | AMRUT | sponge city | climate-induced disaster

GS PAPER 3

Sustainable Development

13 practice questions

Q116

Write a note on India's green energy corridor to alleviate the problems of conventional energy.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | RENEWABLE ENERGY GRID INTEGRATION | 2013

ANSWER OUTLINE

Introduction: Define the Green Energy Corridor as a dedicated transmission network for renewable power.

Body: (1) Why it is needed — variability and grid-stress of clean power; (2) what it builds — intra-state and inter-state lines, substations, control centres; (3) how it eases conventional-energy problems — cuts coal dependence, emissions and import bills.

Conclusion: Position it as the backbone of the non-fossil transition.

KEY POINTS TO INCLUDE

- GEC is implemented by MNRE to evacuate renewable power into the national grid
- Intra-State GEC Phase-I (2015): ~9,700 ckm of lines and ~22,600 MVA substations across resource-rich states
- Intra-State GEC Phase-II (approved 2022): ~10,750 ckm of lines and ~27,500 MVA substations
- Inter-State GEC component adds long-distance lines and HVDC terminals, including the Ladakh evacuation link
- Includes Renewable Energy Management Centres (REMCs) for forecasting and grid balancing
- Funded partly by central financial assistance plus low-cost loans (e.g. KfW)
- Reduces curtailment, lets coal plants be backed down, cutting emissions and fuel imports
- Supports the 500 GW non-fossil capacity target by 2030

EXAMPLES & CASE STUDIES

- Intra-State GEC Phase-I and Phase-II
- Ladakh inter-state transmission link with HVDC terminals

- Renewable Energy Management Centres (REMCs)
- Solar and wind resource-rich states: Rajasthan, Gujarat, Tamil Nadu, Karnataka, Andhra Pradesh

MODEL ANSWER

Introduction: The Green Energy Corridor (GEC) is a dedicated transmission network, steered by the Ministry of New and Renewable Energy, built to carry power from large solar and wind zones into the national grid.

Why it is needed: Renewable output is variable and clustered in a few resource-rich states, while the older grid was designed around steady coal and hydro plants. Without firm evacuation lines, clean power gets curtailed and stranded.

What it builds: Intra-state and inter-state high-voltage lines, new substations and Renewable Energy Management Centres for forecasting and balancing. Phase-I and Phase-II together target thousands of circuit-kilometres and added transformation capacity, part-funded by central grants.

How it helps: By smoothly evacuating wind and solar, it lets fossil generation be backed down, trimming coal use, carbon emissions and fuel imports, and supporting the 500 GW non-fossil goal for 2030.

Conclusion: The corridor is the grid backbone that turns scattered renewable potential into reliable, low-carbon supply.

SOURCES

→MNRE — Green Energy Corridors
→Ministry of Power — Green Energy Corridor
→Ministry of Power — 500 GW Non-Fossil Fuel Target

Green Energy Corridor | renewable evacuation | intra-state and inter-state transmission | REMC | grid integration | circuit-kilometre | 500 GW non-fossil target | curtailment

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Q117

Explain the purpose of the Green Grid Initiative launched at the World Leaders' Summit of the COP26 UN Climate Change Conference in Glasgow (Nov 2021). When was this idea first floated in the International Solar Alliance (ISA)?

10 MARKS | 150 WORDS | 9 MIN | EASY | CLEAN-ENERGY GRID COOPERATION | 2021

ANSWER OUTLINE

Introduction: Identify the Green Grids Initiative–One Sun One World One Grid (GGI–OSOWOG) and its Glasgow launch.

Body: (1) purpose — an interconnected transnational solar/renewable grid; (2) the underlying logic — the sun is always shining somewhere; (3) origin — first floated by India at the ISA's first assembly in 2018.

Conclusion: a route to affordable clean power and decarbonised grids.

KEY POINTS TO INCLUDE

- Full name: Green Grids Initiative–One Sun One World One Grid (GGI–OSOWOG)
- Launched at the World Leaders' Summit of COP26, Glasgow, November 2021
- Co-led by India and the United Kingdom, with the International Solar Alliance and the World Bank
- Purpose: interconnect grids across regions/time zones to move solar and renewable power
- Core logic — the sun is always shining somewhere, smoothing supply and reducing storage need
- Aims to lower power costs, expand clean-energy access and decarbonise grids
- Idea first floated by PM Modi at the first ISA Assembly in October 2018

EXAMPLES & CASE STUDIES

- International Solar Alliance (ISA), headquartered in Gurugram, India
- First ISA Assembly, October 2018 — where OSOWOG was first proposed
- UK–India agreement (2021) to merge GGI and OSOWOG
- World Bank as a launch partner at COP26

MODEL ANSWER

> **Introduction:** The Green Grids Initiative–One Sun One World One Grid (GGI–OSOWOG) was launched by India and the United Kingdom, with the International Solar Alliance and the World Bank, at the World Leaders' Summit of COP26 in Glasgow in November 2021.
>
> **Purpose:**
>
> - **Build interconnected grids:** link national and regional power grids across time zones and continents so solar and other renewable energy can flow freely.

- **Use the 'always-on' sun:** because the sun is shining somewhere at any moment, a connected grid keeps supply steady and cuts the need for fossil-fuel backup and storage.
- **Cheaper, cleaner power:** share renewable resources to lower costs, improve energy access, and decarbonise electricity.

When first floated: Prime Minister Narendra Modi first proposed the One Sun One World One Grid idea at the first Assembly of the International Solar Alliance in October 2018.

Conclusion: It offers a cooperative path to affordable, reliable clean energy and lower grid emissions.

SOURCES

→International Solar Alliance — Official site
→Invest India — Green Grids Initiative (OSOWOG)

Green Grids Initiative | One Sun One World One Grid | International Solar Alliance | COP26 Glasgow | interconnected grids | renewable energy | decarbonisation | energy access

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Q118

What do you understand by a "run-of-river" hydroelectricity project? How is it different from any other hydroelectricity project?

10 MARKS | 150 WORDS | 9 MIN | EASY | HYDROPOWER TECHNOLOGY | 2013

ANSWER OUTLINE

Introduction: Define a run-of-river (RoR) project as one that uses the natural flow of a river with little or no storage.

Body: (1) How it works — diversion, channel/penstock, turbine, with small pondage for diurnal balancing; (2) contrast with storage/reservoir projects on storage, flow regulation and submergence; (3) trade-offs — lower social/ecological footprint but seasonal, less firm power.

Conclusion: RoR suits hilly perennial rivers and lower-impact development.

KEY POINTS TO INCLUDE

- RoR uses natural river flow with little/no large reservoir
- Water diverted via weir/barrage and penstock to turbines, then returned to river
- Small "pondage" balances only diurnal or weekly demand, not seasonal

- Output is seasonal and varies with river flow — less firm power
- Storage projects impound water for months, giving dispatchable power and irrigation
- Storage dams cause large submergence, displacement and altered downstream flow
- RoR affects only a short stretch of river — smaller social and ecological footprint
- Suited to perennial Himalayan rivers with high natural gradient

EXAMPLES & CASE STUDIES

- Kishanganga RoR project, Jammu and Kashmir
- Baglihar and other Chenab basin schemes designed largely as RoR
- Bhakra Nangal as a contrasting large storage-reservoir project
- Sardar Sarovar as a contrasting multipurpose storage dam

MODEL ANSWER

Introduction: A run-of-river (RoR) project generates electricity from the natural flow of a river, holding little or no water behind a large dam. It diverts part of the stream through a channel or penstock to drive turbines.

How it works: A small barrage or weir creates only modest "pondage" — enough to balance daily or weekly demand swings — after which water rejoins the river. Output rises and falls with the river's flow rather than being fully controlled.

How it differs: A conventional storage project builds a tall dam and a large reservoir that impounds water for months. That allows firm, dispatchable power and irrigation, but submerges land and forests, displaces people and alters downstream flow heavily. RoR affects only a short river stretch and stores almost nothing, so it has a smaller social and ecological footprint but offers seasonal, less reliable output.

Conclusion: RoR fits perennial hill rivers where steep gradients give head without large submergence, making it a lower-impact path to hydropower.

SOURCES

→Central Electricity Authority — Ministry of Power
→Ministry of Power — Hydro Power

run-of-river | pondage | penstock | diversion weir | storage reservoir | firm power | submergence | head

Q119

To what factors can the recent dramatic fall in equipment costs and the tariff of solar energy be attributed? What implications does the trend have for thermal power producers and the related industry?

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | SOLAR ECONOMICS AND ENERGY TRANSITION | 2015

ANSWER OUTLINE

Introduction: Note that solar module costs and auction tariffs have collapsed to record lows.

Body: (1) Factors behind the fall — technology, manufacturing scale, finance, policy/auctions; (2) implications for thermal producers — lower utilisation, stranded-asset risk; (3) implications for related industry — coal, equipment makers, storage and grid.

Conclusion: A managed, just transition rather than abrupt disruption.

KEY POINTS TO INCLUDE

- Module prices fell from ~$2.4/watt (2010) toward ~$0.10/watt, driven by learning-curve and over-capacity
- Indian solar auction tariffs hit record lows around Rs 2/kWh
- Bifacial modules and single-axis trackers raise the capacity utilisation factor
- Reverse auctions via SECI and large solar parks cut developer risk and price
- Low cost of borrowing and aggressive competitive bidding pushed tariffs down
- Cheap solar lowers coal plant load factors, raising stranded-asset and NPA risk
- Coal mining and rail freight demand soften; thermal equipment makers pivot to solar
- Rising need for battery storage, pumped hydro and grid strengthening to firm up solar

EXAMPLES & CASE STUDIES

- SECI reverse auctions reaching ~Rs 2/kWh solar tariffs
- Solar parks such as Bhadla (Rajasthan) and Pavagada (Karnataka)
- Bifacial modules with single-axis trackers
- Solar-plus-storage tenders bundling 4-hour battery capacity

MODEL ANSWER

> **Introduction:** Solar module prices have crashed — from a few dollars per watt at the start of the last decade to a small fraction of that today — and competitive auction tariffs in India have touched record lows near two rupees a unit, deeply reshaping the power market.
>
> **Factors behind the fall:**

- **Technology:** higher-efficiency crystalline-silicon cells, bifacial modules and single-axis trackers raise the capacity utilisation factor and squeeze cost per unit of output.
- **Manufacturing scale:** massive global over-capacity, automation and the learning-curve effect keep cutting the per-watt price year after year.
- **Finance and policy:** cheaper borrowing, transparent reverse auctions run through agencies like the Solar Energy Corporation of India, and ready-to-build solar parks remove land and clearance risk, letting developers bid aggressively.

Implications for thermal producers: Because cheap daytime solar is dispatched first, coal plants run for fewer hours, their plant load factors drop, and older, costlier units face stranded-asset risk and stressed bank loans. Fresh investment in new thermal capacity slows sharply, and some plants survive only by supplying flexibility and night-time balancing.

Implications for related industry: Coal mining and railway freight demand soften over time; thermal equipment makers pivot toward solar modules, inverters and balance-of-system supply; and demand surges for batteries, pumped-storage hydro and stronger transmission grids to firm up variable solar.

Conclusion: The trend pushes the system toward clean, low-cost power, but firm capacity and storage are still needed — so the goal is a managed, just transition that protects workers and grid reliability rather than abrupt closure.

SOURCES

→MNRE — Solar Energy
→Ministry of Power — Renewable Energy
→Ministry of Power — 500 GW Non-Fossil Fuel Target

solar tariff | reverse auction | capacity utilisation factor | plant load factor | stranded assets | learning curve | battery storage | just transition

Q120

Give an account of the current status and the targets to be achieved pertaining to renewable energy sources in the country. Discuss briefly the importance of the National Programme on Light Emitting Diodes (LEDs).

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | RENEWABLE TARGETS AND ENERGY EFFICIENCY | 2016

ANSWER OUTLINE

Introduction: Frame the twin track — scaling renewable supply and cutting wasteful demand.

Body: (1) Current status of renewables — capacity, leading sources, global rank; (2) targets — 500 GW non-fossil by 2030 and NDC commitments; (3) importance of the national LED programme (UJALA and street lighting) for demand-side efficiency.

Conclusion: Supply expansion and efficiency together deliver energy security with lower emissions.

KEY POINTS TO INCLUDE

- India is the world's third-largest renewable energy nation; non-fossil capacity ~280-290 GW
- Solar is the largest source (over half the RE fleet), followed by wind
- India crossed 50% of installed power capacity from non-fossil sources ahead of the 2030 target
- Headline target: 500 GW non-fossil capacity by 2030, ~50 GW added per year
- Paris NDC: ~50% electric capacity from non-fossil sources; large cut in emissions intensity
- UJALA (homes) and Street Lighting National Programme (SLNP) run by EESL
- Bulk procurement crashed LED prices and drove mass uptake of bulbs and streetlights
- LED programme saves tens of billions of kWh yearly and cuts peak demand by thousands of MW

EXAMPLES & CASE STUDIES

- UJALA domestic LED scheme (launched 2015)
- Street Lighting National Programme (SLNP) with over 1.3 crore LED streetlights
- Energy Efficiency Services Limited (EESL) as implementing agency
- Solar parks and wind clusters underpinning the 500 GW target

MODEL ANSWER

> **Introduction:** India is pursuing energy security on two complementary tracks — adding clean generation capacity and cutting wasteful electricity demand. The growth of renewables and the national LED push together advance both at once.

Current status: India is the world's third-largest renewable power nation, with non-fossil installed capacity now in the range of about 280–290 GW. Solar leads, making up over half the renewable fleet, followed by wind, with hydro, large bio-power and small hydro adding the balance. The country crossed the milestone of sourcing half its installed power capacity from non-fossil fuels well ahead of schedule.

Targets: The headline goal is 500 GW of non-fossil capacity by 2030, requiring roughly 50 GW of additions each year. Under the Paris Agreement Nationally Determined Contribution, India also aims to source about half its electric capacity from non-fossil sources and to cut the emissions intensity of its economy steeply by 2030.

Importance of the LED programme: The national LED effort runs through UJALA for households and the Street Lighting National Programme for municipalities, both implemented by Energy Efficiency Services Limited. Bulk demand-aggregation crashed the retail price of an LED bulb, putting crores of bulbs and over a crore of streetlights into use. It now saves tens of billions of kilowatt-hours every year, trims peak demand by thousands of megawatts and avoids tens of millions of tonnes of carbon — saving energy far more cheaply than building new plants.

Conclusion: Expanding renewable supply while curbing demand through efficient lighting delivers reliable, affordable and low-carbon energy.

SOURCES

- →MNRE — Renewable Energy Overview
- →MNRE — Energy Efficiency / UJALA
- →Ministry of Power — 500 GW Non-Fossil Fuel Target

500 GW non-fossil | renewable capacity | UJALA | Street Lighting National Programme | EESL | demand-side efficiency | peak demand | Paris NDC

Q121

Rehabilitation of human settlements is one of the important environmental impacts which always attract controversy while planning major projects. Discuss measures suggested for mitigation of this impact while proposing major developmental projects.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | DISPLACEMENT AND REHABILITATION | 2016

ANSWER OUTLINE

Introduction: Frame development-induced displacement as a recurring social-environmental impact of large projects.

Body: (1) Legal and policy mitigation — RFCTLARR Act, EIA and public hearings; (2) economic and livelihood measures — fair compensation, R&R packages, land-for-land, jobs; (3) participatory and social measures — consent, Gram Sabha, special safeguards for tribals, grievance redress.

Conclusion: Rehabilitation as a right and a planning input, not an afterthought.

