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PCS Special:	08 April
26M	President confers Padma awards; Dharmendra, N. Rajam honoured राष्ट्रपति ने पद्म पुरस्कार प्रदान किए; धर्मेन्द्र और एन. राजम सम्मानित



Nation's honour



BJP MP Hema Malini receives the Padma Vibhushan, conferred posthumously to her late husband and legendary actor Dharmendra, on his behalf from President Droupadi Murmu at the Rashtrapati Bhavan in New Delhi on Monday. (PII (REPORT ON PAGE 2))

BJP MP Hema Malini receives the **Padma Vibhushan**, conferred posthumously to her late husband and legendary actor **Dharmendra**, on his behalf of President Droupadi Murmu at the Rashtrapati Bhavan in New Delhi on Monday.

President confers Padma awards; Dharmendra, N. Rajam honoured

PCS
The Hindu Bureau
 NEW DELHI

President Droupadi Murmu on Monday presented Padma Vibhushan, Padma Bhushan, and Padma Shri awards for 2026 at the Civil Investiture Ceremony-I held at the Rashtrapati Bhavan here.

Among the dignitaries present on the occasion were Vice-President C. P. Radhakrishnan, Prime Minister Narendra Modi, and Union Home Minister Amit Shah.

For this year, the President has approved 131 Padma awards, including five Padma Vibhushan, 13 Padma Bhushan, and 113 Padma Shri.

They are announced ev-

ery year on Republic Day. On Monday, the President presented two Padma Vibhushan, six Padma Bhushan, and 58 Padma Shri awards. She conferred the Padma Vibhushan on legendary Bollywood actor Dharmendra posthumously, received by his wife and MP Hema Malini; and violin virtuoso N. Rajam, for exceptional contribution to their respective fields.

'Singing violin'

Ms. Rajam pioneered a revolutionary approach to classical music by introducing "Gayaki Ang" – a technique that enables violin to emulate human vocals – earning her global renown as the "Singing



High honour: President Droupadi Murmu conferring the Padma Vibhushan on violinist N. Rajam, the Padma Bhushan on Kotak Mahindra Bank founder Uday Suresh Kumar Kotak, and the Padma Shri on cricket player Harmanpreet Kaur Bhullar in New Delhi on Monday. (PII)

Violin. The Padma Bhushan was presented to former Uttarakhand Chief Minister Bhagat Singh Koshyari; Shatavadhani R.

Ganesh, who revived the classical art form of "Avadhana"; Uday Suresh Kumar Kotak, founder of Kotak Mahindra Bank; and emi-

nent gastroenterologist Kallipatti Ramasamy Palaniswamy. The award was conferred posthumously on

former MP Vijay Kumar Malhotra and "ad guru" Piyush Pandey. The remaining Padma awardees will be felicitated

in the second round of the ceremony to be held later. Among the Padma Shri recipients were Prosenjit Chatterjee, one of the most influential figures of Indian cinema; Harmanpreet Kaur Bhullar, an inspirational figure in Indian women's cricket; para athlete Praveen Kumar; former Central Reserve Police Force (CRPF) Director-General K. Vijay Kumar; folk musician Mir Haji Kasam; Tamil devotional music artist N. Swaminathan; and traditional folk music artist Taga Ram Bheel.

Other awardees

While Silambam master K. Pajanjel was awarded for promoting the ancient art

originating from Tamil Nadu, hockey coach Baldev Singh was felicitated for distinguished service to Indian hockey for over four decades.

"Kantha" embroidery artist Tripti Mukherjee, social worker Janardan Bapurao Bothe, and husband-wife duo of Dr. Ramchandra Godbole and Suneeta Godbole, who provided healthcare and social support to tribal communities, also received the Padma Shri. Environmentalists Devaki Amma G. and Hally War; bibliophile Ankegowda M.; Sanskrit scholar Vempaty Kutumba Shastri; and botanist Gambir Singh Yonzone were the others who received the Padma Shri.

26M. President confers Padma awards; Dharmendra, N. Rajam honoured

राष्ट्रपति ने पद्म पुरस्कार प्रदान किए; धर्मेंद्र और एन. राजम सम्मानित

- Among the dignitaries present on the occasion were **Vice-President C. P. Radhakrishnan, Prime Minister Narendra Modi, and Union Home Minister Amit Shah.**
 इस अवसर पर उपस्थित गणमान्य व्यक्तियों में उपराष्ट्रपति सी. पी. राधाकृष्णन, प्रधानमंत्री नरेंद्र मोदी, और केंद्रीय गृह मंत्री अमित शाह शामिल थे।
- For this year, the President has approved 131 **Padma awards**, including five **Padma Vibhushan**, 13 **Padma Bhushan**, and 113 **Padma Shri.**
 इस वर्ष राष्ट्रपति ने 131 पद्म पुरस्कारों को स्वीकृति दी है, जिनमें पाँच पद्म विभूषण, 13 पद्म भूषण, और 113 पद्म श्री शामिल हैं।
- They are announced every year on **Republic Day.**
 इनकी घोषणा हर वर्ष गणतंत्र दिवस पर की जाती है।
- She conferred the **Padma Vibhushan** on legendary **Bollywood actor Dharmendra** posthumously, received by his wife and MP **Hema Malini**; and **violin virtuoso N. Rajam**, for exceptional contribution to their respective • elds.
 उन्होंने महान बॉलीवुड अभिनेता धर्मेंद्र को मरणोपरांत पद्म विभूषण प्रदान किया, जिसे उनकी पत्नी और सांसद हेमा मालिनी ने ग्रहण किया; तथा वायलिन वादक एन. राजम को उनके-अपने क्षेत्रों में असाधारण योगदान के लिए सम्मानित किया।

'Singing violin' 'सिंगिंग वायलिन'

- Ms. **Rajam** pioneered a revolutionary approach to classical music by introducing "**Gayaki Ang**" — a technique that enables violin to emulate human vocals — earning her global



renown as the “Singing Violin”.

