Science & Technology · GS - III

Distinguish between a Fast Breeder Reactor (FBR) and a thermal nuclear reactor. In the context of first indigenously developed prototype FBR at Kalpakkam, explain the term 'criticality'. What are its implications for clean energy future of our country?

EXAM YEAR	PAPER	SUBJECT
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MARKS	WORD LIMIT
10	~150 words

Answer Hint

FBR, thermal reactor, fast neutrons, moderator, plutonium, thorium cycle, PFBR, criticality, 500 MWe, nuclear energy

Model Answer

A thermal reactor uses slow neutrons moderated by materials such as water or heavy water, whereas a Fast Breeder Reactor uses fast neutrons without a moderator and is designed to breed more fissile material than it consumes.

The 500 MWe Prototype Fast Breeder Reactor (PFBR) at Kalpakkam, indigenously designed by IGCAR and built by BHAVINI, achieved first criticality on 6 April 2026.

Criticality means achieving a self-sustaining, controlled nuclear chain reaction in which each generation of fission produces, on average, enough neutrons to sustain the next generation. It is the essential transition from a subcritical system to controlled reactor operation.

Implications for India:

1. Better utilisation of uranium resources through plutonium breeding.

2. Supports the second stage of India’s three-stage nuclear programme.
3. Creates a pathway towards eventual utilisation of India’s thorium resources.
4. Provides reliable low-carbon baseload electricity, complementing renewables.

Therefore, PFBR represents both an energy-security and technological milestone. Its long-term contribution will depend on safety, economic viability, waste management and successful scaling.

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