KEY POINTS TO INCLUDE

- Development-induced displacement is a recurring social-environmental impact of large projects
- RFCTLARR Act, 2013 mandates Social Impact Assessment, consent and R&R entitlements
- EIA Notification requires public hearings before environmental clearance
- Compensation at enhanced market value plus solatium and resettlement allowance
- Resettlement package: house sites, civic amenities, land-for-land where feasible
- Livelihood restoration via jobs, skilling and annuity, not cash alone
- Special safeguards for Scheduled Tribes via Forest Rights Act 2006 and PESA 1996
- Gram Sabha consent and independent grievance-redress and monitoring mechanism

EXAMPLES & CASE STUDIES

- RFCTLARR Act, 2013
- EIA Notification public hearing process
- Forest Rights Act, 2006 and PESA, 1996 safeguards
- Sardar Sarovar resettlement and rehabilitation debate

MODEL ANSWER

> **Introduction:** Large dams, mines, highways and industrial parks often submerge or acquire inhabited land, displacing whole communities. This “development-induced displacement” is a social and environmental impact that controversy follows, and that careful planning must mitigate rather than ignore.
>
> **Legal and procedural measures:** The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 mandates a Social

Impact Assessment, consent thresholds for affected families and a defined schedule of resettlement entitlements. Separately, environmental clearance under the Environment Impact Assessment notification requires public hearings, so affected people can record their objections before a project is approved.

Economic and livelihood measures:

- Fair, transparent compensation reckoned at enhanced market value, with solatium and a resettlement allowance.
- A resettlement package covering house sites, roads, water, schools and health centres, and, where feasible, land-for-land instead of cash.
- Livelihood restoration through jobs, skilling and a long-term annuity, since one-time cash rarely rebuilds incomes.

Participatory and social measures: Genuine Gram Sabha consultation, prior informed consent, and stronger safeguards for Scheduled Tribes and forest-dwellers under the Forest Rights Act and PESA. An independent grievance-redress and monitoring mechanism then tracks whether the promises made are actually delivered.

Conclusion: Treating rehabilitation as an enforceable right and a built-in planning input — fully funded and time-bound from the outset — lets major projects proceed while protecting the dignity and livelihoods of displaced people.

SOURCES

→Department of Land Resources — RFCTLARR Act, 2013
→MoEFCC — EIA Notification
→Ministry of Tribal Affairs — Forest Rights Act

rehabilitation and resettlement | RFCTLARR Act 2013 | Social Impact Assessment | land-for-land | livelihood restoration | public hearing | Gram Sabha consent | grievance redress

Q122

Not many years ago, river linking was a concept but it is becoming a reality in the country. Discuss the advantages of river linking and its possible impact on the environment.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | INTER-BASIN WATER TRANSFER | 2017

ANSWER OUTLINE

Introduction: Define interlinking of rivers as inter-basin transfer under the National Perspective Plan, now moving from idea to construction.

Body: (1) Advantages — water security, irrigation, flood-drought balancing, hydropower, navigation; (2) environmental impacts — submergence, forest and biodiversity loss, altered flows; (3) the balance — safeguards and selective implementation.

Conclusion: A case-by-case, science-led approach with strong environmental safeguards.

KEY POINTS TO INCLUDE

- Interlinking transfers water from surplus to deficit basins under the National Perspective Plan
- Managed by National Water Development Agency (NWDA) under Ministry of Jal Shakti
- 30 identified links: 14 Himalayan and 16 Peninsular components
- Advantages: assured irrigation, drinking water, flood-drought balancing, hydropower, navigation
- Ken-Betwa is the first link under construction, serving Bundelkhand
- Ken-Betwa would submerge part of the Panna Tiger Reserve's core area
- Risks: deforestation, biodiversity and fish-migration loss, altered silt and downstream flow
- Concept of hydrological 'surplus' is scientifically contested

EXAMPLES & CASE STUDIES

- Ken-Betwa Link Project (Madhya Pradesh-Uttar Pradesh)
- National Perspective Plan and NWDA
- Panna Tiger Reserve submergence concern
- Polavaram / Godavari-Krishna peninsular transfers

MODEL ANSWER

> **Introduction:** Interlinking of rivers means transferring water from basins judged to be in surplus to those in deficit through a network of dams, canals and reservoirs. Conceived under the National Perspective Plan and steered by the National Water Development Agency, it has now moved from blueprint to construction.
>
> **Advantages:**
>
> - **Water security and irrigation:** moving “surplus” monsoon water to chronically drought-prone regions such as Bundelkhand expands assured irrigation and drinking-water supply.
> - **Flood and drought balancing:** diverting flood flows of the Ganga and Brahmaputra can reduce devastating floods in the east while relieving scarcity in

the water-short west and south.

- **Co-benefits:** additional hydropower generation, year-round inland navigation and inland fisheries.

Environmental impacts: Large new dams and long canals submerge land and forests — the Ken-Betwa link, for example, affects part of the core of the Panna Tiger Reserve. Inter-basin transfer can disturb river ecology and fish migration, cut the natural silt load that nourishes deltas, dry out wetlands and estuaries downstream, and even alter local rainfall by changing land-atmosphere feedback. The very premise that a basin has "surplus" water is itself contested by many hydrologists.

Conclusion: The gains in water and food security are real, but so are the ecological and social costs. A case-by-case, science-led approach — backed by rigorous environmental impact assessment, sound basin studies and firm biodiversity safeguards — should decide which links proceed and how.

SOURCES

→National Water Development Agency (NWDA)
→Ministry of Jal Shakti
→MoEFCC — Environmental Clearance

interlinking of rivers | inter-basin transfer | National Perspective Plan | NWDA | Ken-Betwa | Panna Tiger Reserve | water security | environmental impact assessment

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Q123

Sikkim is the first 'Organic State' in India. What are the ecological and economic benefits of an Organic State?

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | ORGANIC FARMING AND SUSTAINABLE AGRICULTURE | 2018

ANSWER OUTLINE

Introduction: Note Sikkim's 2016 declaration as India's first fully organic state via the Sikkim Organic Mission.

Body: (1) Ecological benefits — soil health, water and biodiversity, lower emissions; (2) economic benefits — premium prices, exports, tourism, lower input costs; (3) caveats — yield and certification challenges.

Conclusion: A replicable model for sustainable, climate-resilient agriculture.

KEY POINTS TO INCLUDE

- Sikkim declared India's first fully organic state in 2016
- Sikkim Organic Mission launched 2010; chemical fertilisers and pesticides phased out
- Certification via Sikkim State Organic Certification Agency to international standards
- Ecological gains: restored soil organic carbon, clean water, protected biodiversity
- Avoiding synthetic nitrogen cuts nitrous-oxide emissions and aids soil carbon
- Economic gains: price premiums, exports, lower input costs, higher farmer income (~20%)
- Eco-tourism surged (tourist arrivals up over 50% between 2014 and 2017)
- Supported nationally by Paramparagat Krishi Vikas Yojana and Jaivik Bharat / FSSAI organic norms

EXAMPLES & CASE STUDIES

- Sikkim Organic Mission (2010)
- Sikkim State Organic Certification Agency (SSOCA)
- Paramparagat Krishi Vikas Yojana (PKVY)
- FSSAI Jaivik Bharat organic logo

MODEL ANSWER

Introduction: In 2016 Sikkim was declared India’s first fully organic state. This was the fruit of the Sikkim Organic Mission begun in 2010, which phased out chemical fertilisers and pesticides and certified all its farmland to recognised organic standards through a dedicated state certification agency.

Ecological benefits:

- **Soil health:** compost, farmyard manure and crop rotation rebuild soil organic carbon and microbial life, reversing the degradation and hardening that long chemical use causes.
- **Water and biodiversity:** the absence of agro-chemical run-off keeps rivers and groundwater clean and protects pollinators, soil fauna and the fragile Himalayan ecosystems on which the state depends.
- **Climate:** avoiding synthetic nitrogen fertiliser cuts nitrous-oxide emissions and improves carbon sequestration in the soil.

Economic benefits: Certified organic produce earns clear price premiums and opens niche and export markets, and farmers reported meaningfully higher incomes after the switch. Input costs fall as households make their own compost rather than buy

fertiliser and pesticide. The organic identity also became a strong tourism brand, lifting visitor arrivals sharply, while better food quality and lower chemical exposure bring public-health gains.

Caveats: Lower yields during the transition years, the cost of certification and weak market linkages all need continued policy support.

Conclusion: Sikkim shows that an organic state can pair ecological restoration with rural prosperity, offering a replicable, climate-resilient model — backed nationally by schemes like the Paramparagat Krishi Vikas Yojana.

SOURCES

→Government of Sikkim — Sikkim Organic Mission
→Ministry of Agriculture — PKVY
→FSSAI — Organic Food

organic state | Sikkim Organic Mission | soil organic carbon | agro-chemical run-off | price premium | eco-tourism | Paramparagat Krishi Vikas Yojana | certification

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Q124

Define the concept of "carrying capacity" of an ecosystem as relevant to the environment. Explain how understanding this concept is vital while planning for sustainable development of a region.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | CARRYING CAPACITY & ECOLOGICAL LIMITS | 2019

ANSWER OUTLINE

Introduction: Define carrying capacity as the maximum population/use an ecosystem can support without degrading its resource base.

Body: (1) the two limbs — supportive (resource supply) and assimilative (waste absorption) capacity; (2) why it matters for planning — sets the ceiling for water, land, tourism, industry; (3) tools that operationalise it — EIA, eco-sensitive zones, the Niyamgiri and Himalayan-town cases.

Conclusion: living within capacity is the operational core of sustainable development.

KEY POINTS TO INCLUDE

- Carrying capacity = maximum sustainable load an ecosystem supports without degrading its resource base
- Two components: supportive capacity (resource supply) and assimilative capacity (waste absorption)

- Sets the upper limit for population, tourism, construction, water draft and industry in a region
- Operationalised through Environmental Impact Assessment (EIA) and eco-sensitive zones
- Joshimath and Shimla illustrate hill-town development exceeding slope and water carrying capacity
- Groundwater draft must stay below recharge; fish catch below replenishment rate
- Niyamgiri Supreme Court case applied ecological limits against bauxite mining
- Living within capacity is the operational measure of sustainable development

EXAMPLES & CASE STUDIES

- Joshimath subsidence — construction load exceeding Himalayan slope carrying capacity
- Western Ghats eco-sensitive zone demarcation (Gadgil/Kasturirangan reports)
- Niyamgiri Hills Supreme Court verdict (2013) on bauxite mining
- Tourist/vehicle caps in protected areas and tiger reserves
- Shimla water and construction stress from over-tourism

MODEL ANSWER

Introduction: Carrying capacity is the maximum population, level of use, or load that an ecosystem can sustain over time without degrading its natural resource base or its ability to regenerate. It marks the threshold beyond which further pressure causes irreversible damage.

Body: The concept has two limbs. **Supportive capacity** is the rate at which an ecosystem supplies resources — water, soil fertility, fish, fodder, forest produce. **Assimilative capacity** is its ability to absorb and neutralise waste, effluent and pollution without losing function. Sustainable development means keeping human pressure within both limits.

Understanding it matters for regional planning in three concrete ways.

- **Sets the planning ceiling:** it tells planners how many people, vehicles, hotels, or factories a region can safely hold — vital for fragile hill towns like Joshimath and Shimla, where construction and tourist load outran slope stability and water supply.
- **Guides resource allocation:** groundwater draft is kept below recharge, grazing below pasture regeneration, and fish catch below the replenishment rate, so the resource keeps renewing itself.

- **Anchors regulation:** it underpins Environmental Impact Assessment, the eco-sensitive zones around the Western Ghats, and tourist and vehicle caps in protected areas.

The Niyamgiri verdict, which weighed bauxite mining against the hill's ecological and tribal limits, shows the principle applied judicially.

Conclusion: Understanding carrying capacity converts "sustainability" from a slogan into a measurable budget. Planning a region's growth within its supportive and assimilative limits is the surest way to keep development from eroding the very base it stands on.

SOURCES

→MoEFCC — Environmental Impact Assessment Notification
→Ministry of Environment, Forest & Climate Change

carrying capacity | supportive capacity | assimilative capacity | sustainable development | eco-sensitive zone | Environmental Impact Assessment | ecological threshold | resource regeneration

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Q125

What are the salient features of the Jal Shakti Abhiyan launched by the Government of India for water conservation and water security?

10 MARKS | 150 WORDS | 9 MIN | EASY | WATER CONSERVATION CAMPAIGNS | 2020

ANSWER OUTLINE

Introduction: Name the campaign — a time-bound, mission-mode water conservation drive by the Ministry of Jal Shakti, first run in 2019.

Body: (1) targeted water-stressed blocks and districts; (2) five focused interventions; (3) convergence, Jan Andolan and theme-based annual editions.

Conclusion: a campaign that turns water conservation into a people's movement.

KEY POINTS TO INCLUDE

- Run by the Ministry of Jal Shakti; first launched in 2019 as a time-bound, mission-mode campaign
- First edition targeted around 1,592 water-stressed blocks across 256 districts
- Five interventions: rainwater harvesting, renovation of water bodies, reuse/recharge structures, watershed development, intensive afforestation
- Convergence of central officers with district and panchayat administration

- Citizen-driven Jan Andolan with school and community participation
- Later editions ran under the 'Catch the Rain' theme
- Aim is source sustainability and long-term groundwater recharge
- Covers both southwest and northeast monsoon windows

EXAMPLES & CASE STUDIES

- Catch the Rain — 'Catch the rain, where it falls, when it falls' annual theme
- Renovation of traditional tanks, ponds and stepwells
- Watershed development under convergence with MGNREGA works
- Intensive afforestation drives in campaign districts

MODEL ANSWER

Introduction: Jal Shakti Abhiyan is a time-bound, mission-mode water conservation campaign run by the Ministry of Jal Shakti, first launched in 2019 to accelerate rainwater harvesting and groundwater recharge.

Salient features:

- **Targeted geography:** the first edition focused on around 1,592 water-stressed blocks across 256 districts, where extraction had outpaced recharge.
- **Five focused interventions:** rainwater harvesting and water conservation, renovation of traditional water bodies, reuse and recharge structures, watershed development, and intensive afforestation.
- **Convergence and field teams:** central officers and technical staff worked alongside district and panchayat machinery to prepare and execute water conservation plans on the ground.
- **Twin monsoon windows:** the drive ran across both the southwest and northeast monsoon periods to maximise capture.
- **Jan Andolan:** citizen participation, school drives and the later “Catch the Rain” theme made water saving a people’s movement.

Conclusion: By combining sharp targeting, inter-ministerial convergence and mass participation, the campaign strengthens long-term water security at the source.

SOURCES

→Ministry of Jal Shakti — Jal Shakti Abhiyan
→Jal Shakti Abhiyan — Catch the Rain portal

Jal Shakti Abhiyan | Ministry of Jal Shakti | water-stressed blocks | rainwater harvesting | groundwater recharge | Catch the Rain | Jan Andolan | watershed development

Q126

The world is facing an acute shortage of clean and safe freshwater. What are the alternative technologies which can solve this crisis? Briefly discuss any three such technologies citing their key merits and demerits.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | FRESHWATER TECHNOLOGIES | 2024

ANSWER OUTLINE

Introduction: Frame the freshwater stress and the range of engineered alternatives.

Body: Discuss three technologies, each with merits and demerits — (1) desalination (reverse osmosis); (2) wastewater treatment and reuse; (3) atmospheric water generation / fog harvesting.

Conclusion: a portfolio approach matched to local conditions, paired with demand-side conservation.

KEY POINTS TO INCLUDE

- Over two billion people lack safely managed drinking water — the demand-side context
- Desalination uses reverse-osmosis membranes; near-limitless coastal source but energy-intensive with harmful brine
- Chennai's Minjur and Nemmeli plants are real desalination examples
- Wastewater reuse is drought-proof and cheaper than desalination but faces 'toilet-to-tap' stigma
- Atmospheric water generation and fog harvesting are decentralised but humidity-dependent and low-yield
- Brine discharge raises salinity and damages marine ecosystems
- Each answer must pair merits with demerits explicitly
- Portfolio approach plus demand-side conservation is the way forward

EXAMPLES & CASE STUDIES

- Minjur and Nemmeli seawater desalination plants, Chennai
- Singapore NEWater — high-grade recycled wastewater
- Israel's large-scale reverse-osmosis desalination
- Fog-harvesting nets in arid hill and coastal communities

- Per Drop More Crop micro-irrigation as the demand-side complement

MODEL ANSWER

Introduction: With over two billion people lacking safely managed drinking water, several engineered technologies now supplement rivers and aquifers. Three stand out, each carrying clear trade-offs between cost, energy and reliability.