सुश्री राजम ने शास्त्रीय संगीत में “गायकी अंग” नामक क्रांतिकारी शैली प्रस्तुत की — एक ऐसी तकनीक जो वायलिन को मानवीय स्वर की तरह प्रस्तुत करने में सक्षम बनाती है — जिससे उन्हें वैश्विक स्तर पर “सिंगिंग वायलिन” के रूप में प्रसिद्धि मिली।

- The **Padma Bhushan** was presented to former **Uttarakhand Chief Minister Bhagat Singh Koshyari; Shatavadhani R. Ganesh**, who revived the classical art form of “Avadhana”; **Uday Suresh Kumar Kotak**, founder of **Kotak Mahindra Bank**; and eminent gastroenterologist **Kallipatti Ramasamy Palaniswamy**.
पद्म भूषण पूर्व उत्तराखंड मुख्यमंत्री भगत सिंह कोश्यारी; “अवधान” नामक शास्त्रीय कला रूप को पुनर्जीवित करने वाले शतावधानी आर. गणेश; कोटक महिंद्रा बैंक के संस्थापक उदय सुरेश कुमार कोटक; और प्रसिद्ध गैस्ट्रोएंटेरोलॉजिस्ट कल्लिपट्टी रामासामी पलानीस्वामी को प्रदान किया गया।
- The award was conferred posthumously on former MP **Vijay Kumar Malhotra** and “ad guru” **Piyush Pandey**.
यह पुरस्कार पूर्व सांसद विजय कुमार मल्होत्रा और “एड गुरु” पीयूष पांडे को मरणोपरांत प्रदान किया गया।
- The remaining **Padma awardees** will be felicitated in the second round of the ceremony to be held later.
शेष पद्म पुरस्कार विजेताओं को बाद में आयोजित समारोह के दूसरे चरण में सम्मानित किया जाएगा।
- Among the **Padma Shri** recipients were **Prosenjit Chatterjee**, one of the most influential figures of Indian cinema; **Harmanpreet Kaur Bhullar**, an inspirational figure in Indian women’s cricket; para athlete **Praveen Kumar**; former **Central Reserve Police Force (CRPF) Director-General K. Vijay Kumar**; folk musician **Mir Haji Kasam**; Tamil devotional music artist **N. Swaminathan**; and traditional folk music artist **Taga Ram Bheel**.
पद्म श्री प्राप्तकर्ताओं में भारतीय सिनेमा की प्रभावशाली हस्तियों में से एक प्रोसेनजीत चटर्जी; भारतीय महिला क्रिकेट की प्रेरणास्रोत हरमनप्रीत कौर भुल्लर; पैरा एथलीट प्रवीण कुमार; पूर्व केंद्रीय रिजर्व पुलिस बल (CRPF) महानिदेशक के. विजय कुमार; लोक संगीतकार मीर हाजी कासम; तमिल भक्ति संगीत कलाकार एन. स्वामीनाथन; और पारंपरिक लोक संगीत कलाकार तगा राम भील शामिल थे।

Other awardees

अन्य पुरस्कार विजेता

- While **Silambam** master **K. Pajanivel** was awarded for promoting the ancient art originating from Tamil Nadu, hockey coach **Baldev Singh** was felicitated for distinguished service to Indian hockey for over four decades.
जहाँ सिलंबम गुरु के. पजानिवेल को तमिलनाडु की प्राचीन कला के प्रचार-प्रसार के लिए सम्मानित किया गया, वहीं हॉकी कोच बलदेव सिंह को भारतीय हॉकी में चार दशकों से अधिक समय तक विशिष्ट सेवा के लिए सम्मानित किया गया।
- “**Kantha**” embroidery artist **Tripti Mukherjee**, social worker **Janardan Bapurao Bothe**, and husband-wife duo of **Dr. Ramchandra Godbole** and **Suneeta Godbole**, who provided healthcare and social support to tribal communities, also received the **Padma Shri**.
“कांथा” कढ़ाई कलाकार तृप्ति मुखर्जी, समाजसेवी जनार्दन बापुराव बोथे, तथा जनजातीय समुदायों को स्वास्थ्य सेवा और सामाजिक सहयोग प्रदान करने वाले दंपति डॉ. रामचंद्र गोडबोले और सुनीता गोडबोले को भी पद्म श्री प्रदान किया गया।
- Environmentalists **Devaki Amma G.** and **Hally War**; bibliophile **Ankegowda M.**; Sanskrit scholar **Vempaty Kutumba Shastry**; and botanist **Gambir Singh Yonzon** were the others who received the **Padma Shri**.
पर्यावरणविद् देवकी अम्मा जी. और हैली वार; पुस्तक प्रेमी अंकेगौड़ा एम.; संस्कृत विद्वान वेम्पटी कुटुम्ब शास्त्री; तथा वनस्पति वैज्ञानिक गंबीर सिंह यॉंजोन भी पद्म श्री प्राप्त करने वालों में शामिल थे।



GS Paper 1: Society		26 May 2026
TOPICS COVERED		
26M	From black to grey काले से धूसर तक	
26M	Baby bait बेबी बेट	
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GS I: Society

From black to grey

India needs to prepare for a future with an ageing population

If India wanted proof of its shifting demographic status, then the latest SRS bulletin, 2024, offers incontrovertible proof – falling fertility rate, low crude birth rate – to show that India's pace of population growth is considerably slowing down. While the pundits predict at least three decades of population growth for the country, the plunging fertility rate certainly commands pause for contemplation and forward planning, for India to crest a crisis that several nations are struggling to manage. India's Total Fertility Rate has dropped to 1.9, lower than the replacement level of 2.1, aided, in large, by a falling birth rate. As per the latest SRS data, India's birth rate fell from 21 in 2014 to 18.3 in 2024; while death rate marginally went down from 6.7 to 6.4. The country is well on its way from population 'explosion' to one of ageing population and shrinking workforce expansion. India might still reap its demographic dividend – the median age in India is 29.2 years, in stark contrast to China (median age of 40.2), and several other European nations. In 2026, India has approximately 370 to 380 million youth, aged 15-29 years, representing roughly 27% of the country's population. Estimates also put India's below 35 years population at over 65% of the total, making it one of the world's youngest cohorts.

