Science & Technology · GS - III

Strategic competition over artificial intelligence is increasingly shaped by control over the underlying technological supply chains. Critically examine the significance of international cooperation in securing semiconductor, critical mineral and energy supply chains for India's technological sovereignty.

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MARKS	WORD LIMIT
15	~250 words

Answer Hint

Pax Silica, San Francisco Declaration, AI infrastructure, semiconductor ecosystem, rare earth elements, critical minerals, China dependence, supply-chain resilience, energy security, technology partnerships, strategic autonomy, domestic manufacturing.

Model Answer

Introduction

Artificial intelligence is not merely a software-based technology; it depends on semiconductors, critical minerals, computing infrastructure and reliable energy supplies. Competition over these inputs has made technological supply chains an important dimension of national security.

Significance of International Cooperation

1. **Supply-chain resilience:** Partnerships can diversify sources of critical minerals, semiconductor components and advanced manufacturing technologies.
2. **Reduced strategic dependence:** Cooperation can reduce excessive dependence on concentrated production and processing hubs.

3. **Technology access:** Collaboration can facilitate research, investment and access to advanced semiconductor technologies.
4. **Energy security:** AI data centres and semiconductor fabrication require reliable and substantial electricity supplies.
5. **Strategic coordination:** Initiatives such as Pax Silica provide platforms for coordinating policies among participating countries.

Challenges for India

- **Import dependence:** India remains dependent on external sources for several advanced semiconductor inputs and technologies.
- **Processing limitations:** Domestic availability of minerals does not automatically translate into economically viable extraction and processing capacity.
- **High investment requirements:** Semiconductor fabrication demands substantial capital, skilled personnel and advanced infrastructure.
- **Geopolitical risks:** Excessive dependence on any single technology partner may constrain strategic autonomy.
- **Environmental concerns:** Mining and mineral processing can create ecological and social costs.

Way Forward

India should combine international partnerships with domestic capacity-building through semiconductor manufacturing initiatives, critical mineral exploration, recycling and research and development. Diversified partnerships and resilient energy infrastructure are equally important.

Conclusion

International cooperation can strengthen India's technological sovereignty, but it must complement indigenous capabilities. A diversified, secure and sustainable supply-chain ecosystem is essential for India's long-term AI ambitions.

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