1. Desalination (reverse osmosis): seawater is forced through semi-permeable membranes that strip out salts to yield potable water. *Merits* — a near-limitless, drought-proof source ideal for coastal cities, with mature technology; the Minjur and Nemmeli plants supply Chennai. *Demerits* — very energy-intensive and capital-heavy, and the concentrated brine discharged back to sea raises salinity and harms marine life.

2. Wastewater treatment and reuse: municipal sewage is purified through multi-stage treatment for irrigation, industry or even drinking. *Merits* — a continuously generated, drought-proof supply that also reduces pollution of rivers, and it is far cheaper than desalination. *Demerits* — it needs costly advanced infrastructure, and the "toilet-to-tap" stigma slows public acceptance despite rigorous purification.

3. Atmospheric water generation and fog harvesting: moisture is condensed from air or trapped on mesh nets. *Merits* — decentralised and useful in remote or emergency settings; fog nets are low-cost and almost energy-free. *Demerits* — output depends heavily on humidity, so yields stay small and unreliable in the arid regions that need water most.

Conclusion: No single fix works everywhere — coastal cities suit desalination, urban areas suit reuse, and humid uplands suit fog harvesting. A locally matched portfolio, combined with strong demand-side conservation, offers the durable answer to freshwater stress.

SOURCES

→Ministry of Jal Shakti — Department of Water Resources
→UN-Water — Water Scarcity

desalination | reverse osmosis | wastewater reuse | atmospheric water generation | fog harvesting | brine discharge | freshwater security | demand-side conservation

Q127

Examine the factors responsible for depleting groundwater in India. What are the steps taken by the government to mitigate such depletion of groundwater?

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | GROUNDWATER DEPLETION & MANAGEMENT | 2025

ANSWER OUTLINE

Introduction: India is the world's largest groundwater user; over-extraction has pushed many blocks past recharge.

Body: (1) factors — agricultural over-draft, power/MSP subsidies, urban demand, weak regulation; (2) government steps — Atal Bhujal Yojana, Jal Shakti Abhiyan, CGWB/NAQUIM, micro-irrigation.

Conclusion: demand management plus community-led recharge is the durable path.

KEY POINTS TO INCLUDE

- India is the world's largest user of groundwater; a large share of assessed units are over-exploited or critical
- Agriculture consumes the bulk of groundwater; paddy and sugarcane are water-intensive
- Roughly 20 million borewells drive extraction beyond recharge
- Free/subsidised power and crop procurement distort incentives toward over-pumping
- Atal Bhujal Yojana (Atal Jal) — community-led demand-side management with water-security plans
- CGWB aquifer mapping (NAQUIM) and Central Ground Water Authority regulate extraction
- Per Drop More Crop under PMKSY promotes drip and sprinkler micro-irrigation
- Jal Jeevan Mission piped supply reduces reliance on private bore-wells

EXAMPLES & CASE STUDIES

- Atal Bhujal Yojana priority states (Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh)
- Central Ground Water Board (CGWB) periodic groundwater resource assessment
- NAQUIM National Aquifer Mapping and Management Programme
- Jal Shakti Abhiyan and Mission Amrit Sarovar recharge works
- Punjab–Haryana paddy belt as an over-exploited zone

MODEL ANSWER

Introduction: India draws more groundwater than any other country, and the Central Ground Water Board reports a large share of assessed units as over-exploited or critical, where extraction exceeds annual recharge.

Factors responsible for depletion:

- **Agricultural over-draft:** farming consumes the bulk of groundwater; water-guzzling paddy and sugarcane, with about 20 million borewells, drive extraction.
- **Distorted incentives:** free or subsidised power and assured procurement of water-intensive crops encourage continuous pumping.
- **Urban and industrial demand:** unregulated private bore-wells in fast-growing cities and industrial clusters deepen the deficit.
- **Weak regulation, lost recharge and erratic monsoon:** concretisation of catchments, loss of traditional tanks and uneven rainfall all cut natural replenishment.

Government steps: Atal Bhujal Yojana funds community-led, demand-side groundwater management through participatory water-security plans in seven priority states. Jal Shakti Abhiyan and Mission Amrit Sarovar boost rainwater harvesting and recharge structures. The CGWB's aquifer-mapping programme (NAQUIM) prepares area-specific management plans, and the Central Ground Water Authority regulates extraction. Per Drop More Crop under PMKSY pushes drip and sprinkler micro-irrigation to cut farm demand, while Jal Jeevan Mission's assured piped supply reduces household reliance on private bore-wells.

Conclusion: Stopping depletion needs less pumping, not just more recharge. Pairing community-managed demand control with crop diversification away from paddy, rational power pricing, and large-scale recharge structures offers the most durable safeguard for India's stressed aquifers and the food security that rests on them.

SOURCES

→Central Ground Water Board (CGWB)
→Ministry of Jal Shakti — Atal Bhujal Yojana

groundwater depletion | over-exploited blocks | Atal Bhujal Yojana | Central Ground Water Board | NAQUIM aquifer mapping | Per Drop More Crop | micro-irrigation | demand-side management

Q128

What is Carbon Capture, Utilization and Storage (CCUS)? What is the potential role of CCUS in tackling climate change?

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | CARBON CAPTURE & CLIMATE MITIGATION | 2025

ANSWER OUTLINE

Introduction: Define CCUS as the chain of capturing CO2, using it, and storing the rest.

Body: (1) the three steps; (2) role in hard-to-abate sectors; (3) link to net-zero and carbon removal.

Conclusion: a bridge technology, not a substitute for emission cuts.

KEY POINTS TO INCLUDE

- CCUS = capturing CO2 at source or from air, utilising it, and storing the remainder
- Sources include power, steel, cement, refineries and direct air capture (DAC)
- Utilisation: synthetic fuels, chemicals, building materials, enhanced oil recovery
- Storage: injection into deep saline aquifers and depleted reservoirs
- Key for hard-to-abate sectors with unavoidable process emissions (cement, steel, fertiliser)
- Supports India's net-zero-by-2070 commitment
- Enables negative emissions when paired with bioenergy (BECCS) or DAC
- A bridge technology that complements, not replaces, emission reduction

EXAMPLES & CASE STUDIES

- NITI Aayog CCUS policy framework study report
- Cement-sector CCUS as a hard-to-abate use case
- BECCS — bioenergy with carbon capture and storage
- Direct Air Capture (DAC) for atmospheric removal
- Captured CO2 used in synthetic fuels and building aggregates

MODEL ANSWER

> **What is CCUS:** Carbon Capture, Utilization and Storage is a set of technologies that capture carbon dioxide at its source — power plants, steel, cement, refineries — or directly from air, then either use it to make fuels, chemicals and building materials, or inject it into deep geological formations for permanent storage.
>
> **Potential role in tackling climate change:**

- **Decarbonising hard-to-abate sectors:** cement, steel and fertiliser have process emissions that renewables alone cannot remove; CCUS offers a route to cut them.
- **Reaching net-zero:** by abating residual emissions and converting captured CO2 into useful products, it supports India's 2070 net-zero goal.
- **Carbon removal:** paired with bioenergy or direct air capture, it can deliver negative emissions to offset what cannot be eliminated.

Conclusion: CCUS is a vital bridge for industries that are otherwise difficult to clean up, but it complements rather than replaces the core task of cutting emissions at source.

SOURCES

→NITI Aayog — CCUS Policy Framework report (PIB)
→Ministry of Environment, Forest & Climate Change

Carbon Capture Utilization and Storage | hard-to-abate sectors | net-zero 2070 | direct air capture | geological storage | negative emissions | BECCS | decarbonisation

GS PAPER 3

Climate Change

6 practice questions

Q129

Should the pursuit of carbon credit and clean development mechanism set up under the UNFCCC be maintained, even though there has been a massive slide in the value of carbon credit? Discuss with respect to India's energy needs for economic growth.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | CARBON MARKETS & CDM | 2014

ANSWER OUTLINE

Introduction: Define the Clean Development Mechanism (CDM) and carbon credits (CERs) under the Kyoto Protocol, and note the post-2012 price collapse.

Body: (1) Why the value slid — surplus credits, weak demand, expiry of the first commitment period. (2) The case to retain it — cheapest abatement route, technology and finance transfer, jobs in renewables for a developing economy. (3) Link to India's energy needs — coal-heavy base, rising demand, and how market mechanisms square growth with low-carbon transition.

Conclusion: Keep the architecture but reform it toward the Paris Article 6 market.

KEY POINTS TO INCLUDE

- CDM and Joint Implementation and International Emissions Trading are the three flexible mechanisms of the Kyoto Protocol (1997)
- Carbon credits under CDM are called Certified Emission Reductions (CERs)
- CER prices collapsed after 2012 due to oversupply and weak demand at the close of the first commitment period
- India was among the largest hosts of registered CDM projects (renewables, biomass, energy efficiency)
- Mechanism transfers clean technology and climate finance to developing countries at lowest abatement cost
- Principle of Common But Differentiated Responsibilities (CBDR) under the UNFCCC underpins India's stance
- Paris Agreement Article 6 provides the successor framework for international carbon markets

- India's coal-heavy electricity mix and rising demand make market-based incentives valuable for a low-carbon transition

EXAMPLES & CASE STUDIES

- India's registered CDM wind and biomass projects earning CERs
- Waste-heat recovery and energy-efficiency CDM projects in Indian cement and steel plants
- Kyoto Protocol first commitment period 2008-2012 and its CER surplus
- Transition to Article 6 carbon markets under the Paris Agreement
- Perform Achieve Trade (PAT) scheme as a domestic market-based efficiency instrument

MODEL ANSWER

Introduction: The Clean Development Mechanism (CDM), set up under the 1997 Kyoto Protocol, lets developed nations meet their targets by funding emission-cutting projects in developing countries, which earn tradable carbon credits called Certified Emission Reductions (CERs). After 2012 their price slid from over €20 to near zero, raising doubts about whether the model is still worth pursuing.

Body:

- **Why the value fell:** a glut of issued credits, the close of the Kyoto first commitment period, and weak demand as several developed economies dropped or watered down their binding targets together crashed the CER price. With no buyers, the market signal that was meant to reward clean investment all but vanished.
- **The case to retain it:** the mechanism still channels low-cost finance and clean technology to where abatement is cheapest. India hosted one of the largest shares of registered CDM projects, spanning wind, biomass, and waste-heat recovery in cement and steel plants, building local capacity, manufacturing, and green jobs. Scrapping it would punish the very economies that built projects in good faith.
- **India's energy needs:** a fast-growing economy with a coal-heavy base must expand power supply while bending the emissions curve. Carbon markets let India earn revenue for renewables and efficiency gains, squaring growth with the equity principle of common but differentiated responsibilities.

Conclusion: The architecture should be kept but reformed — capping supply, restoring demand, and migrating to the Paris Agreement's Article 6 market — so it once again rewards clean investment in growing economies.

SOURCES

→UNFCCC — Clean Development Mechanism (CDM)
→UNFCCC — What is the Kyoto Protocol
→MoEFCC — Climate Change

Clean Development Mechanism | Certified Emission Reductions | carbon credit | Kyoto Protocol | UNFCCC | Common But Differentiated Responsibilities | Article 6 | low-carbon transition

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Q130

'Climate change' is a global problem. How will India be affected by climate change? How will the Himalayan and coastal states of India be affected?

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | REGIONAL VULNERABILITY & IMPACTS | 2017

ANSWER OUTLINE

Introduction: Frame climate change as a global problem with sharply unequal local impacts, and note India's high exposure.

Body: (1) National impacts — agriculture, monsoon, health, water. (2) Himalayan states — glacial retreat, GLOFs, springs drying. (3) Coastal states — sea-level rise, cyclones, saline intrusion, fisheries.

Conclusion: Anchor in the National Action Plan on Climate Change and adaptation-led resilience.

KEY POINTS TO INCLUDE

- India is among the most climate-vulnerable countries due to long coastline, Himalayan cryosphere and monsoon dependence
- National Action Plan on Climate Change (NAPCC, 2008) with eight missions guides India's response
- State Action Plans on Climate Change operationalise NAPCC at the regional level
- Himalayan impacts: glacial retreat, Glacial Lake Outburst Floods (GLOFs), drying springs, altered river flow
- Coastal impacts: sea-level rise, intensified cyclones, saline intrusion, mangrove and fishery loss
- Agriculture: erratic monsoon and heat stress threaten rain-fed crop yields and food security
- Health: rising temperatures expand vector-borne diseases and heatwave mortality
- National Mission for Sustaining the Himalayan Ecosystem addresses cryosphere risks

EXAMPLES & CASE STUDIES

- Sundarbans mangrove erosion and island submergence in West Bengal
- Chamoli (2021) and Sikkim South Lhonak Lake GLOF events in the Himalaya
- Cyclones Fani, Amphan and Tauktae hitting the eastern and western coasts
- Saline intrusion in the Krishna-Godavari and Kerala coastal deltas
- National Action Plan on Climate Change and its eight national missions

MODEL ANSWER

Introduction: Climate change is global in cause but local in effect. India, with a long coastline, the Himalayan cryosphere, and a monsoon-dependent farm economy, ranks among the most exposed countries, so the impacts fall unevenly across its regions and demand region-specific responses.

Body:

- **National-level impacts:** an erratic monsoon and rising heat threaten rain-fed agriculture, crop yields, and water security; warmer temperatures widen the spread of vector-borne diseases such as malaria and dengue; and extreme events — floods, droughts, and heatwaves — grow more frequent and severe, hurting the rural and urban poor hardest of all.
- **Himalayan states:** warming drives glacial retreat, the swelling and bursting of glacial lakes (GLOFs), and the drying of mountain springs that feed perennial rivers. Uttarakhand, Himachal Pradesh, and Sikkim face landslides, altered flows in the Ganga and Brahmaputra, and risks to hydropower and tourism.
- **Coastal states:** sea-level rise and intensifying cyclones threaten Odisha, Tamil Nadu, Kerala, and West Bengal. Saline intrusion damages farmland and aquifers, the Sundarbans mangroves and low-lying islands erode, and warming, acidifying seas disrupt fisheries and the livelihoods that depend on them. Storm surge and coastal flooding also threaten ports, refineries, and dense urban settlements.

Conclusion: A region-specific response under the National Action Plan on Climate Change and the State Action Plans — protecting glaciers, coasts, and farms together — is essential to build resilience across these varied landscapes.

SOURCES

→MoEFCC — National Action Plan on Climate Change
→MoES — India Meteorological Department
→UNFCCC — What is Climate Change

climate vulnerability | glacial retreat | GLOF | sea-level rise | saline intrusion | monsoon variability | NAPCC | adaptation

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Q131

Describe the major outcomes of the 26th session of the Conference of the Parties (COP) to the UNFCCC. What commitments did India make at this conference?

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | UNFCCC NEGOTIATIONS & INDIA'S PLEDGES | 2021

ANSWER OUTLINE

Introduction: Place the 26th COP at Glasgow (2021) and name its headline deal, the Glasgow Climate Pact.

Body: (1) Global outcomes — coal phase-down, methane pledge, Article 6, 1.5°C. (2) Finance and adaptation outcomes. (3) India's five-fold Panchamrit pledge and LIFE.

Conclusion: Note the gap between pledges and the carbon budget, and the road to delivery.