In demographic terms, falling birth rate reflects a decline in fertility, linked to factors such as urbanisation, better education, access to contraception, and the desire for smaller families. India's high life expectancy at birth (72 years) and dipping death rate offer the other side of the transition paradigm, implying better access to health care. India needs to reassess the path ahead and pivot to prepare for the needs of a future greying nation, when the demographic dividend disappears. The SRS data, however, flags a more immediate concern too – one of vast regional and rural/urban disparities. Overall, performance in rural areas is not on a par with the urban centres, and the southern States continue to stay ahead of the northern States. Overall, child survival improvements are real (the Infant Mortality Rate has fallen to 24) but high-burden States in the north are still at a much higher IMR. States and areas that lag will need targeted interventions, whether it is access to health care, awareness or education facilities to effect a national convergence.

Mortality Rate has fallen to 24) but high-burden States in the north are still at a much higher IMR.

समग्र रूप से, बाल जीवितता में सुधार वास्तविक हैं (शिशु मृत्यु दर घटकर 24 हो गई है), किन्तु उत्तर के उच्च-भार वाले राज्यों में IMR अब भी काफी अधिक है।

26M. From black to grey

काले से धूसर तक

- India might still reap its **demographic dividend** — the median age in India is **29.2 years**, in stark contrast to **China** (median age of **40.2**), and several other European nations.

भारत अभी भी अपने **जनसांख्यिकीय लाभ** का लाभ उठा सकता है — भारत की मध्य आयु **29.2 वर्ष** है, जो **चीन** (मध्य आयु **40.2 वर्ष**) तथा अनेक यूरोपीय देशों की तुलना में अत्यंत कम है।

- In **2026**, India has approximately **370 to 380 million youth**, aged **15-29 years**, representing roughly **27%** of the country's population.

2026 में भारत में लगभग **370 से 380 मिलियन युवा**, जिनकी आयु **15-29 वर्ष** है, निवास करते हैं, जो देश की कुल जनसंख्या का लगभग **27%** प्रतिनिधित्व करते हैं।

- Estimates also put India's below **35 years** population at over **65%** of the total, making it one of the world's youngest cohorts.

अनुमानों के अनुसार, भारत की **35 वर्ष से कम आयु** की जनसंख्या कुल आबादी के **65%** से अधिक है, जिससे यह विश्व के सबसे युवा समूहों में से एक बनता है।

- In demographic terms, falling birth rate reflects a decline in fertility, linked to factors such as **urbanisation, better education, access to contraception, and the desire for smaller families.**

जनसांख्यिकीय दृष्टि से, घटती जन्म दर प्रजनन में गिरावट को दर्शाती है, जो **शहरीकरण, बेहतर शिक्षा, गर्भनिरोधक साधनों की उपलब्धता तथा छोटे परिवारों की इच्छा** जैसे कारकों से जुड़ी हुई है।

- India's high **life expectancy at birth (72 years)** and dipping death rate offer the other side of the transition paradigm, implying better access to health care.

भारत की उच्च **जन्मकालीन जीवन प्रत्याशा (72 वर्ष)** तथा घटती मृत्यु दर संक्रमण प्रक्रिया के दूसरे पक्ष को प्रस्तुत करती है, जो स्वास्थ्य सेवाओं तक बेहतर पहुँच का संकेत देती है।

- Overall, child survival improvements are real (the **Infant Mortality Rate** has fallen to **24**) but high-burden States in the north are still at a much higher IMR.



Baby bait

Incentives for having more children will keep poorer women out of workforce

Departing from decades of family-planning policies in India, the Andhra Pradesh government has proposed new incentives for families in the State to have three or more children. The State's total fertility rate has dropped from around 3 in the 1990s to 1.5 today, well below the replacement rate of 2.1 as well as the national average. According to some projections, nearly a quarter of the State population will be elderly by the mid-century, resulting in a smaller workforce relative to the old-age dependency burden. But while South India is ageing faster than the North, the evidence for cash incentives leading to larger families and doing so without significant socio-economic trade-offs is weak. At present, Andhra Pradesh has proposed ₹30,000 for a third child and ₹40,000 for a fourth; ₹1,000 monthly for five years; free education until the age of 18; provisions for mothers to work from home; enhanced funding for the 'Thalliki Vandanam' scheme, which currently pays ₹15,000 per child for school attendance; longer maternity leave; and other Anganwadi and childcare support. While one-time payments may encourage some families to have children earlier than planned, evidence from India and around the world indicates that they rarely produce large or sustained increases in fertility.

People in the State are having fewer children likely because housing and private education have become more expensive, stable employment is accessible later rather than sooner, and aspirations around children's quality of life have expanded. The proposed incentives are unlikely to offset the 18-year cost of raising one additional child even under optimistic assumptions about public provisions. The State government has also said that it wants to double women's labour force participation, which is antithetical to having more children with the existing social infrastructure. Indeed, France and the Nordic states were able to maintain this two-pronged success only by investing heavily in universal childcare, flexible working arrangements, paid parental leave, high-quality public schooling, and legal protections against career penalties that mothers are at risk of. Otherwise, as is already prevalent in India, mothers end up absorbing more unpaid care work and cannot enter the workforce. Crucially, the economics of the proposed incentives are more likely to influence poorer households seeking immediate cash, leading to an uncomfortable possibility: the State modestly increasing the size of economically vulnerable families without guaranteeing adequate long-term support for child development. Finally, ecological concerns such as water scarcity, urban congestion, waste management, and recycling will also be tested in the long term. While the southern States are anxious about population-based delimitation, asking families to alter personal decisions about having children to address a problem of constitutional design would be a profound mismatch between instrument and objective.

26M. Baby bait

बेबी बेट

• The State's **total fertility rate** has dropped from around 3 in the 1990s to 1.5 today, well below the **replacement rate** of 2.1 as well as the national average.

राज्य की कुल प्रजनन दर 1990 के दशक में लगभग 3 से घटकर आज 1.5 रह गई है, जो प्रतिस्थापन दर 2.1 तथा राष्ट्रीय औसत दोनों से काफी कम है।

• At present, Andhra Pradesh has proposed ₹30,000 for a third child and ₹40,000 for a fourth; ₹1,000 monthly for five years; free education until the age of 18; provisions for mothers to work from home; enhanced funding for the 'Thalliki Vandanam' scheme, which currently pays ₹15,000 per child for school attendance; longer maternity leave; and other Anganwadi and childcare support.

वर्तमान में, आंध्र प्रदेश ने तीसरे बच्चे के लिए ₹30,000 और चौथे बच्चे के लिए ₹40,000; पाँच वर्षों तक प्रतिमाह ₹1,000; 18 वर्ष की आयु तक निःशुल्क शिक्षा; माताओं के लिए घर से कार्य करने की व्यवस्था; वर्तमान में विद्यालय उपस्थिति हेतु प्रति बच्चे ₹15,000 प्रदान करने वाली 'थल्लिकी वंदनम' योजना के लिए बढ़ा हुआ वित्तपोषण; अधिक अवधि का मातृत्व अवकाश; तथा अन्य आंगनवाड़ी एवं बाल-देखभाल सहायता प्रस्तावित की है।

• Indeed, France and the Nordic states were able to maintain this two-pronged success only by investing heavily in universal childcare, flexible working arrangements, paid parental leave, high-quality public schooling, and legal protections against career penalties that mothers are at risk of.

वास्तव में, फ्रांस और नॉर्डिक देशों ने सार्वभौमिक बाल-देखभाल, लचीली कार्य-व्यवस्था, वेतन सहित अभिभावकीय अवकाश, उच्च-गुणवत्ता वाली सार्वजनिक शिक्षा तथा माताओं के करियर पर पड़ने वाले प्रतिकूल प्रभावों से सुरक्षा देने वाले कानूनी प्रावधानों में भारी निवेश करके ही इस दोहरी सफलता को बनाए रखा।

• Finally, ecological concerns such as water scarcity, urban congestion, waste management, and recycling will also be tested in the long term.

अंततः, जल-संकट, शहरी भीड़भाड़, अपशिष्ट प्रबंधन तथा पुनर्चक्रण जैसी पारिस्थितिक चिंताओं की भी दीर्घकाल में परीक्षा होगी।

Pak. Shia Muslims deported from UAE return to lost jobs and frozen savings

Since the Iran war began, the UAE has reportedly deported thousands of Shia Muslims from Pakistan, home to the biggest Shia population after Iran; even as Islamabad has not openly taken up the issue for 'diplomatic reasons', Human Rights Watch, probing the reports, says the cases are 'alarming'

CS in Society/Religion

Reuters
CHAKWAL

In a cluster of villages in Pakistan's largely rural Chakwal district, more than 100 Shia Muslims have returned from the United Arab Emirates without jobs, luggage or access to the savings they spent years building abroad.

They are among potentially thousands of Shias deported from the UAE to Pakistan during the Iran war, raising alarm in Pakistan's Shia community and prompting Human Rights Watch to investigate.

Reuters reviewed immigration documents, visa-status screenshots and flight details for 103 Pakistanis who said they were deported Shias, interviewing 24 of them. Each interviewee said they were unable to retrieve luggage or savings before being placed on flights alongside dozens of other Shia deportees.

'7,500 deportees'

A database compiled by the Pakistani Shia political organisation Majlis Wahdat-e-Muslimeen, seen by Reuters, lists 7,500 Pakistani Shias deported from the Gulf Arab state since February 28, when the U.S. and Israel launched strikes on Iran.

Group spokesperson Mohsin Abidi said the actual number was likely far higher.

Leaders of Pakistan's Shia community say the



Sent back home: A 24-year-old airport customer service officer and a 26-year-old building security officer, both Shias who were working in the UAE, pose after being deported in Chakwal, Pakistan. REUTERS

deportations have accelerated during the war, which has heightened tensions across the Gulf, particularly as Iran responded by launching missile and drone strikes on the UAE.

Reuters could not determine the criteria the UAE authorities used to select the Pakistanis for deportation.

The UAE Ministry of Foreign Affairs declined to comment on a list of questions from Reuters about the deportations.

Pakistan's Interior Ministry said in a statement

the UAE had not deported anyone based on sect, saying any deportations were for violating UAE regulations. Pakistan's Foreign Ministry said "deportation figures remain steady" this year, without providing details.

But a senior Pakistani government official, who asked not to be identified due to the sensitivity of the matter, said Islamabad was "reviewing the situation after receiving thousands of Pakistanis deported from UAE", most of them Shias.

He said the Pakistani go-

vernment had not openly taken up the case for "diplomatic reasons", without offering details.

Human Rights Watch's deputy West Asia and North Africa director, Michael Page, said that "reports of UAE deportations of Pakistani Shia residents are deeply alarming" and the group was "investigating these serious allegations".

About 1.8 million Pakistanis live and work in the UAE, according to the Association of Overseas Pakistanis, accounting for

more than \$6 billion a year in remittances to Pakistan, which has also been working as a mediator to de-escalate the Iran conflict.

After Iran, Pakistan has the world's biggest Shia population, at around 40 million, or 17% of Pakistan's total.

The UAE and other Gulf Arab states are Sunni-ruled.

'Back to zero'

"The crackdown on Shia Muslims in the UAE is not new," said Falah Sayed, human rights officer at MENA Rights Group. The Geneva-based NGO has "documented cases of arbitrary detention and enforced disappearance targeting foreign nationals of Shia origin for years", but recent reports indicate "an escalation in this crackdown", she said.

Ali Ahmed Naqvi and his wife, Quratul Ain, both Shias, moved to Dubai in 2024 to work in technology.

Mr. Naqvi said his wife was deported on April 18 after being detained when she applied to change her employment visa with the immigration authorities as she switched jobs.

Mr. Naqvi said he was detained when trying to board a flight to return to Pakistan and taken to a UAE facility where he said he met other Shias facing deportation. He said he was put on a flight with 93 other detainees, all of them Shias.

"No one told us why we

were being deported," he said.

In Pakistan's Kurram district, a predominantly Shia area in the northwest that has endured decades of sectarian violence, community leader Musarat Hussain Bangash said 1,500 people from the region had been sent back from the UAE since the war began, most of whom were supporting extended families.

One is Laiq Hussain, who worked in Dubai for 20 years and managed to buy a cargo van and set up a business.

"In just one day, or rather in minutes, everything was over," Mr. Hussain said.

In Chakwal in the central province of Punjab, a 38-year-old former Dubai Metro manager, who said he was deported after 16 years in the emirate, sat with a handful of neighbours.

One who worked in construction said UAE officials asked him about salary and remittances.

"Then they asked whether I fund Iran," said the 41-year-old, who asked not to be named because he hoped to pursue work in another Gulf state.