KEY POINTS TO INCLUDE

- 26th COP held at Glasgow in 2021; outcome named the Glasgow Climate Pact
- First COP decision to call for phase-down of unabated coal and inefficient fossil-fuel subsidies
- Global Methane Pledge: cut methane emissions 30% by 2030 (signed by 100-plus countries)
- Article 6 rulebook on international carbon markets finalised, completing the Paris rulebook
- 1.5°C reaffirmed as the central temperature goal; countries asked to revisit 2030 targets
- India's Panchamrit: 500 GW non-fossil capacity by 2030; 50% energy from renewables by 2030
- India: cut projected emissions by 1 billion tonnes and carbon intensity by 45% by 2030; net-zero by 2070
- India launched Lifestyle for Environment (LIFE) to promote sustainable consumption

EXAMPLES & CASE STUDIES

- Glasgow Climate Pact (2021)
- Panchamrit five-fold pledge announced by India

- Global Methane Pledge
- Glasgow Leaders' Declaration on Forests and Land Use
- Lifestyle for Environment (LIFE) initiative

MODEL ANSWER

Introduction: The 26th session, held at Glasgow in 2021, produced the Glasgow Climate Pact, the first global climate deal to explicitly target coal and to keep the 1.5°C goal alive as the guiding limit on warming.

Body:

- **Mitigation outcomes:** nations agreed for the first time to "phase down" unabated coal power and inefficient fossil-fuel subsidies; over 100 countries joined a Global Methane Pledge to cut methane 30% by 2030; and a separate leaders' declaration aimed to halt and reverse deforestation by 2030.
- **Rules and finance:** the long-pending Article 6 rulebook on international carbon markets was finalised, completing the Paris rulebook. Developed countries were pressed on the unmet 100-billion-dollar annual climate-finance promise, adaptation finance was set to double, and a work programme on the global goal on adaptation was launched.
- **India's commitments (Panchamrit):** 500 GW of non-fossil installed capacity by 2030; meeting 50% of energy needs from renewables by 2030; a one-billion-tonne cut in projected emissions by 2030; a 45% cut in the economy's carbon intensity by 2030 over 2005 levels; and net-zero by 2070. India also launched the Lifestyle for Environment (LIFE) idea, urging mindful, low-waste consumption rather than mindless use of resources.

Conclusion: The Pact narrowed but did not fully close the emissions gap to 1.5°C, leaving delivery, climate finance, and equity between developed and developing nations as the real tests of its ambition.

SOURCES

→UNFCCC — The Glasgow Climate Pact: Key Outcomes from COP26
→PIB — India's Stand at COP-26
→MoEFCC — Climate Change

Glasgow Climate Pact | Panchamrit | net-zero 2070 | coal phase-down | Article 6 | Global Methane Pledge | LIFE | climate finance

Q132

Discuss global warming and mention its effects on the global climate. Explain the control measures to bring down the level of greenhouse gases which cause global warming, in the light of the Kyoto Protocol (1997).

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | GREENHOUSE GASES & KYOTO PROTOCOL | 2022

ANSWER OUTLINE

Introduction: Define global warming and name the main greenhouse gases.

Body: (1) Effects on global climate. (2) The Kyoto Protocol's binding-target approach for Annex I countries. (3) Its three flexible mechanisms as control measures.

Conclusion: Bridge to the Paris Agreement as the broader successor.

KEY POINTS TO INCLUDE

- Global warming is the long-term rise in Earth's average surface temperature from greenhouse-gas buildup
- Main GHGs: carbon dioxide, methane, nitrous oxide and fluorinated gases
- Effects: sea-level rise, ocean acidification, erratic monsoons, heatwaves, droughts and intense storms
- Kyoto Protocol (1997) set binding emission targets only on developed (Annex I) countries
- Reflects the principle of Common But Differentiated Responsibilities (CBDR)
- Three flexible mechanisms: International Emissions Trading, Clean Development Mechanism, Joint Implementation
- CDM lets developed nations fund clean projects in developing countries for carbon credits (CERs)
- Paris Agreement (2015) is the universal successor with nationally determined contributions

EXAMPLES & CASE STUDIES

- International Emissions Trading of Assigned Amount Units among Annex I countries
- Clean Development Mechanism projects (wind, biomass) hosted in India
- Joint Implementation projects between developed nations with economies in transition
- Kyoto first commitment period 2008-2012
- Paris Agreement (2015) as the successor framework

MODEL ANSWER

Introduction: Global warming is the long-term rise in Earth's average surface temperature, driven by greenhouse gases (GHGs) — chiefly carbon dioxide, methane, and nitrous oxide — that trap outgoing heat in the atmosphere. The 1997 Kyoto Protocol was the first treaty to set legally binding limits on these gases.

Body:

- **Effects on global climate:** melting glaciers and polar ice raise sea levels and threaten coasts; ocean warming and acidification harm coral reefs and fisheries; monsoon and rainfall patterns turn erratic; and heatwaves, droughts, and intense storms grow more frequent, stressing food, water, and health systems worldwide.
- **Kyoto's binding approach:** the Protocol placed quantified, legally binding emission-reduction targets on developed (Annex I) countries for the 2008-2012 first commitment period while exempting developing ones, reflecting the principle of common but differentiated responsibilities.
- **Control measures (flexible mechanisms):** it created three market tools to cut costs — International Emissions Trading, where countries trade surplus emission allowances; the Clean Development Mechanism (CDM), funding clean projects in developing nations in return for carbon credits; and Joint Implementation, where one developed country invests in emission cuts within another. Alongside the market tools, the treaty encouraged carbon sinks through afforestation and a shift to cleaner energy and industrial practices.

Conclusion: Kyoto pioneered legally binding cuts but covered only a slice of global emissions, so the 2015 Paris Agreement, with universal nationally determined pledges, now carries the effort forward.

SOURCES

→UNFCCC — What is the Kyoto Protocol
→UNFCCC — Mechanisms under the Kyoto Protocol
→MoEFCC — Climate Change

global warming | greenhouse gases | Kyoto Protocol | Annex I | flexible mechanisms | Clean Development Mechanism | emissions trading | Paris Agreement

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Q133

The Intergovernmental Panel on Climate Change (IPCC) has predicted a global sea level rise of about one metre by AD 2100. What would be its

impact on India and the other countries in the Indian Ocean region?

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | SEA-LEVEL RISE & INDIAN OCEAN REGION | 2023

ANSWER OUTLINE

Introduction: Note the IPCC projection and the special exposure of low-lying coasts and islands.

Body: (1) Impacts on India's coasts and deltas. (2) Impacts on Indian Ocean island and littoral states. (3) Economic, ecological and security dimensions.

Conclusion: Point to adaptation and regional cooperation.

KEY POINTS TO INCLUDE

- IPCC AR6 projects up to about one metre of sea-level rise by 2100 under high-emission scenarios
- India's roughly 7,500-km coastline and major deltas are highly exposed
- Coastal megacities Mumbai, Chennai and Kolkata face increased flooding
- Sundarbans and other mangroves erode; saline intrusion hits farmland and aquifers
- Low islands such as Lakshadweep and the Maldives face partial or near-total submergence
- Bangladesh's Ganga-Brahmaputra delta is among the most vulnerable in the region
- Knock-on effects: climate migration, port and fishery losses, coral-reef damage
- Indian Ocean Rim Association (IORA) and ICZM provide cooperation and protection frameworks

EXAMPLES & CASE STUDIES

- Maldives, an atoll nation barely a metre above sea level
- Sundarbans delta of India and Bangladesh
- Coastal flooding risk to Mumbai, Chennai and Kolkata
- Lakshadweep low-lying islands
- Integrated Coastal Zone Management (ICZM) project in India

MODEL ANSWER

> **Introduction:** A roughly one-metre rise in sea level by 2100, as projected under high-emission scenarios, would reshape the densely settled, low-lying coasts and islands of the Indian Ocean region, where millions of people live and work within a few metres of the sea.
>
> **Body:**

- **Impact on India:** a coastline of about 7,500 km and major river deltas are exposed. Cities like Mumbai, Chennai, and Kolkata face more frequent flooding and storm surge; the Sundarbans and other mangroves erode; saline intrusion damages farmland and drinking-water aquifers; and fishing communities are displaced. The Lakshadweep and other low-lying islands risk partial submergence, loss of freshwater lenses, and damage to their fragile coral ecosystems.
- **Indian Ocean states:** atoll nations such as the Maldives, lying barely a metre above sea level, face an existential threat to their territory; Bangladesh's Ganga-Brahmaputra delta could lose large tracts and displace millions; and Sri Lanka, Indonesia, and the East African coast face shoreline retreat, loss of beaches, and inundation of coastal infrastructure.
- **Cross-cutting effects:** losses to ports, tourism, and fisheries; large-scale climate-driven migration and displacement; damaged coral reefs and coastal wetlands that naturally buffer storms; and heightened geopolitical tension over shared freshwater, fisheries, and maritime territory between neighbouring states.

Conclusion: Coastal protection, restored mangroves, integrated coastal-zone management, early-warning systems, and regional cooperation through bodies like IORA are vital to manage this shared and rising threat.

SOURCES

→IPCC — Sixth Assessment Report (AR6)
→MoEFCC — Integrated Coastal Zone Management
→MoES — National Centre for Coastal Research

sea-level rise | IPCC AR6 | Sundarbans | saline intrusion | Maldives | coastal vulnerability | climate migration | IORA

Q134

Write a review on India's climate commitments under the Paris Agreement (2015) and mention how these have been further strengthened in COP26 (2021). In this direction, how has the first Nationally Determined Contribution intended by India been updated in 2022?

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | PARIS AGREEMENT, COP26 & INDIA'S NDC | 2025

ANSWER OUTLINE

Introduction: Frame India's pledge architecture from Paris (2015) to the 2022 NDC update.

Body: (1) Original Paris (2015) commitments. (2) Strengthening at COP26 via Panchamrit. (3) What the 2022 updated NDC formalised.

Conclusion: Assess credibility and the equity dimension.

KEY POINTS TO INCLUDE

- India's first NDC (Paris, 2015): cut emissions intensity of GDP 33-35% by 2030 over 2005
- First NDC also targeted about 40% non-fossil installed power capacity by 2030
- First NDC included an additional carbon sink of 2.5-3 billion tonnes CO2-equivalent via forest cover
- COP26 Panchamrit (2021) raised ambition with five commitments including net-zero by 2070
- Updated NDC (August 2022) raised emissions-intensity cut to 45% by 2030 over 2005
- Updated NDC raised non-fossil cumulative installed power capacity target to about 50% by 2030
- Updated NDC embedded Lifestyle for Environment (LIFE) as a behaviour-change pillar
- Targets rest on equity and Common But Differentiated Responsibilities, with support from finance and technology

EXAMPLES & CASE STUDIES

- India's first NDC under the Paris Agreement (2015)
- Panchamrit pledge at COP26 Glasgow (2021)
- Updated First NDC communicated to the UNFCCC in August 2022
- Net-zero by 2070 target
- Lifestyle for Environment (LIFE) initiative

MODEL ANSWER

> **Introduction:** India’s climate pledges have steadily deepened — from its first Nationally Determined Contribution (NDC) under the 2015 Paris Agreement, through the COP26 Panchamrit announcement, to the formal NDC update of 2022 communicated to the UNFCCC.
>
> **Body:**
>
> - **Paris Agreement (2015):** India’s first NDC promised to cut the emissions intensity of GDP by 33-35% by 2030 over 2005 levels, reach about 40% of installed power capacity from non-fossil sources by 2030, and create an additional carbon sink of 2.5-3 billion tonnes of CO2-equivalent through extra forest and tree cover.

- **Strengthening at COP26 (2021):** the Panchamrit raised ambition across five fronts — 500 GW of non-fossil capacity and meeting 50% of energy needs from renewables by 2030, a one-billion-tonne cut in projected emissions, a 45% carbon-intensity cut by 2030 over 2005 levels, and the headline goal of net-zero by 2070.
- **Updated NDC (2022):** the Union Cabinet formalised two enhanced targets — a 45% cut in emissions intensity of GDP by 2030 (up from 33-35%) and about 50% of cumulative installed power capacity from non-fossil sources by 2030 (up from 40%) — and embedded the Lifestyle for Environment (LIFE) message as a behaviour-change pillar, while keeping the net-zero by 2070 goal as the long-term anchor.

Conclusion: The progression from Paris to the 2022 update shows rising ambition anchored in equity and common but differentiated responsibilities, though delivery hinges on adequate finance and technology support.

SOURCES

→UNFCCC — India's Updated First Nationally Determined Contribution (2022)
→PMINDIA — Cabinet approves India's Updated NDC
→PIB — India to reduce Emissions Intensity of GDP by 45% by 2030

Paris Agreement | Nationally Determined Contribution | Panchamrit | emissions intensity | non-fossil capacity | net-zero 2070 | LIFE | carbon sink

GS PAPER 3

Ecosystems

5 practice questions

Q135

What is a wetland? Explain the Ramsar concept of 'wise use' in the context of wetland conservation. Cite two examples of Ramsar sites from India.

15 MARKS | 250 WORDS | 11 MIN | EASY | WETLANDS & RAMSAR CONVENTION | 2018

ANSWER OUTLINE

Introduction: Define a wetland using the Ramsar Convention's own wording (the <6 m low-tide rule).

Body: (1) What 'wise use' means — maintaining ecological character within sustainable development; (2) how it works in practice (ecosystem-services lens, no-net-loss, community use); (3) two named Indian Ramsar sites with a line on each.

Conclusion: Wise use balances livelihoods and ecology; link to India's domestic rules.

KEY POINTS TO INCLUDE

- Ramsar definition: marsh/fen/peatland/water, incl. marine water up to 6 m deep at low tide
- Convention on Wetlands adopted at Ramsar, Iran (1971); India a Contracting Party since 1982
- 'Wise use' = sustainable use maintaining the wetland's ecological character within sustainable development
- Ecological character = the components, processes and benefits/services of the wetland
- Wise use balances human livelihoods (fishing, tourism) with ecosystem-service protection
- India has the highest number of Ramsar sites in South Asia (99 sites by 2026)
- Chilika Lake (Odisha) — largest brackish coastal lagoon, Irrawaddy dolphins
- Keoladeo National Park (Rajasthan) — man-made waterfowl wetland, also a World Heritage Site
- Wetlands (Conservation and Management) Rules, 2017 give domestic effect to the principle

EXAMPLES & CASE STUDIES

- Chilika Lake, Odisha
- Keoladeo National Park, Bharatpur, Rajasthan
- Wetlands (Conservation and Management) Rules, 2017
- Convention on Wetlands, Ramsar 1971

MODEL ANSWER

Introduction: A wetland is land that stays saturated or covered by water for part or all of the year, sitting between purely terrestrial and aquatic systems. The Convention on Wetlands signed at Ramsar (Iran) defines it broadly as areas of marsh, fen, peatland or water — natural or artificial, permanent or temporary, static or flowing, fresh or saline — including marine water no deeper than six metres at low tide.

Body:

- **What 'wise use' means:** It is the Convention's core principle — the sustainable use of a wetland that maintains its *ecological character* (its biological, physical and chemical components and the services they support) within the framework of sustainable development. So conservation and human use are not opposed; fishing, grazing and regulated tourism can continue as long as the wetland's functions survive for future generations.
- **How it works:** Wise use treats wetlands as service-providers — flood buffering, groundwater recharge, fisheries, water purification and carbon storage — and asks managers to keep these intact through integrated management plans, regular monitoring of ecological character, and local stewardship, rather than simply fencing people out.
- **Two Indian Ramsar sites:** *Chilika Lake* (Odisha), India's largest brackish coastal lagoon and a wintering ground for migratory birds and Irrawaddy dolphins; and *Keoladeo National Park* (Bharatpur, Rajasthan), a man-made waterfowl wetland that is also a World Heritage Site.

Conclusion: Wise use makes conservation work for communities, not against them. India operationalises this idea through the Wetlands (Conservation and Management) Rules, 2017, anchoring the Ramsar principle firmly in domestic law.

SOURCES

→Ramsar — Country Profile: India
→MoEFCC — Wetlands Division

Ramsar Convention | wise use | ecological character | ecosystem services | Chilika Lagoon | Keoladeo | sustainable development | Contracting Party

Q136

Coastal sand mining, whether legal or illegal, poses one of the biggest threats to our environment. Analyze the impact of sand mining along India's coasts, citing specific examples.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | COASTAL ZONES & RESOURCE EXTRACTION | 2019

ANSWER OUTLINE

Introduction: Frame coastal sand mining — beach placer minerals and construction sand — and why it cuts across legality.