The metro manager said police took his phones, handcuffed him and, after detaining him for nine days, loaded him onto a darkened, overcrowded bus to the airport.

"I was back to zero in the blink of an eye," he said.

26M. Pak. Shia Muslims deported from UAE return to lost jobs and frozen savings

यूई से निर्वासित पाकिस्तानी शिया मुसलमान खोई नौकरियों और जमे हुए बचत धन के साथ लौटे

- Since the **Iran war** began, the **UAE** has reportedly deported thousands of **Shia Muslims** from **Pakistan**, home to the biggest Shia population after Iran; even as **Islamabad** has not openly taken up the issue for 'diplomatic reasons', **Human Rights Watch**, probing the reports, says the cases are 'alarming'.

ईरान युद्ध शुरू होने के बाद से, यूई ने कथित रूप से पाकिस्तान से हजारों शिया मुसलमानों को निर्वासित किया है, जहाँ ईरान के बाद सबसे बड़ी शिया आबादी रहती है; जबकि इस्लामाबाद ने 'कूटनीतिक कारणों' से इस मुद्दे को खुलकर नहीं उठाया है, वहीं इन रिपोर्टों की जांच कर रहे **ह्यूमन राइट्स वॉच** ने इन मामलों को 'चिंताजनक' बताया है।

- After **Iran**, Pakistan has the world's biggest **Shia** population, at around **40 million**, or **17%** of **Pakistan's** total.

ईरान के बाद पाकिस्तान में दुनिया की सबसे बड़ी शिया आबादी है, जो लगभग **4 करोड़** या पाकिस्तान की कुल आबादी का **17%** है।

- The **UAE** and other **Gulf Arab** states are **Sunni-ruled**.

यूई और अन्य खाड़ी अरब देश **सुन्नी शासन** वाले हैं।



- “The crackdown on Shia Muslims in the UAE is not new,” said Falah Sayed, human rights officer at MENA Rights Group.
 “यूएई में शिया मुसलमानों पर कार्रवाई नई नहीं है,” MENA Rights Group की मानवाधिकार अधिकारी फलाह सैयद ने कहा।

GS Paper II: Polity		26 May 2026
TOPICS COVERED		
26M	Finance Commission transfers and equity issue वित्त आयोग अंतरण और समानता का प्रश्न	

Finance Commission transfers and equity issue

GS II: Polity

The Finance Commission (FC), constituted under the Constitution, determines the distribution of the Union's gross tax revenues between Centre and States and among the States themselves to address vertical and horizontal fiscal imbalances. Following earlier commissions, the 16th FC has retained the vertical devolution share of 41% for the States and continued to emphasise equity as the guiding principle in determining horizontal transfers.

During consultations with the FC, States raised several concerns regarding the structure of fiscal transfers. Since cesses and surcharges exceeded 15% of gross tax revenues, they should either be included in the divisible pool or capped at around 8%-10%. In addition, the Centre receives substantial non-tax revenues from natural resource extraction, asset monetisation and surplus transfers from the Reserve Bank of India.

States and pressures

States also face mounting fiscal pressures. The COVID-19 pandemic, structural changes introduced by the Goods and Services Tax (and recent rate rationalisation from four rates to two principal rates), and mounting public debt further constrained their fiscal space. Moreover, the growing dominance of Centrally Sponsored Schemes has narrowed their fiscal autonomy (the restructuring of the National Rural Employment Guarantee programme requires States to bear 40% of programme costs), while buoyancy of central taxes has slowed. These factors could reduce the actual transfers to States, leading several States to demand a 50% vertical share.

Another concern is frequent changes in devolution criteria and their assigned weights across successive FCs in order to transfer more resources to fiscally weaker States, making it difficult for States to predict their future shares. Many States called for a reduced weight for the income-distance criterion and suggested adjusting it for purchasing-power differences to better reflect variations in the cost of living.

Over time, the shares of better-performing States have steadily declined compared with those of major beneficiary States. The combined shares of four major beneficiary States – Bihar (including Jharkhand), Madhya Pradesh (including Chhattisgarh), Uttar Pradesh (including Uttarakhand) and West Bengal – increased from 42.5% during the Sixth FC period to 51% under the 15th FC. In contrast, the combined share of the four southern States – Andhra Pradesh (including Telangana), Karnataka, Kerala and Tamil Nadu – declined from 24.8% to 15.8%, widening the gap to 35.2%. Continued reliance on unconditional equalisation transfers may weaken incentives for revenue mobilisation and fiscal discipline in weaker States. Moreover, rising



K.R. Shanmugam

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Under the 16th Finance Commission, arbitrary weights affect better-performing States

transfers to poorer States have not eliminated disparities in public expenditure even on basic services. In 2022-23, Bihar spent ₹937 per person on health, against Arunachal Pradesh's ₹10,148 (10.8 times lower), while Bihar's per-student spending on elementary education in 2023-24 was ₹20,282 compared with Sikkim's ₹1,30,498. These gaps show that fiscal transfers alone have not ensured convergence in public service delivery.

Recommendations of Finance Commission

The 16th FC accepted the Centre's argument that cesses and surcharges cannot be shared because they often finance welfare and infrastructure programmes that indirectly benefit States and retained 41% vertical share. It also abolished revenue-deficit grants as well as sector-specific and State-specific grants and recommended that States discontinue off-budget borrowings, bring all liabilities onto their budgets and maintain fiscal deficits below 3%. These measures could increase short-term fiscal stress for States.

The FC made only modest adjustments to the criteria used by the 15th FC. Income distance received a weight of 42.5%; population 17.5%; area 10%; forest cover 10%; and the demographic criterion – modified by replacing the inverse fertility rate with population growth – 10%. It also introduced States' contribution to national GDP, replacing tax effort, with a 10% weight. However, instead of using actual GSDP shares, the FC applied a square-root transformation to State GSDP shares, with a weight of just 10%, far below the expected 25%. This significantly reduced the advantage of economically stronger States and altered the rankings. Maharashtra's actual GSDP share of 14.23% fell to 8.31% after the transformation, while Tamil Nadu's declined from 9.09% to 6.67% and Karnataka's from 8.95% to 6.59%. At the same time, the shares of many smaller States increased.

Consequently, overall devolution shares of 14 States rose marginally compared with the 15th FC. Karnataka gained the most (0.484 percentage point increase), followed by Kerala (0.457) and Gujarat (0.277). Tamil Nadu saw only a negligible rise, from 4.079% to 4.097%. Meanwhile, the shares of 14 States declined, with Madhya Pradesh experiencing the largest reduction (0.503 percentage points), followed by Arunachal Pradesh (0.403) and Uttar Pradesh (0.32).

From a longer-term perspective, however, disparities remain substantial. Under the 16th FC, the southern States' share has risen slightly to about 17%, while the share of the largest beneficiary States has fallen to just under 50% – a shift of only about 1.2% in favour of the southern States. The balance between equity and efficiency has changed only marginally. Under the 15th FC, efficiency-related criteria accounted for 25% of

the weight and equity criteria for 75%; under the 16th FC, this has shifted to 30% and 70%, respectively – an adjustment too small to significantly alter outcomes. Poorer States such as Uttar Pradesh (17.62%), Bihar (9.95%), Madhya Pradesh (7.35%) and West Bengal (7.22%) continue to receive larger shares than fiscally stronger and better-performing States.

Devolutions with alternative schemes

Alternative weighting schemes suggest that the outcomes could have been different. If the FC had assigned a 25% weight to the square root of GDP contribution while reducing the weight of income distance to 27.5%, Karnataka's share would have increased from 4.131% to 4.928%, Maharashtra's from 6.441% to 7.218%, and Tamil Nadu's from 4.097% to 4.867%. Under an equal-weight scheme across the six criteria, their shares would have risen further to 5.544%, 7.845%, and 5.246%, respectively.

Had the FC used actual GSDP share (instead of square root formula) with 10% weight, the devolution shares of Maharashtra, Karnataka and Tamil Nadu would have increased to 7.033%, 4.367% and 4.342% respectively. With 25% weight (and 27.5% weight to income distance), they would have increased to 8.698%, 5.517% and 5.478%. With equal weighting scheme, their respective shares might have increased to 8.833%, 5.937% and 5.653%. That is, their respective shares increased by 2.392%, 1.806% and 1.556%.

Given that the 16th FC estimates total vertical transfers of ₹104 lakh crore over the award period, these differences are significant. A 2.392% increase in Maharashtra's share would translate into an additional ₹2.49 lakh crore, or about ₹49,744 crore annually. Karnataka's additional 1.806% share would yield about ₹1.88 lakh crore, or roughly ₹37,565 crore annually. Tamil Nadu's 1.556% increase would amount to approximately ₹1.62 lakh crore, or ₹32,365 crore annually.

In India, unlike other large federations such as Australia and China, States with greater political influence in terms of parliamentary representation are not necessarily the economically stronger ones. Consequently, these States tend to receive higher fiscal transfers. The issue is likely to intensify after delimitation, as governments may have stronger incentives to favour politically influential States. Since the FC's primary objective is to address both vertical and horizontal fiscal imbalances, future FCs should place greater emphasis on fiscal capacity and fiscal outcome indicators rather than relying predominantly on non-fiscal indicators. Additionally, they should adopt more data-driven approaches for assigning weights, such as the principal component analysis method.

The views expressed are personal

26M. Finance Commission transfers and equity issue वित्त आयोग अंतरण और समानता का प्रश्न

- Following earlier commissions, the **16th FC** has retained the vertical devolution share of **41%** for the States and continued to emphasise **equity** as the guiding principle in determining horizontal transfers.



पूर्ववर्ती आयोगों की परंपरा का अनुसरण करते हुए, 16वें वित्त आयोग ने राज्यों के लिए ऊर्ध्वाधर हस्तांतरण में 41% हिस्सेदारी को बनाए रखा है तथा क्षैतिज हस्तांतरण निर्धारित करने में समानता को मार्गदर्शक सिद्धांत के रूप में महत्व देना जारी रखा है।

- During consultations with the FC, States raised several concerns regarding the structure of **fiscal transfers**.

वित्त आयोग के साथ परामर्श के दौरान राज्यों ने राजकोषीय हस्तांतरणों की संरचना को लेकर अनेक चिंताएँ व्यक्त कीं।

- Since **cesses and surcharges** exceeded 15% of gross tax revenues, they should either be included in the divisible pool or capped at around 8%-10%.

चूँकि उपकर और अधिभार सकल कर राजस्व के 15% से अधिक हो चुके हैं, इसलिए उन्हें या तो विभाज्य पूल में शामिल किया जाना चाहिए अथवा लगभग 8%-10% तक सीमित किया जाना चाहिए।

- In addition, the Centre receives substantial **non-tax revenues** from natural resource extraction, asset monetisation and surplus transfers from the Reserve Bank of India.

इसके अतिरिक्त, केंद्र को प्राकृतिक संसाधनों के दोहन, परिसंपत्ति मुद्राकरण तथा भारतीय रिज़र्व बैंक से अधिशेष अंतरण के माध्यम से पर्याप्त गैर-कर राजस्व प्राप्त होता है।

States and pressures

राज्य और दबाव

- Moreover, the growing dominance of **Centrally Sponsored Schemes** has narrowed their fiscal autonomy (the restructuring of the **National Rural Employment Guarantee programme** requires States to bear 40% of programme costs), while buoyancy of central taxes has slowed.

इसके अतिरिक्त, केंद्र प्रायोजित योजनाओं के बढ़ते प्रभुत्व ने राज्यों की राजकोषीय स्वायत्तता को सीमित कर दिया है (राष्ट्रीय ग्रामीण रोजगार गारंटी कार्यक्रम के पुनर्गठन के अंतर्गत राज्यों को कार्यक्रम की 40% लागत वहन करनी पड़ती है), जबकि केंद्रीय करों की वृद्धि दर धीमी हो गई है।

- Many States called for a reduced weight for the **income-distance criterion** and suggested adjusting it for **purchasing-power differences** to better reflect variations in the cost of living.

कई राज्यों ने आय-दूरी मानदंड के भार को कम करने की माँग की तथा इसे क्रय-शक्ति के अंतर के अनुसार समायोजित करने का सुझाव दिया, ताकि जीवन-यापन की लागत में भिन्नताओं को बेहतर ढंग से दर्शाया जा सके।

- The combined shares of four major beneficiary States — **Bihar** (including Jharkhand), **Madhya Pradesh** (including Chhattisgarh), **Uttar Pradesh** (including Uttarakhand) and **West Bengal** — increased from 42.5% during the Sixth FC period to 51% under the 15th FC.