Body: (1) Physical/geomorphic impacts — erosion, shoreline retreat, saline ingress; (2) ecological impacts — turbidity, turtle nesting, fisheries; (3) socio-economic and radiological angle plus named sites.

Conclusion: Regulation exists; the gap is enforcement and science-based mining.

KEY POINTS TO INCLUDE

- Beach placer minerals: ilmenite, monazite, zircon, garnet, rutile, sillimanite
- Mining disrupts the coastal sediment budget → beach erosion, shoreline retreat
- Saline intrusion into coastal aquifers and farmland; lowered water table
- Increased turbidity smothers seagrass, benthos; damages turtle nesting beaches
- Loss of sand reduces natural buffer against storm surges and cyclones
- Monazite contains radioactive thorium — radiological/health concern
- Coastal Regulation Zone (CRZ) Notification, 2019 restricts coastal activity
- Sustainable Sand Mining Management Guidelines, 2016 (MoEFCC)
- Offshore Areas Mineral (Development and Regulation) Act and 2023 offshore push off Kerala

EXAMPLES & CASE STUDIES

- Chavara coast, Kerala — placer (ilmenite/monazite) mining belt
- Manavalakurichi, Tamil Nadu — heavy-mineral mining
- Olive Ridley turtle nesting beaches, Odisha & Tamil Nadu
- Sustainable Sand Mining Management Guidelines, 2016
- CRZ Notification, 2019

MODEL ANSWER

Introduction: India's beaches hold heavy-mineral 'placer' deposits — ilmenite, monazite, zircon, garnet and rutile — alongside construction-grade sand. Their extraction, whether licensed or illegal, removes the very sediment that keeps a coast in dynamic equilibrium, so the environmental damage is broadly similar regardless of legal status.

Body:

- **Geomorphic damage:** Sand is a coast's natural buffer and store. Mining it disrupts the sediment budget, accelerates beach erosion and shoreline retreat, lowers the water table, and lets seawater intrude into coastal aquifers and adjoining farmland, leaving land unfit for cultivation.
- **Ecological harm:** Dredging and pit-digging raise water turbidity, smother seagrass meadows and bottom-dwelling life, and destroy nesting beaches — Olive Ridley turtles along Odisha and Tamil Nadu lose breeding habitat. The loss of protective sand banks and dunes weakens the natural defence against storm surges and cyclones, undercutting near-shore fisheries that coastal communities depend on.
- **Socio-economic and radiological angle:** Monazite carries radioactive thorium, raising radiation and health concerns near mined belts. Decades of heavy mining at *Chavara* (Kerala) and around *Manavalakurichi* (Tamil Nadu) have been linked to coastal recession and groundwater stress, directly hitting fishing livelihoods.

Conclusion: The 2023 push for offshore sand mining off Kerala shows the pressure is only growing. The regulatory frameworks already exist — the CRZ Notification and the Sustainable Sand Mining Guidelines — so the real task is rigorous sediment auditing, replenishment monitoring and firm action against illegal extraction.

SOURCES

→MoEFCC — Coastal Regulation Zone Notification, 2019
→MoEFCC — Sustainable Sand Mining Management Guidelines

placer minerals | sediment budget | coastal erosion | saline intrusion | CRZ Notification | monazite | beach nourishment | sand auditing

Q137

Explain the causes and effects of coastal erosion in India. What are the available coastal management techniques for combating this hazard?

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | COASTAL HAZARDS & SHORELINE MANAGEMENT | 2022

ANSWER OUTLINE

Introduction: Define coastal erosion and the scale of the problem on India's ~7,500 km coast.

Body — three parts to match the question: (1) causes (natural + anthropogenic); (2) effects; (3) management techniques split into hard, soft and planning measures.

Conclusion: Move from reactive hard structures to science-led shoreline management.

KEY POINTS TO INCLUDE

- Coastal erosion = landward retreat when sediment loss exceeds supply
- Natural causes: wave action, storm surges, cyclones, sea-level rise
- Anthropogenic: dams/barrages cut sediment supply; harbours interrupt longshore drift
- Sand mining and mangrove/coral loss remove natural buffers
- Effects: land loss, saline intrusion, fisher displacement, port/road/tourism damage
- Hard structures: seawalls, groynes, breakwaters, revetments — shift erosion downdrift
- Soft measures: beach nourishment, geotextile tubes, dune & mangrove restoration
- National Centre for Coastal Research (NCCR) maps the eroding shoreline
- Shoreline Management Plans and CRZ hazard-line approach guide protection vs retreat

EXAMPLES & CASE STUDIES

- National Centre for Coastal Research (NCCR), Chennai — shoreline mapping
- Pentha (Odisha) geotube embankment
- Shoreline Management Plans for Tamil Nadu, Andhra Pradesh, Kerala, Puducherry
- CRZ Notification, 2019 hazard-line provisions

MODEL ANSWER

> **Introduction:** Coastal erosion is the wearing away and landward retreat of the shoreline that occurs when sediment loss outpaces sediment supply. A large share of India's roughly 7,500 km mainland coast is under erosion, mapped by the National Centre for Coastal Research, with the east coast the worst affected.
>
> **Body:**
>
> - **Causes:** Natural drivers include wave action, storm surges, cyclones and rising sea levels. Human drivers often dominate — dams and barrages starve rivers of sediment, ports, harbours and groynes interrupt the longshore drift of sand, sand

mining strips the protective buffer, and the destruction of mangroves and coral reefs removes natural shock-absorbers.

- **Effects:** Outcomes include land and beach loss, saltwater intrusion into freshwater aquifers, displacement of fishing and coastal communities, damage to ports, coastal roads, settlements and tourism infrastructure, increased flooding during high tides, and the loss of mangrove, seagrass and turtle nesting habitat that further weakens future resilience.
- **Management techniques:** *Hard engineering* — seawalls, groynes, breakwaters and revetments hold the line but tend to shift erosion downdrift. *Soft and eco-measures* — beach nourishment, sand-filled geotextile tubes, dune restoration and mangrove bio-shields work with natural processes. *Planning measures* — Shoreline Management Plans, hazard-line mapping and the CRZ regime decide where to protect, accommodate or retreat.

Conclusion: Hard walls alone merely displace the problem along the coast. India's better path lies in sediment-cell-based Shoreline Management Plans that blend nourishment, bio-shields and managed retreat.

SOURCES

→Ministry of Earth Sciences / NCCR
→MoEFCC — Coastal Regulation Zone Notification, 2019

longshore drift | sediment budget | sea-level rise | seawall | groyne | beach nourishment | Shoreline Management Plan | geotextile tubes

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Q138

Each year a large amount of plant material — cellulose — is deposited on Earth's surface. What natural processes does this cellulose undergo before yielding carbon dioxide, water, and other end products?

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | DECOMPOSITION & NUTRIENT CYCLING | 2022

ANSWER OUTLINE

Introduction: Name cellulose as the main structural carbohydrate of plant litter and frame decomposition as the route back to CO_2 and water.

Body: Three sequential processes — leaching, fragmentation/comminution, and microbial catabolism (enzymatic hydrolysis + mineralisation, with humification of the residue).

Conclusion: Closes the carbon cycle and builds soil.

KEY POINTS TO INCLUDE

- Cellulose = β-1,4 linked glucose polymer, main structural carbohydrate of plants
- Leaching: water dissolves and removes soluble sugars/minerals first
- Fragmentation/comminution by detritivores (earthworms, termites, mites) increases surface area
- Decomposers: fungi (acidic conditions), bacteria & actinomycetes (neutral/alkaline)
- Cellulase enzymes hydrolyse cellulose to glucose
- Mineralisation: aerobic respiration converts glucose to CO_2 and water
- Humification: resistant residues form stable dark humus
- Net result recycles carbon and nutrients, building soil fertility

EXAMPLES & CASE STUDIES

- Earthworms and termites as litter fragmenters
- Cellulolytic fungi (e.g. Trichoderma) and actinomycetes
- Forest-floor leaf litter decomposition
- Humus formation in topsoil

MODEL ANSWER

Introduction: Cellulose, a long polymer of glucose units, is the chief structural material of fallen leaves, stems and wood. As litter on the ground it is broken down step by step by decomposers until it finally returns to carbon dioxide, water and stable humus.

Body:

- **Leaching:** Rain and percolating soil water first dissolve and wash out the soluble sugars and minerals from the litter.
- **Fragmentation (comminution):** Detritivores — earthworms, termites and mites — shred the litter into finer particles, exposing far more surface area for microbial attack.
- **Catabolism:** Fungi, bacteria and actinomycetes secrete *cellulase* enzymes that hydrolyse cellulose into glucose. Aerobic respiration then mineralises this glucose into carbon dioxide and water, while the more resistant residues are converted into dark, stable *humus* through humification.

Conclusion: These linked processes recycle carbon and nutrients back to the atmosphere and soil, closing the carbon cycle and sustaining long-term soil fertility.

SOURCES

→ICAR — Soil organic matter and decomposition
→NCERT Biology — Ecosystem: decomposition

cellulose | leaching | fragmentation | cellulase | mineralisation | humification | detritivores | carbon cycle

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Q139

Comment on the National Wetland Conservation Programme initiated by the Government of India, and name a few Indian wetlands of international importance included in the Ramsar Sites.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | WETLAND POLICY & RAMSAR SITES | 2023

ANSWER OUTLINE

Introduction: Place the National Wetland Conservation Programme (NWCP) as India's first dedicated wetland scheme (1985-86).

Body: (1) NWCP objectives & how it worked; (2) its evolution into NPCA (2013) and the legal/scheme architecture around it; (3) a clutch of named Indian Ramsar sites.

Conclusion: From identification to integrated management — and the gaps that remain.

KEY POINTS TO INCLUDE

- NWCP launched in 1985-86 by the environment ministry — India's first wetland scheme
- Objectives: identify priority wetlands, fund management action plans, community participation
- Tools: catchment treatment, weed/water-hyacinth control, de-silting, monitoring
- Merged in 2013 with National Lake Conservation Plan into NPCA
- NPCA = centrally-sponsored, cost-shared scheme between Centre and States/UTs
- Wetlands (Conservation and Management) Rules, 2017 provide the legal framework
- Amrit Dharohar (2023) links Ramsar-site conservation to local livelihoods
- India has 99 Ramsar sites by 2026 — highest in South Asia
- Remaining gaps: encroachment, pollution, weak inter-agency coordination

EXAMPLES & CASE STUDIES

- Chilika Lake, Odisha
- Keoladeo National Park, Rajasthan
- Sundarban Wetland, West Bengal

- Wular Lake, Jammu & Kashmir
- Loktak Lake, Manipur

MODEL ANSWER

Introduction: The National Wetland Conservation Programme (NWCP) was India's first dedicated wetland scheme, launched in 1985-86 by the environment ministry to conserve ecologically important wetlands through scientific management and active community involvement.

Body:

- **What NWCP did:** It identified priority wetlands across the states, provided central financial assistance for site-specific management action plans, and promoted catchment-area treatment, weed and water-hyacinth control, de-silting and regular monitoring — shifting conservation from neglect to planned, recurring upkeep.
- **Evolution:** In 2013 the NWCP was merged with the National Lake Conservation Plan into the National Plan for Conservation of Aquatic Ecosystems (NPCA), a single centrally-sponsored scheme with costs shared between the Centre and the States and Union Territories. This now sits alongside the Wetlands (Conservation and Management) Rules, 2017, the Save Wetlands Campaign and the Amrit Dharohar initiative, which ties Ramsar-site conservation to local livelihoods and ecotourism.
- **Indian Ramsar sites:** Wetlands of international importance designated in India include Chilika Lake (Odisha), Keoladeo National Park (Rajasthan), Sundarban (West Bengal), Wular Lake (Jammu & Kashmir), Loktak Lake (Manipur) and Sambhar Lake (Rajasthan). India now has the highest number of Ramsar sites in South Asia, reflecting a wide spread across coastal, freshwater and high-altitude wetlands.

Conclusion: The programme moved India to integrated, plan-based wetland management and seeded the institutions that followed. Persistent gaps in encroachment control, pollution and inter-agency coordination mean that enforcement on the ground, not policy design, is now the binding constraint.

SOURCES

→MoEFCC — National Plan for Conservation of Aquatic Ecosystems
→Wetlands of India Portal (MoEFCC)

NWCP · NPCA · Ramsar sites · Wetlands Rules 2017 · Amrit Dharohar · centrally-sponsored scheme · catchment treatment · Save Wetlands Campaign

GS PAPER 3

Environmental Impact Assessment

3 practice questions

Q140

Environmental Impact Assessment studies are increasingly undertaken before a project is cleared by the Government. Discuss the environmental impacts of coal-fired thermal plants located at coal pitheads.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | THERMAL POWER & COAL MINING | 2014

ANSWER OUTLINE

Introduction: Define EIA as a pre-clearance appraisal under the EIA Notification, 2006, then set up the pithead plant — a coal-fired station built at the mine mouth to cut transport cost.

Body: Cover three impact clusters — (1) air pollution from combustion, (2) land and water stress from ash and cooling, (3) compounded mining-cum-power burden on local communities.

Conclusion: A balancing line on the energy-security rationale plus a forward look on super-critical units, FGD and ash utilisation.

KEY POINTS TO INCLUDE

- EIA Notification, 2006 mandates prior environmental clearance with screening, scoping, public consultation and appraisal
- Pithead plants are sited at the mine mouth to cut coal transport cost and rail load
- Indian coal is high-ash, low-sulphur but volume of fly ash is very large
- Key air pollutants: SO2, NOx, particulate matter (PM10/PM2.5), CO and trace mercury
- Fly ash stored in ash ponds; breaches contaminate land and water with arsenic and heavy metals
- Thermal power is a major source of SO2 and NOx emissions in regional airsheds
- Once-through cooling causes high water withdrawal and thermal pollution of rivers
- MoEFCC emission norms (2015) require SO2, NOx and mercury control and flue-gas desulphurisation
- Fly Ash Notification targets 100% ash utilisation in cement, bricks and mine backfill

EXAMPLES & CASE STUDIES

- Singrauli–Sonbhadra thermal cluster, a notified critically polluted area

- Sasan Ultra Mega Power Project ash-pond breach, 2020
- NTPC Vindhyachal and Rihand pithead super thermal stations
- Korba thermal-cum-mining belt in Chhattisgarh

MODEL ANSWER

Introduction: An Environmental Impact Assessment (EIA) is the pre-clearance study, mandated by the EIA Notification, 2006, that predicts a project's effect on air, water, land and people. A pithead thermal plant sits right at the coal mine mouth, saving rail haulage but concentrating mining and combustion pollution in one airshed, which is why its impacts deserve close scrutiny.

Body:

- **Air pollution:** Burning low-grade, high-ash Indian coal emits sulphur dioxide, oxides of nitrogen, particulate matter and trace mercury. In the Singrauli belt these plants drive a large share of regional SO2 and NOx, worsening PM2.5, acid deposition and respiratory disease among nearby populations.
- **Land and water:** Plants generate huge fly-ash volumes stored in ash ponds; breaches, such as the 2020 Sasan ash-pond failure, bury farmland and leach arsenic and heavy metals into soil and groundwater. Once-through cooling withdraws large volumes from rivers and raises thermal discharge that harms aquatic life.
- **Cumulative mining burden:** Co-located open-cast mining adds overburden dumps, fugitive dust, land subsidence and forest loss, so a single airshed carries both extraction and combustion stress at once. Displacement, noise and loss of farmland fall heaviest on tribal and rural residents living near the complex.

Conclusion: Pithead siting serves energy security but multiplies local damage, so clearances must enforce super-critical efficiency, flue-gas desulphurisation, 100% fly-ash utilisation and robust ash-pond design rather than treat the appraisal as a mere formality.