चार प्रमुख लाभार्थी राज्यों — बिहार (झारखंड सहित), मध्य प्रदेश (छत्तीसगढ़ सहित), उत्तर प्रदेश (उत्तराखंड सहित) और पश्चिम बंगाल — की संयुक्त हिस्सेदारी छठे वित्त आयोग की अवधि में 42.5% से बढ़कर 15वें वित्त आयोग के अंतर्गत 51% हो गई।

- Continued reliance on unconditional **equalisation transfers** may weaken incentives for revenue mobilisation and fiscal discipline in weaker States.

बिना शर्त समानता आधारित हस्तांतरणों पर निरंतर निर्भरता कमजोर राज्यों में राजस्व संग्रहण और राजकोषीय अनुशासन के प्रोत्साहनों को कमजोर कर सकती है।

Recommendations of Finance Commission

वित्त आयोग की सिफारिशें

- The 16th FC accepted the Centre's argument that **cesses and surcharges** cannot be shared because they often finance welfare and infrastructure programmes that indirectly benefit States and retained 41% vertical share.

16वें वित्त आयोग ने केंद्र के इस तर्क को स्वीकार किया कि उपकर और अधिभार साझा नहीं किए जा सकते,



क्योंकि वे प्रायः कल्याणकारी एवं अवसंरचना कार्यक्रमों को वित्तपोषित करते हैं, जिनसे अप्रत्यक्ष रूप से राज्यों को लाभ मिलता है, और इसने 41% ऊर्ध्वाधर हिस्सेदारी को बनाए रखा।

- It also abolished revenue-deficit grants as well as sector-specific and State-specific grants and recommended that States discontinue off-budget borrowings, bring all liabilities onto their budgets and maintain fiscal deficits below 3%.
इसने राजस्व-घाटा अनुदानों के साथ-साथ क्षेत्र-विशिष्ट और राज्य-विशिष्ट अनुदानों को भी समाप्त कर दिया तथा राज्यों को बजट-बाह्य उधारों को बंद करने, सभी देनदारियों को अपने बजट में शामिल करने और राजकोषीय घाटे को 3% से नीचे बनाए रखने की सिफारिश की।
- It also introduced States' contribution to national GDP, replacing tax effort, with a 10% weight. इसने कर-प्रयास के स्थान पर राष्ट्रीय GDP में राज्यों के योगदान को शामिल किया और उसे 10% भार प्रदान किया।
- However, instead of using actual GSDP shares, the FC applied a square-root transformation to State GSDP shares, with a weight of just 10%, far below the expected 25%.
हालाँकि, वास्तविक GSDP हिस्सेदारी का उपयोग करने के बजाय, वित्त आयोग ने राज्यों की GSDP हिस्सेदारी पर वर्गमूल परिवर्तन लागू किया, जिसका भार केवल 10% रखा गया, जो अपेक्षित 25% से काफी कम था।
- This significantly reduced the advantage of economically stronger States and altered the rankings.
इससे आर्थिक रूप से मजबूत राज्यों के लाभ में उल्लेखनीय कमी आई और उनकी रैंकिंग में परिवर्तन हुआ।
- Consequently, overall devolution shares of 14 States rose marginally compared with the 15th FC.
परिणामस्वरूप, 15वें वित्त आयोग की तुलना में 14 राज्यों की कुल हस्तांतरण हिस्सेदारी में मामूली वृद्धि हुई।
- Under the 16th FC, the southern States' share has risen slightly to about 17%, while the share of the largest beneficiary States has fallen to just under 50% — a shift of only about 1.2% in favour of the southern States.
16वें वित्त आयोग के अंतर्गत दक्षिणी राज्यों की हिस्सेदारी थोड़ी बढ़कर लगभग 17% हो गई है, जबकि सबसे बड़े लाभार्थी राज्यों की हिस्सेदारी घटकर 50% से थोड़ी कम रह गई है — यह परिवर्तन दक्षिणी राज्यों के पक्ष में केवल लगभग 1.2% का है।
- The balance between equity and efficiency has changed only marginally.
समानता और दक्षता के बीच संतुलन में केवल मामूली परिवर्तन हुआ है।
- Under the 15th FC, efficiency-related criteria accounted for 25% of the weight and equity criteria for 75%; under the 16th FC, this has shifted to 30% and 70%, respectively — an adjustment too small to significantly alter outcomes.
15वें वित्त आयोग के अंतर्गत दक्षता-संबंधी मानदंडों का भार 25% तथा समानता-संबंधी मानदंडों का भार 75% था; जबकि 16वें वित्त आयोग में यह क्रमशः 30% और 70% हो गया है — यह परिवर्तन परिणामों में उल्लेखनीय बदलाव लाने के लिए बहुत छोटा है।

Devolutions with alternative schemes

वैकल्पिक योजनाओं के साथ कर-वितरण

- If the FC had assigned a 25% weight to the square root of GDP contribution while reducing the weight of income distance to 27.5%, Karnataka's share would have increased from 4.131% to 4.928%, Maharashtra's from 6.441% to 7.218%, and Tamil Nadu's from 4.097% to 4.867%.
यदि वित्त आयोग (FC) ने GDP योगदान के वर्गमूल को 25% भार दिया होता तथा आय दूरी के भार को घटाकर 27.5% कर दिया होता, तो कर्नाटक का हिस्सा 4.131% से बढ़कर 4.928%, महाराष्ट्र का 6.441% से बढ़कर 7.218%, तथा तमिलनाडु का 4.097% से बढ़कर 4.867% हो जाता।
- With 25% weight (and 27.5% weight to income distance), they would have increased to 8.698%, 5.517% and 5.478%.



TELEGRAM CHANNEL: <https://t.me/patrioticIAS>

YOUTUBE CHANNEL: <https://www.youtube.com/@PatrioticIAS>

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25% भार (और आय दूरी को 27.5% भार) देने पर, उनकी हिस्सेदारी बढ़कर क्रमशः 8.698%, 5.517% और 5.478% हो जाती।

- In India, unlike other large federations such as Australia and China, States with greater political influence in terms of parliamentary representation are not necessarily the economically stronger ones.