SOURCES

→MoEFCC — EIA Notification, 2006
→MoEFCC — Environmental standards for thermal power plants
→Central Pollution Control Board — air quality and fly ash

Environmental Impact Assessment | pithead thermal plant | fly ash | ash pond | flue-gas desulphurisation | particulate matter | critically polluted area | super-critical technology

Q141

How does the draft Environment Impact Assessment (EIA) Notification, 2020 differ from the existing EIA Notification, 2006?

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | REGULATORY FRAMEWORK | 2020

ANSWER OUTLINE

Introduction: Frame EIA as the clearance appraisal and note the draft 2020 as a proposed replacement for the 2006 regime.

Body: Three contrasts — post-facto clearance, weaker public consultation, and expanded exemptions/longer compliance gaps.

Conclusion: One line on the regulation-versus-ease-of-business tension.

KEY POINTS TO INCLUDE

- EIA Notification, 2006 requires prior environmental clearance before any construction begins
- Draft 2020 allowed post-facto (ex-post) clearance for projects that started without approval
- Supreme Court has held ex-post-facto clearance contrary to environmental jurisprudence
- Public consultation notice period cut from 30 days to 20 days under the draft
- Draft expanded the Category B2 list exempted from public consultation
- Compliance report frequency relaxed from once every six months to annually
- Several activities listed as 'strategic' could be kept outside public scrutiny
- Both regimes retain the screening, scoping, public consultation and appraisal stages

EXAMPLES & CASE STUDIES

- Category B2 exemptions for minor-mineral mining up to 5 hectares
- Hydroelectric river-valley projects up to 25 MW exempted in the draft
- Offshore and onshore oil and gas exploration exemptions
- Annual versus half-yearly compliance reporting change

MODEL ANSWER

> **Introduction:** An Environmental Impact Assessment (EIA) is the prior appraisal a project must clear under the EIA Notification, 2006. The draft 2020 notification proposed to replace it, and differs sharply on three counts that drew wide criticism.
>
> **Body:**

- **Post-facto clearance:** The 2006 rule barred any construction before clearance; the draft 2020 allowed already-running projects to seek approval after the fact, legitimising past violations through penalties.
- **Public consultation:** It trimmed the minimum notice period for public hearings from 30 to 20 days and exempted a wider list of activities, weakening the affected public's voice in decision-making.
- **Exemptions and oversight:** It expanded the Category B2 list kept out of public consultation and stretched mandatory compliance reporting from once every six months to once a year, easing post-clearance scrutiny.

Conclusion: The draft tilted toward faster approvals and ease of business at the cost of the precautionary safeguards the 2006 regime was built upon.

SOURCES

→MoEFCC — Draft EIA Notification, 2020
→MoEFCC — EIA Notification, 2006

Environmental Impact Assessment | post-facto clearance | public consultation | Category B2 | precautionary principle | environmental clearance | compliance report

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Q142

What role do environmental NGOs and activists play in influencing Environmental Impact Assessment (EIA) outcomes for major projects in India? Cite four examples with all important details.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | CIVIL SOCIETY & PUBLIC PARTICIPATION | 2024

ANSWER OUTLINE

Introduction: Frame NGOs and activists as actors in the public-consultation stage of EIA under the 2006 regime.

Body: State their roles, then cite four cases — Niyamgiri/Vedanta, Sterlite Tuticorin, Lower Subansiri, Athirappilly.

Conclusion: One balancing line on watchdog value versus the need for credible, non-obstructive engagement.

KEY POINTS TO INCLUDE

- EIA public-consultation stage gives NGOs and citizens a statutory voice
- Tools used: public hearings, RTI, scientific critique, PILs and NGT appeals

- Niyamgiri: SC 2013 (Orissa Mining Corporation case) made Gram Sabha consent decisive
- Vedanta's Niyamgiri bauxite mining clearance was ultimately refused
- Sterlite Copper Tuticorin shut in 2018 after pollution protests
- Lower Subansiri (NHPC) construction halted 2011–2019 over dam safety
- Athirappilly hydel project in Kerala repeatedly stalled by clearances challenges
- National Green Tribunal (NGT) is the key forum for environmental appeals

EXAMPLES & CASE STUDIES

- Vedanta bauxite mining, Niyamgiri Hills, Odisha (Dongria Kondh, SC 2013)
- Sterlite Copper smelter, Tuticorin, Tamil Nadu (closed 2018)
- Lower Subansiri Hydroelectric Project, NHPC (stalled 2011–2019)
- Athirappilly Hydroelectric Project, Chalakudy river, Kerala

MODEL ANSWER

Introduction: An Environmental Impact Assessment (EIA) under the 2006 regime opens a public-consultation window where non-governmental organisations (NGOs) and activists scrutinise data, mobilise affected communities and litigate before the courts and the National Green Tribunal (NGT).

Body:

- **Niyamgiri, Odisha:** Campaigns backing the Dongria Kondh led to the 2013 Supreme Court order making Gram Sabha consent binding; the bauxite mining clearance to Vedanta was refused.
- **Sterlite Copper, Tuticorin:** Sustained protests over pollution culminated in the plant's 2018 closure by Tamil Nadu, later upheld by courts.
- **Lower Subansiri, Assam–Arunachal:** Downstream-safety petitions stalled the NHPC dam from 2011 to 2019 pending NGT and expert review.
- **Athirappilly, Kerala:** Activists and tribal groups repeatedly challenged the dam's clearances, keeping it shelved.

Conclusion: Such engagement strengthens transparency and accountability in the clearance process, though it works best when grounded in credible science rather than in blanket obstruction.

SOURCES

→National Green Tribunal — official portal
→MoEFCC — EIA Notification, 2006 (public consultation)
→Ministry of Tribal Affairs — Forest Rights Act and Gram Sabha

public consultation | Gram Sabha consent | National Green Tribunal | Public Interest Litigation | Dongria Kondh | precautionary principle | civil society

GS PAPER 3

Biodiversity & Protected Areas

1 practice question

Q143

How does biodiversity vary in India? How is the Biological Diversity Act (2002) helpful in the conservation of flora and fauna?

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | LEGAL FRAMEWORK FOR CONSERVATION | 2018

ANSWER OUTLINE

Introduction: State that India is a megadiverse country and signal the two parts — spatial variation, then the role of the 2002 Act.

Body: Part one maps how biodiversity varies across zones and hotspots; part two lays out the Act's three-tier structure and conservation tools.

Conclusion: Tie statutory mechanism to outcomes and a forward look on community stewardship.

KEY POINTS TO INCLUDE

- India is one of 17 megadiverse countries, with ~8% of global species
- India has 10 biogeographic zones (Rodgers and Panwar classification)
- Four biodiversity hotspots: Himalaya, Western Ghats, Indo-Burma, Sundaland (Nicobar)
- Endemism highest in Western Ghats and Eastern Himalaya
- Biological Diversity Act, 2002 enacted under the UN Convention on Biological Diversity
- Three-tier structure: NBA (Chennai), State Biodiversity Boards, Biodiversity Management Committees
- BMCs prepare People's Biodiversity Registers documenting local species and knowledge
- Act regulates access and benefit-sharing for biological resources
- Section 37 lets State governments notify Biodiversity Heritage Sites
- National Biodiversity Strategy and Action Plan guides implementation of CBD targets

EXAMPLES & CASE STUDIES

- Western Ghats rainforest with very high plant endemism
- Eastern Himalaya hotspot, rich in flora and fauna
- Nallur Tamarind Grove, Karnataka — a notified Biodiversity Heritage Site
- People's Biodiversity Registers prepared by village-level BMCs

- Convention on Biological Diversity (Rio, 1992) under which the Act was framed

MODEL ANSWER

Introduction: India is one of the world's seventeen megadiverse nations, holding nearly 8% of recorded species on about 2.4% of global land. Its biodiversity varies sharply across space, and the Biological Diversity Act, 2002 supplies the legal scaffolding to conserve this living wealth.

Body — How biodiversity varies: The country spans ten biogeographic zones, from the trans-Himalayan cold desert and arid Thar to the Western Ghats rainforest, Deccan plateau, Gangetic plains, long coasts and oceanic islands. Four global biodiversity hotspots touch India — the Himalaya, Western Ghats, Indo-Burma and Sundaland (Nicobar). Endemism and species richness peak in the high-rainfall Western Ghats and Eastern Himalaya, whereas cold and arid zones host specialised, sparser life adapted to extremes.

How the 2002 Act helps:

- **Three-tier governance:** a National Biodiversity Authority at Chennai, State Biodiversity Boards and local Biodiversity Management Committees (BMCs) in every local body.
- **Documentation:** BMCs maintain People's Biodiversity Registers recording local flora, fauna and traditional knowledge for protection.
- **Access and benefit-sharing:** the Act regulates commercial use of biological resources and channels a fair share of gains to communities; it also empowers States to notify ecologically fragile Biodiversity Heritage Sites under Section 37.

Conclusion: By pairing access regulation with grassroots committees and documentation, the Act roots conservation in local stewardship, and the updated national strategy and action plan now aim to deepen this protection of flora and fauna.

SOURCES

→National Biodiversity Authority — Biological Diversity Act, 2002
→MoEFCC — Biodiversity and CBD
→Convention on Biological Diversity — UN portal

megadiverse country | biogeographic zones | biodiversity hotspots | endemism | National Biodiversity Authority | Biodiversity Management Committee | People's Biodiversity Register | access and benefit-sharing

GS PAPER 3

Environmental Pollution

11 practice questions

Q144

What are the consequences of illegal mining? Discuss the Ministry of Environment and Forests' concept of 'Go' and 'No-Go' zones for the coal mining sector.

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | MINING & LAND DEGRADATION | 2013

ANSWER OUTLINE

Introduction: Define illegal mining as extraction without lease, clearance or beyond sanctioned limits, in breach of the MMDR Act and the Environment (Protection) Act, 1986.

Body: (1) Ecological and revenue consequences; (2) socio-economic and safety fallout; (3) the MoEF Go / No-Go classification and why it was diluted.

Conclusion: Balance coal security with forest protection through GoM-vetted Inviolate Forest Areas.

KEY POINTS TO INCLUDE

- Illegal mining = mining without lease/clearance or beyond sanctioned area, violating the MMDR Act and Environment (Protection) Act, 1986
- Justice M.B. Shah Commission documented large-scale illegal iron-ore mining in Goa and Odisha
- Consequences span ecology (deforestation, erosion, water contamination), revenue (royalty loss), and society (tribal displacement, miner deaths)
- Rat-hole coal mining in Meghalaya's Jaintia Hills caused fatal pit flooding and was banned by the NGT
- Go/No-Go exercise (2010) jointly run by MoEF and Ministry of Coal classified coalfields by forest cover and crown density
- Around half of the assessed coal blocks were initially marked No-Go, blocking mining there
- Industry and Coal Ministry resistance led a Group of Ministers to scrap the Go/No-Go grid
- It was replaced by the 'Inviolate Forest Areas' criteria based on forest cover, density, biodiversity and hydrology

EXAMPLES & CASE STUDIES

- Shah Commission report on illegal iron-ore mining in Goa and Odisha
- Rat-hole mining bans in Meghalaya's Jaintia Hills (NGT)
- Coal-block allocation irregularities highlighted by the CAG
- Mahan forest (Madhya Pradesh) protected from coal mining as a No-Go area
- Inviolate Forest Areas criteria adopted after the Go/No-Go grid was dropped

MODEL ANSWER

Introduction: Illegal mining is extraction without a lease or clearance, or beyond sanctioned limits, in breach of the Mines and Minerals (Development and Regulation) Act and the Environment (Protection) Act, 1986.

Consequences:

- **Ecological:** deforestation, soil erosion, river-bed and groundwater contamination, as flagged by the Shah Commission on Goa and Odisha iron-ore mining.
- **Fiscal and governance:** royalty loss to states, encouragement of a mining mafia, and the corruption exposed in coal-block allocations.
- **Social and safety:** displacement of tribal communities, rat-hole pit collapses in Meghalaya, and respiratory illness near sites.

Go / No-Go concept (2010): The Ministry, with the Coal Ministry, mapped coalfields by forest cover and density. Go zones permitted mining; No-Go zones (dense forest, high biodiversity) barred it. Roughly half of assessed blocks fell in No-Go areas, stalling output, so a Group of Ministers replaced the rigid grid with the Inviolate Forest Areas criteria.

Conclusion: A transparent, science-based inviolate-area framework can reconcile energy needs with forest conservation.

SOURCES

→PIB — Classification of Coal Mining Areas (Go/No-Go)
→MoEFCC — Environment (Protection) Act, 1986

illegal mining | Go and No-Go zones | Inviolate Forest Areas | MMDR Act | Environment (Protection) Act 1986 | Shah Commission | forest clearance | coal blocks

Q145

Enumerate the National Water Policy of India. Taking the river Ganges as an example, discuss the strategies that may be adopted for river-water pollution control and management. What are the legal provisions for the management and handling of hazardous wastes in India?

15 MARKS | 250 WORDS | 11 MIN | HARD | WATER POLLUTION & WASTE LAW | 2013

ANSWER OUTLINE

Introduction: Frame the National Water Policy, 2012 as the apex non-statutory guide treating water as a finite, vulnerable resource.

Body: (1) Enumerate Policy thrusts; (2) Ganga-specific pollution-control strategies; (3) legal provisions for hazardous-waste handling.

Conclusion: Integrated basin governance plus strict enforcement closes the gap between policy and outcome.

KEY POINTS TO INCLUDE

- National Water Policy, 2012 is a non-statutory framework issued by the (then) Ministry of Water Resources
- Treats water as an economic good after priority allocation to drinking water, sanitation, food security and minimum ecosystem needs
- Recommends a Water Regulatory Authority, river-basin planning, minimum environmental flows and community participation
- Sewage is the dominant pollution load on the Ganga; intercept-divert-treat via STPs is the core strategy
- Industrial effluent (tanneries at Kanpur) needs CETPs, zero-liquid-discharge and real-time effluent monitoring
- Aviral dhara (uninterrupted flow) and nirmal dhara (clean flow) underpin Ganga rejuvenation
- Environment (Protection) Act, 1986 is the parent law for hazardous-waste regulation
- Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 govern handling; CPCB/SPCBs authorise; Basel Convention covers transboundary movement

EXAMPLES & CASE STUDIES

- National Mission for Clean Ganga (NMCG) and the National Ganga River Basin Authority
- Tannery clusters at Kanpur (Jajmau) and the leather-effluent problem

- Common Effluent Treatment Plants and online continuous emission/effluent monitoring
- Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016
- Basel Convention on transboundary movement of hazardous wastes

MODEL ANSWER

Introduction: The National Water Policy, 2012 is the apex non-statutory framework that treats water as a finite, vulnerable resource and seeks a unified national plan for its conservation and equitable use across competing demands.

Policy thrusts: after meeting priority drinking, sanitation, food-security and minimum ecosystem needs, water is to be treated as an economic good to curb waste; a statutory Water Regulatory Authority to fix tariffs; river basins as the unit of planning; minimum environmental flows in every river; recycling, reuse and demand management; and participatory management by user communities.

Ganga strategies:

- Intercept, divert and treat municipal sewage through Sewage Treatment Plants, since untreated sewage is the largest pollution source along the river.
- Enforce zero-liquid-discharge on tanneries and other industries via Common Effluent Treatment Plants and real-time online monitoring.
- Maintain ecological flow ('aviral dhara') and restore wetlands, floodplains and riparian forests.
- Run the whole-basin approach under the National Mission for Clean Ganga with public participation and Ganga-Gram sanitation.

Hazardous-waste law: The parent statute is the Environment (Protection) Act, 1986, under which the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 govern storage, packaging, transport, recycling, treatment and disposal. The Central Pollution Control Board and State Boards authorise generators and recyclers, while transboundary movement of such waste follows the Basel Convention.

Conclusion: Integrated basin governance backed by strict enforcement of these rules can close the gap between policy intent and on-ground water quality.

SOURCES

→National Water Mission — National Water Policy (2012)
→CPCB — Environment (Protection) Act, 1986 & Rules

→NMCG — National Mission for Clean Ganga

National Water Policy 2012 | river-basin approach | environmental flow | Sewage Treatment Plant | zero liquid discharge | Hazardous Wastes Rules 2016 | Environment (Protection) Act 1986 | Basel Convention

Q146

Discuss the Namami Gange and National Mission for Clean Ganga (NMCG) programmes and the causes of mixed results from previous schemes. What quantum leaps can help preserve the river Ganga better than incremental inputs?

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | GANGA REJUVENATION | 2015

ANSWER OUTLINE

Introduction: Position Namami Gange (2014) as the integrated flagship implemented by NMCG, contrasting it with the earlier Ganga Action Plan.

Body: (1) Programme design; (2) why earlier schemes gave mixed results; (3) quantum-leap interventions.

Conclusion: A river-basin, outcome-linked model can outperform piecemeal spending.

KEY POINTS TO INCLUDE

- Namami Gange approved in 2014; NMCG registered in 2011 as the implementing arm under the (now) National Ganga Council
- Initial outlay around Rs 20,000 crore for 2015–2021, later extended with enhanced funding to 2026
- Pillars: sewage treatment, industrial-effluent monitoring, river-surface cleaning, river-front development, afforestation, biodiversity, Ganga Gram, public awareness
- Predecessor Ganga Action Plan (1985) gave limited results due to capacity gaps and weak coordination
- Sewage generation has persistently outpaced installed STP treatment capacity
- Poor operation-and-maintenance and low cost recovery undermined existing plants
- Quantum leaps: hybrid-annuity (one-city-one-operator) STP model, online effluent monitoring, treated-water reuse, ecological flow restoration
- Non-point agricultural runoff and floodplain encroachment remain under-addressed

EXAMPLES & CASE STUDIES

- Ganga Action Plan, 1985 (the earlier scheme with mixed results)

- Hybrid-Annuity Model STP projects under NMCG (e.g., Haridwar, Varanasi)
- National Ganga Council and State Ganga Committees
- Ganga Gram pilot villages for open-defecation-free riverbanks
- Notified environmental-flow norms for the upper Ganga

MODEL ANSWER

Introduction: Namami Gange, the integrated flagship approved in 2014, is implemented by the National Mission for Clean Ganga, the executive arm of the National Ganga Council. It marks a decisive shift from the narrow, sectoral Ganga Action Plan to a whole-basin mission.

Programme design: An initial outlay of about Rs 20,000 crore, later raised and extended to 2026, funds sewerage networks and Sewage Treatment Plants, industrial-effluent control, river-front and river-surface cleaning, afforestation, biodiversity conservation, and the Ganga Gram public-awareness pillar in riverside villages.

Why earlier schemes gave mixed results:

- Treatment capacity chronically lagged the rising volume of sewage flowing into the river.
- Fragmented Centre-state institutions and weak coordination across the five main riparian states.
- Poor operation and maintenance of built plants, plus low cost recovery and irregular electricity supply.
- Neglect of ecological flow and of diffuse non-point pollution from farms and small towns.

Quantum leaps: hybrid-annuity contracts that pay operators for measured performance over fifteen years; a one-city-one-operator model for sewage management; mandatory online effluent monitoring backed by real penalties; treated-water reuse by thermal and industrial users; restored floodplains and notified environmental flows; and decentralised treatment in small towns rather than reliance on a few mega-plants.

Conclusion: A river-basin, outcome-linked model that funds long-term maintenance, not just one-time construction, and treats the Ganga as a living ecological system can preserve the river far better than incremental, asset-heavy spending.

SOURCES

→NMCG — Namami Gange Programme

→Jal Shakti / DoWR — Namami Gange

Namami Gange | National Mission for Clean Ganga | Ganga Action Plan | hybrid annuity model | Sewage Treatment Plant | environmental flow | river-basin approach | Ganga Gram

Q147

What are the impediments to disposing of the huge quantities of discarded solid waste that are continuously being generated? How do we safely remove the toxic wastes accumulated in our habitable environment?

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | SOLID & HAZARDOUS WASTE | 2018

ANSWER OUTLINE

Introduction: Frame the scale of municipal solid waste and the legal architecture under the Solid Waste Management Rules, 2016.

Body: (1) Impediments to disposal; (2) safe removal of toxic and legacy wastes; (3) supporting institutions.

Conclusion: Source segregation plus a circular-economy push reduces both volume and toxicity.

KEY POINTS TO INCLUDE

- India generates over 1.5 lakh tonnes per day of municipal solid waste; a large fraction is unprocessed
- Solid Waste Management Rules, 2016 mandate source segregation into wet, dry and domestic-hazardous streams
- Key impediments: poor segregation, land scarcity for landfills (NIMBY), weak ULB finances, informal recycling sector
- Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 cover industrial hazardous waste
- E-Waste (Management) Rules, 2022 and Bio-Medical Waste Management Rules, 2016 cover specialised toxic streams
- Extended Producer Responsibility shifts collection and recycling duty onto producers
- Bio-mining and bio-remediation reclaim legacy dumpsites such as Delhi's Ghazipur and Mumbai's Deonar
- TSDFs, secured landfills and common incinerators, authorised by CPCB/SPCBs, enable safe toxic-waste disposal

EXAMPLES & CASE STUDIES

- Legacy garbage mountains at Ghazipur (Delhi), Deonar (Mumbai) and Mandur (Bengaluru)
- Solid Waste Management Rules, 2016 and the source-segregation mandate
- Extended Producer Responsibility under the E-Waste (Management) Rules, 2022
- Indore's segregation-led model under the Swachh Bharat Mission
- Treatment, Storage and Disposal Facilities (TSDFs) for hazardous waste

MODEL ANSWER

Introduction: India generates upward of 1.5 lakh tonnes of municipal solid waste a day, governed by the Solid Waste Management Rules, 2016, yet a large share stays uncollected, untreated or simply dumped on the urban fringe.

Impediments to disposal:

- Low source segregation, so wet, dry and domestic-hazardous fractions arrive mixed and unfit for composting or recycling.
- Scarce, contested land for scientific landfills and waste-to-energy plants, hardened by ‘not-in-my-backyard’ resistance.
- Weak finances, low user-fee recovery and patchy technical capacity of urban local bodies.
- A largely informal recycling sector working outside any safety net, plus fast-growing volumes of plastic, packaging and electronic waste.

Safe removal of toxic wastes: Industrial hazardous waste falls under the Hazardous and Other Wastes Rules, 2016, e-waste under the E-Waste (Management) Rules, 2022, and infectious waste under the Bio-Medical Waste Management Rules, 2016. Safe handling needs engineered Treatment, Storage and Disposal Facilities, secured landfills and common hazardous-waste incinerators that meet emission norms; Extended Producer Responsibility that puts collection and recycling duty on producers; bio-mining and bio-remediation to reclaim the towering legacy dumpsites in our cities; and continuous authorisation, tracking and audit by the Central and State Pollution Control Boards.

Conclusion: Mandatory at-source segregation, decentralised composting, scientific landfilling and a circular-economy push that designs out toxicity at the production stage can cut both the volume and the hazard of accumulated solid and toxic waste.

SOURCES

→CPCB — Waste Management Rules
→MoEFCC — Environment (Protection) Act, 1986

municipal solid waste | source segregation | Solid Waste Management Rules 2016 | Extended Producer Responsibility | bio-mining | TSDF | e-waste | circular economy

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Q148

What are the key features of the National Clean Air Programme (NCAP) initiated by the Government of India?

10 MARKS | 150 WORDS | 9 MIN | EASY | AIR QUALITY POLICY | 2020

ANSWER OUTLINE

Introduction: Define NCAP (2019) as the first national time-bound strategy to cut particulate pollution, run by the (then) Ministry of Environment, Forest and Climate Change.

Body: three feature clusters — targets and coverage, city-level action, and monitoring/finance.

Conclusion: A mid-course correction towards airshed management.

KEY POINTS TO INCLUDE

- NCAP launched in January 2019 by the Ministry of Environment, Forest and Climate Change
- First national, time-bound programme to address particulate air pollution
- Original target: 20–30% reduction in PM10/PM2.5 by 2024 against a 2017 base year
- Revised target: up to 40% reduction in PM10 by 2025–26 against a 2019–20 base year
- Covers roughly 130 non-attainment and Million-Plus cities across about 24 states/UTs
- City-specific clean-air action plans target road dust, vehicles, industry and biomass burning
- Strengthened national air-quality monitoring network and source-apportionment studies
- Funded via Fifteenth Finance Commission air-quality grants and dedicated NCAP allocation

EXAMPLES & CASE STUDIES

- Non-attainment cities such as Delhi, Kanpur, Patna and Ghaziabad

- Fifteenth Finance Commission million-plus-cities air-quality grants
- Source-apportionment studies feeding city action plans
- Prana portal for monitoring NCAP implementation

MODEL ANSWER

Introduction: The National Clean Air Programme, launched in 2019 by the Ministry of Environment, Forest and Climate Change, is the first national, time-bound strategy to cut particulate air pollution across the country's most polluted cities.

Key features:

- **Targets:** originally a 20–30% cut in PM10 and PM2.5 by 2024 against a 2017 base, later revised to up to 40% reduction in PM10 by 2025–26 against a 2019–20 base.
- **Coverage:** about 130 non-attainment and Million-Plus cities across roughly 24 states and union territories that breached national ambient air-quality standards over several years.
- **City action plans:** each city prepares a tailored plan covering road and construction dust, vehicular and industrial emissions, and biomass and waste burning.
- **Monitoring and finance:** an expanded ambient-monitoring network, source-apportionment studies, the Prana tracking portal, and funding routed through Fifteenth Finance Commission grants and a dedicated budget.

Conclusion: NCAP is gradually shifting from city-centric plans towards airshed-level management for more lasting gains in air quality.

SOURCES

→PIB — Goals set under NCAP
→MoEFCC — Environment (Protection) Act, 1986 & CPCB standards

National Clean Air Programme | non-attainment cities | PM10 | PM2.5 | city action plan | airshed management | source apportionment | Finance Commission grants

Q149

Describe the key points of the revised Global Air Quality Guidelines (AQGs) recently released by the WHO. How are these different from its last update in 2005? What changes in India's NCAP are required to achieve these revised standards?

15 MARKS | 250 WORDS | 11 MIN | HARD | AIR QUALITY STANDARDS | 2021

ANSWER OUTLINE

Introduction: Frame the WHO 2021 Global Air Quality Guidelines as far stricter health-based reference values prompted by new evidence.

Body: (1) key revised values; (2) how they differ from 2005; (3) changes needed in India's NCAP.

Conclusion: Align national standards with health science and move to airshed management.

KEY POINTS TO INCLUDE

- WHO released revised Global Air Quality Guidelines in 2021, its first update since 2005
- Annual PM2.5 guideline halved from 10 to 5 micrograms per cubic metre
- Annual PM10 guideline lowered from 20 to 15 micrograms per cubic metre
- Annual NO2 guideline cut sharply from 40 to 10 micrograms per cubic metre
- 24-hour values tightened (PM2.5 to 15, PM10 to 45) and staged interim targets introduced
- India's National Ambient Air Quality Standards (CPCB, last revised 2009) are far weaker than WHO values
- NCAP needs revised standards, airshed-level management, and legally binding, accountable targets
- Source-level action — clean fuels, crop-residue management, industrial controls — and denser real-time monitoring are required

EXAMPLES & CASE STUDIES

- WHO 2021 Global Air Quality Guidelines (six classical pollutants)
- India's National Ambient Air Quality Standards notified by CPCB in 2009
- Commission for Air Quality Management in the NCR airshed
- National Clean Air Programme city action plans
- PM2.5 annual value: WHO 5 vs India's 40 micrograms per cubic metre

MODEL ANSWER

> **Introduction:** The World Health Organization's 2021 Global Air Quality Guidelines sharply tightened the health-based reference values for six classical pollutants, citing strong new evidence of harm at concentrations once thought safe.

Key revised values: the annual PM2.5 guideline was halved to 5 micrograms per cubic metre and PM10 lowered to 15; the annual nitrogen-dioxide guideline was cut to 10; and tighter 24-hour values plus staged interim targets were set for particulate matter, ozone, sulphur dioxide and carbon monoxide.

Difference from 2005:

- Annual PM2.5 fell from 10 to 5 micrograms per cubic metre.
- Annual PM10 fell from 20 to 15 micrograms per cubic metre.
- Annual NO2 fell sharply from 40 to 10 micrograms per cubic metre.
- The 2021 edition adds graded interim targets so countries can chart gradual, measurable progress.

Changes needed in India's NCAP: progressively revise the National Ambient Air Quality Standards, set by the Central Pollution Control Board and far weaker than the new values, towards the WHO benchmarks; shift from isolated city plans to coordinated airshed-level management; make pollution-cut targets legally binding with clear accountability; expand the real-time monitoring network and source-apportionment studies; and drive deep emission cuts at source through clean cooking and transport fuels, crop-residue management and tighter industrial norms.

Conclusion: Aligning national standards with this health science, backed by enforceable airshed governance and sustained finance, is essential to move India's most polluted cities towards genuinely breathable air.

SOURCES

→WHO — Global Air Quality Guidelines (2021)
→CPCB — National Ambient Air Quality Standards
→PIB — Goals set under NCAP

WHO Air Quality Guidelines 2021 | PM2.5 | PM10 | nitrogen dioxide | National Ambient Air Quality Standards | airshed management | interim targets | National Clean Air Programme

Q150

Discuss in detail photochemical smog, emphasizing its formation, effects, and mitigation. Explain the 1999 Gothenburg Protocol.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | AIR POLLUTION & PHOTOCHEMICAL SMOG | 2022

ANSWER OUTLINE

Introduction: Define photochemical smog as an oxidising, sunlight-driven secondary air pollution dominated by ground-level ozone.

Body: (1) Formation chemistry — NOx + VOCs + UV. (2) Effects on health, vegetation and materials. (3) Mitigation at source and policy. (4) The 1999 Gothenburg Protocol and its multi-pollutant, multi-effect design.

Conclusion: Link source-control to cooperative emission ceilings for clean air.

KEY POINTS TO INCLUDE

- Photochemical smog is a secondary, oxidising pollution; chief component is ground-level (tropospheric) ozone
- Precursors are NOx and VOCs; sunlight (UV) drives the reactions, so smog peaks on hot sunny afternoons
- PAN (peroxyacetyl nitrate) and aldehydes are characteristic by-products
- Health effects: eye/throat irritation, aggravated asthma, reduced lung function; ozone also lowers crop yields
- Mitigation: BS-VI emission norms, catalytic converters, cleaner fuels, EVs and public transport, VOC controls
- Gothenburg Protocol (1999) was adopted under the UNECE CLRTAP, in force from 2005
- It set binding national ceilings for four pollutants — sulphur, NOx, VOCs and ammonia — in one multi-effect instrument
- The 2012 revision added PM2.5 and, for the first time, black carbon as a short-lived climate pollutant

EXAMPLES & CASE STUDIES

- Los Angeles — the classic photochemical-smog city that drove early ozone research
- Delhi-NCR — summer ozone exceedances alongside winter particulate smog
- BS-VI fuel and vehicle norms rolled out across India to cut NOx and VOCs
- UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP) — the parent treaty
- 2012 amendment to the Gothenburg Protocol adding PM2.5 and black carbon

MODEL ANSWER

Introduction: Photochemical smog is a brownish, oxidising haze that forms when sunlight drives reactions among nitrogen oxides (NOx) and volatile organic compounds (VOCs). Its signature pollutant is ground-level ozone, accompanied by peroxyacetyl nitrate (PAN) and aldehydes. It is a secondary pollutant — created in the air, not emitted directly from any chimney or tailpipe.

Formation: Vehicle exhaust and industry release NOx and VOCs. Ultraviolet radiation splits nitrogen dioxide into nitric oxide and atomic oxygen; that free oxygen joins molecular O2 to make ozone. VOCs feed and sustain the cycle, so ozone builds up faster than it breaks down. So smog peaks on hot, sunny, traffic-heavy afternoons in cities such as Delhi and Los Angeles.

Effects:

- Health — eye and throat irritation, aggravated asthma and bronchitis, and reduced lung function over time.
- Vegetation — ozone scorches leaves, slows photosynthesis and cuts crop yields.
- Materials — it degrades rubber, paint and textiles, corrodes surfaces and sharply reduces visibility.

Mitigation: The only durable fix is cutting precursors — tighter vehicle emission norms (BS-VI), catalytic converters, cleaner fuels, a shift to public transport and electric vehicles, VOC controls on refineries and paints, and real-time air-quality monitoring.

Gothenburg Protocol, 1999: Adopted under the UNECE Convention on Long-range Transboundary Air Pollution and in force since 2005, it was the first agreement to tackle four pollutants at once — sulphur, NOx, VOCs and ammonia — through binding national emission ceilings. Its 2012 revision added fine particulate matter (PM2.5) and black carbon, applying a multi-pollutant, multi-effect approach.

Conclusion: Smog yields only when precursor emissions are attacked at source; Gothenburg shows how shared, science-based ceilings can deliver cleaner air across borders.

SOURCES

→UNECE — Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol)
→MoEFCC — Ministry of Environment, Forest and Climate Change
→Central Pollution Control Board — National Air Quality Monitoring

ground-level ozone | secondary pollutant | NOx and VOCs | peroxyacetyl nitrate (PAN) | BS-VI emission norms | national emission ceilings | multi-pollutant multi-effect | CLRTAP

Q151

What is oil pollution? What are its impacts on the marine ecosystem? In what way is oil pollution particularly harmful for a country like India?

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | MARINE & OIL POLLUTION | 2023

ANSWER OUTLINE

Introduction: Define oil pollution and its main sources at sea.

Body: (1) Impacts on the marine ecosystem — physical, chemical, food-chain. (2) Why India is especially vulnerable — long coastline, busy shipping lanes, coastal livelihoods. (3) Named instances and the response gap.

Conclusion: Stress prevention, preparedness and ecological restoration.

KEY POINTS TO INCLUDE

- Oil pollution sources: tanker accidents, rig blowouts, pipeline leaks, refinery effluent, routine ballast/bilge discharge
- Physical impact: surface slick blocks sunlight and oxygen exchange; oil coats gills and feathers, killing fish and seabirds
- Chemical impact: polycyclic aromatic hydrocarbons (PAHs) are toxic and bioaccumulate up the food chain
- Mangroves, salt marshes, corals and turtle-nesting beaches suffer multi-year damage
- India has a coastline of about 7,500 km along busy international shipping routes, raising spill risk
- Coastal fishing communities lose catch and income; the 2017 Ennore spill hurt fishers for years
- Sensitive Indian ecosystems exposed: Sundarbans, Gulf of Mannar, Gulf of Kachchh corals
- India's National Oil Spill Disaster Contingency Plan is coordinated by the Indian Coast Guard

EXAMPLES & CASE STUDIES

- 2017 Ennore (Chennai) spill — collision of MT BW Maple and MT Dawn Kanchipuram released heavy fuel oil into the Bay of Bengal

- 2010 MV MSC Chitra collision off Mumbai harbour, spilling oil and containers
- Sundarbans mangroves and Gulf of Mannar — high-value marine biodiversity at risk
- Indian Coast Guard's National Oil Spill Disaster Contingency Plan (NOS-DCP)
- Double-hull tanker standards under the international MARPOL convention

MODEL ANSWER

Introduction: Oil pollution is the release of crude or refined petroleum into the sea — from tanker collisions and groundings, offshore-rig blowouts, pipeline leaks, refinery effluent and the routine discharge of ballast or bilge water. Once spilled, oil spreads as a thin slick that resists natural breakdown and drifts with currents and wind.

Impacts on the marine ecosystem:

- Physical — a surface film blocks sunlight and oxygen exchange, harming plankton and corals; oil coats feathers and gills, so seabirds and fish suffocate.
- Chemical — toxic polycyclic aromatic hydrocarbons (PAHs) poison eggs and larvae and bioaccumulate up the food chain, reaching humans through seafood.
- Habitat — mangroves, salt marshes, coral reefs and turtle-nesting beaches are smothered, with damage lasting years.

Why India is particularly harmed:

- A coastline of about 7,500 km, with dense traffic past the busy West Asian oil-tanker routes and the Strait of Malacca, raises collision and spill risk.
- Millions of people depend on coastal fisheries; a slick devastates catch and income, as seen near Chennai where fishers felt the impact for years.
- Sensitive ecosystems — Sundarbans mangroves, Gulf of Mannar and Gulf of Kachchh corals — are highly exposed and slow to recover.
- Limited spill-response capacity and delayed clean-up worsen outcomes; the Indian Coast Guard runs the National Oil Spill Disaster Contingency Plan.

Conclusion: For a maritime nation with fishing-dependent coasts, the priority is prevention — double-hulled tankers, strict ballast and discharge rules — backed by rapid containment and mangrove restoration to protect both biodiversity and livelihoods.

SOURCES

→Indian Coast Guard — National Oil Spill Disaster Contingency Plan
→Ministry of Earth Sciences — Marine environment and INCOIS
→MoEFCC — Coastal and marine environment

oil slick | polycyclic aromatic hydrocarbons (PAHs) | bioaccumulation | mangroves and corals | coastal fisheries livelihoods | National Oil Spill Disaster Contingency Plan | ballast and bilge discharge | double-hull tankers

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Q152

Industrial pollution of river water is a significant environmental issue in India. Discuss the various mitigation measures to deal with this problem and also the government's initiatives in this regard.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | WATER POLLUTION & RIVER MANAGEMENT | 2024

ANSWER OUTLINE

Introduction: Frame industrial effluent as a major source of river pollution and name the governing law.

Body: (1) Technical and regulatory mitigation measures. (2) Government programmes and missions. (3) Institutional and enforcement levers.

Conclusion: Move from end-of-pipe treatment to circular, polluter-pays river management.

KEY POINTS TO INCLUDE

- Water (Prevention and Control of Pollution) Act, 1974 is the anchor law; CPCB and SPCBs enforce standards
- Polluting sectors: tanneries, textiles/dyeing, distilleries, pulp-and-paper, chemicals — high BOD and heavy metals
- Effluent Treatment Plants (ETPs) per unit and Common Effluent Treatment Plants (CETPs) for clusters
- Zero Liquid Discharge (ZLD) mandated for highly polluting industries to recover and reuse water
- Online/real-time effluent monitoring connected to CPCB; polluter-pays principle and penalties
- Namami Gange under the National Mission for Clean Ganga inspects Grossly Polluting Industries (GPIs)
- National River Conservation Plan extends interception and treatment beyond the Ganga basin
- National Green Tribunal orders closures and environmental compensation on defaulting units

EXAMPLES & CASE STUDIES

- Namami Gange Programme (launched 2014) under the National Mission for Clean Ganga (NMCG)
- Kanpur tannery cluster on the Ganga — CETP and relocation directives for leather units
- National River Conservation Plan covering rivers such as the Yamuna, Cauvery and Godavari
- Central Pollution Control Board's directions on Grossly Polluting Industries
- National Green Tribunal rulings on industrial effluent and river clean-up

MODEL ANSWER

Introduction: Tanneries, textiles and dyeing units, distilleries, pulp-and-paper and chemical plants discharge effluent loaded with heavy metals, dyes and high organic load into rivers, raising biochemical oxygen demand (BOD) and killing aquatic life. The Water (Prevention and Control of Pollution) Act, 1974 is the anchor law, enforced by the Central and State Pollution Control Boards.

Mitigation measures:

- Effluent Treatment Plants (ETPs) at each unit and Common Effluent Treatment Plants (CETPs) for industrial clusters that share treatment costs.
- Zero Liquid Discharge (ZLD) for highly polluting sectors, so treated water is recovered and reused rather than dumped into the river.
- Online, real-time effluent monitoring linked to the CPCB to flag violations as they occur.
- Cleaner production processes and the polluter-pays principle, with penalties and bank guarantees on Grossly Polluting Industries.

Government initiatives:

- Namami Gange, run by the National Mission for Clean Ganga, mandates ETPs, ZLD and regular inspection of Grossly Polluting Industries along the Ganga, having cut their effluent load sharply.
- The National River Conservation Plan extends sewage and effluent interception, diversion and treatment to rivers beyond the Ganga basin.
- The National Green Tribunal orders closures and levies environmental compensation on defaulting units.

Conclusion: Lasting clean-up needs a shift from end-of-pipe treatment to circular reuse, real-time monitoring and firm enforcement — treating river health as a shared

> public resource, not an industry externality to be passed downstream.

SOURCES

- →National Mission for Clean Ganga — Namami Gange Programme
- →Central Pollution Control Board — Water quality and industrial effluent
- →MoEFCC — Water pollution control

Water Act 1974 | Common Effluent Treatment Plant (CETP) | Zero Liquid Discharge (ZLD) | Grossly Polluting Industries | Namami Gange | National Mission for Clean Ganga | polluter-pays principle | National Green Tribunal

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Q153

Seawater intrusion in the coastal aquifers is a major concern in India. What are the causes of seawater intrusion and the remedial measures to combat this hazard?

10 MARKS | 150 WORDS | 9 MIN | MEDIUM | GROUNDWATER & COASTAL AQUIFERS | 2025

ANSWER OUTLINE

Introduction: Define seawater intrusion as saline water displacing fresh groundwater in coastal aquifers.

Body: Causes (over-extraction, reduced recharge, sea-level rise) and remedial measures (managed recharge, regulation, barriers, alternative supply).

Conclusion: Sustainable coastal groundwater management.

KEY POINTS TO INCLUDE

- Seawater intrusion = inland movement of dense saline water into freshwater coastal aquifers, salinising wells and soil
- Primary cause is over-extraction lowering the freshwater table below sea level (the Ghyben-Herzberg balance is disturbed)
- Reduced recharge from urbanisation/impervious cover and declining rainfall aggravates it
- Sea-level rise, storm surges, and canals/salt pans channel saline water inland
- Minjur well-field near Chennai is a documented Indian case of intrusion from over-pumping
- Remedies: regulate coastal pumping via the Central Ground Water Authority; managed aquifer recharge (check dams, recharge wells)
- Engineered subsurface barriers or freshwater injection to repel the saline wedge

- Reduce dependence through desalination and treated-wastewater reuse

EXAMPLES & CASE STUDIES

- Minjur well-field, north Chennai (Tamil Nadu) — intrusion after over-pumping for city supply
- Saurashtra and Kachchh coast, Gujarat — salinity ingress in over-exploited coastal blocks
- Central Ground Water Authority regulation of notified over-exploited coastal areas
- Atal Bhujal Yojana — community-led sustainable groundwater management
- Desalination plants supplying Chennai to ease groundwater pressure

MODEL ANSWER

Introduction: Seawater intrusion is the inland movement of dense, saline seawater into freshwater coastal aquifers, contaminating wells and soils with salt and disturbing the natural freshwater-saltwater balance.

Causes:

- Over-extraction of groundwater lowers the freshwater table below sea level, so denser seawater pushes inland — as near Minjur, Chennai.
- Reduced natural recharge from urban concreting, falling rainfall and reduced river flow to the coast.
- Sea-level rise and storm surges, plus canals and salt pans that channel saline water inland.

Remedial measures:

- Regulate and cap coastal pumping under the Central Ground Water Authority.
- Managed aquifer recharge — check dams, recharge wells and rooftop harvesting to lift the freshwater head.
- Engineered subsurface barriers or freshwater injection to repel the saline wedge.
- Alternative supply through desalination and treated-wastewater reuse to cut groundwater dependence.

Conclusion: Demand control paired with active recharge can restore the freshwater balance and safeguard coastal aquifers for the long term.

SOURCES

→Central Ground Water Board — Coastal aquifer management and saline intrusion
→Ministry of Jal Shakti — Atal Bhujal Yojana

→MoEFCC — Coastal zone management

seawater intrusion | coastal aquifer | groundwater over-extraction | saline wedge | managed aquifer recharge | Central Ground Water Authority | subsurface barrier | desalination

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Q154

Mineral resources are fundamental to the country's economy and these are exploited by mining. Why is mining considered an environmental hazard? Explain the remedial measures required to reduce the environmental hazard due to mining.

15 MARKS | 250 WORDS | 11 MIN | MEDIUM | MINING & LAND DEGRADATION | 2025

ANSWER OUTLINE

Introduction: Note minerals' economic role and that mining damages land, water, air and ecology.

Body: (1) Why mining is an environmental hazard — multi-medium damage. (2) Remedial measures — regulatory, technical and community.

Conclusion: Sustainable, scientific mining with restoration.

KEY POINTS TO INCLUDE

- Open-cast mining and overburden dumps cause deforestation, soil erosion, land subsidence and landscape scarring
- Acid mine drainage and heavy-metal leachate pollute rivers and groundwater; siltation chokes streams
- Air pollution from blasting, haulage dust and particulate matter harms worker and community health
- Habitat loss and displacement of forest-dependent and tribal communities in biodiverse belts
- Scientific/progressive Mine Closure Plans mandate land reshaping and compensatory afforestation
- Acid mine drainage treated via limestone neutralisation and constructed wetlands; overburden stored on impervious dumps
- MMDR Act and Mineral Conservation and Development Rules, 2017 govern sustainable mining and closure
- District Mineral Foundation (statutory trust) channels mining revenue to local restoration and welfare

- Environmental Impact Assessment and prior clearance required before mining is sanctioned

EXAMPLES & CASE STUDIES

- Coal belts of Jharia and Raniganj — fires, subsidence and land degradation
- Bellary iron-ore mining (Karnataka) — court-ordered curbs on illegal and damaging mining
- District Mineral Foundation under the MMDR Amendment Act, 2015 — Pradhan Mantri Khanij Kshetra Kalyan Yojana
- Mineral Conservation and Development Rules, 2017 — progressive mine closure and reclamation
- Compensatory afforestation of mined-out land by coal and lignite PSUs

MODEL ANSWER

Introduction: Minerals power energy, steel and construction and earn vital export revenue, but extracting them scars the environment across land, water, air and biodiversity. Sound regulation and reclamation can soften, though not erase, this footprint.

Why mining is an environmental hazard:

- Land — open-cast pits and overburden dumps cause deforestation, soil erosion and land subsidence; abandoned pits leave a permanently scarred landscape.
- Water — acid mine drainage and heavy-metal leachate contaminate rivers and groundwater, while silt and tailings choke streams.
- Air — dust and particulate matter from blasting, crushing and haulage, plus diesel emissions, harm worker and community health.
- Ecology — habitat loss, fragmentation and displacement of forest-dependent and tribal communities, often in the most biodiverse belts.

Remedial measures:

- Scientific, progressive Mine Closure Plans that mandate land reshaping and compensatory afforestation as each seam is exhausted.
- Treat acid mine drainage through limestone neutralisation and constructed wetlands; store overburden on impervious dumps to cut leaching.
- Dust suppression by water sprinkling, green belts around mines and continuous emission monitoring.

- Enforce the MMDR Act and Mineral Conservation and Development Rules, and fund local restoration and welfare through the District Mineral Foundation.
- Rigorous Environmental Impact Assessment and prior clearances before any project is sanctioned.

Conclusion: The goal is sustainable, scientific mining — extracting mineral value while progressively reclaiming land, restoring ecology and sharing benefits with the communities that bear the cost.

SOURCES

→Ministry of Mines — Mines and Minerals (Development and Regulation) Act and rules
→Pradhan Mantri Khanij Kshetra Kalyan Yojana / District Mineral Foundation
→MoEFCC — Environmental Impact Assessment and forest clearance

open-cast mining | overburden dumps | acid mine drainage | land subsidence | Mine Closure Plan | MMDR Act | District Mineral Foundation | compensatory afforestation

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