भारत में, ऑस्ट्रेलिया और चीन जैसे अन्य बड़े संघीय देशों के विपरीत, संसदीय प्रतिनिधित्व के संदर्भ में अधिक राजनीतिक प्रभाव रखने वाले राज्य आवश्यक रूप से आर्थिक रूप से अधिक सशक्त नहीं होते।

- Consequently, these States tend to receive higher fiscal transfers.
- Since the FC's primary objective is to address both vertical and horizontal fiscal imbalances, future FCs should place greater emphasis on fiscal capacity and • scal outcome indicators rather than relying predominantly on non-fiscal indicators.

चूँकि वित्त आयोग का प्रमुख उद्देश्य ऊर्ध्वाधर तथा क्षैतिज राजकोषीय असंतुलों को दूर करना है, इसलिए भविष्य के वित्त आयोगों को मुख्यतः गैर-राजकोषीय संकेतकों पर निर्भर रहने के बजाय राजकोषीय क्षमता तथा राजकोषीय परिणाम संकेतकों पर अधिक बल देना चाहिए।

- Additionally, they should adopt more data-driven approaches for assigning weights, such as the principal component analysis method.

इसके अतिरिक्त, भार निर्धारित करने के लिए उन्हें अधिक डेटा-आधारित दृष्टिकोणों को अपनाना चाहिए, जैसे कि प्रिंसिपल कंपोनेंट एनालिसिस पद्धति।

GS Paper II: Governance		26 May 2026
TOPICS COVERED		
26M	SC blames NTA for leak of 2026 NEET paper सुप्रीम कोर्ट ने 2026 NEET पेपर लीक के लिए NTA को ठहराया जिम्मेदार	
26M	Minister calls for report from CBSE as Class 12 exam results trigger concerns कक्षा 12 परीक्षा परिणामों पर चिंता के बीच मंत्री ने CBSE से रिपोर्ट मांगी	

SC blames NTA for leak of 2026 NEET paper

Bench issues notice to Ministry of Education, and NTA, on plea to 'replace or restructure' the body | NTA to file an affidavit on measures to implement recommendations of the monitoring committee | Plea said the NTA did not answer to Parliament, which shielded it from direct audits by the govt

GS II: Governance
Krishnadas Rajagopal
NEW DELHI

The Supreme Court on Monday squarely blamed the National Testing Agency (NTA) for the National Eligibility-cum-Entrance Test-Undergraduate (NEET-UG), 2026, paper leak, saying the exam body sadly had not learnt its lesson even two years after the previous security breach in 2024.

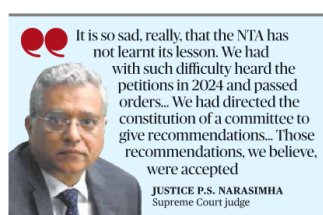
The hard work of 23 lakh students came to nothing with the cancellation of the examination after it was learnt that the question paper had been leaked.

A Central Bureau of Investigation (CBI) probe is under way into the issue and a retest is scheduled on June 21.

"It is so sad, really, that

the NTA has not learnt its lesson. We had with such difficulty heard the petitions in 2024 and passed orders... We had directed the constitution of a committee to give recommendations... Those recommendations, we believe, were accepted... a monitoring/high-powered committee was appointed," Justice P.S. Narasimha, heading a two-judge Bench, observed on Monday while hearing a petition filed by the Federation of All India Medical Association to "replace or fundamentally restructure" the NTA.

Affidavit sought
The Bench directed the NTA to file an affidavit in the next three days on measures taken by it to implement the recommendations of the monitoring/



high-powered committee and listed the case for hearing on an urgent basis later this week.

The top court also issued notices to the Union of India, the Union Ministry of Education, and other respondents arraigned by the petitioners.

A second petition by the United Doctors Front was also heard, which sought the transition of the NTA

It is so sad, really, that the NTA has not learnt its lesson. We had with such difficulty heard the petitions in 2024 and passed orders... We had directed the constitution of a committee to give recommendations... Those recommendations, we believe, were accepted

from a registered society to a statutory body established by an Act of Parliament to ensure constitutional and parliamentary accountability.

For the Supreme Court, the NEET-UG 2026 paper leak was a repetition from 2024, when over 20 lakh students were affected by a paper leak.

The court had, at the time, taken cognisance of

Pradhan seeks report on CBSE marking glitches

NEW DELHI
Union Minister for Education Dharmendra Pradhan has sought a detailed report on the glitches in the CBSE portal after multiple complaints about the new On Screen Marking system. » PAGE 6

the fiasco and heard petitioners over many days. It had finally not cancelled the 2024 exam, reasoning that the leak had been localised.

However, the apex court had acknowledged the need to reform the exam process. It had directed the constitution of a committee headed by former Indian Space Research Organisation Chairman K.

Radhakrishnan to recommend changes in the way the NTA conducted the crucial annual exam for medical admissions across the country.

The recommendations of the monitoring/high-powered committee included the shift to a computer-based test (CBT) mechanism. Mr. Radhakrishnan has also been asked to file a separate affidavit within the same time period as the NTA on what steps were taken to ensure that the committee's recommendations had been followed.

The petitions have sought sweeping directions to the government to mandate "digital locking" of question papers, and transition to the CBT model to eliminate the physical chain-of-custody risks.

The doctors' body

pointed out that, unlike the Union Public Service Commission or the Staff Selection Commission, the NTA was not directly answerable to Parliament. It operated under the Ministry of Education, shielding it from direct audits by the Comptroller and Auditor General, and mandatory probes by Parliamentary Committees.

"The recurrence proves that cosmetic administrative tweaks and expert committees like the K. Radhakrishnan Committee are inadequate without a fundamental legislative overhaul," the petition has contended.

The doctors' front sought the dissolution of the NTA in its current form and the enactment of a parliamentary Act to create a new testing authority.



26M. SC blames NTA for leak of 2026 NEET paper

सुप्रीम कोर्ट ने 2026 NEET पेपर लीक के लिए NTA को ठहराया जिम्मेदार

- The **Supreme Court** on Monday squarely blamed the **National Testing Agency (NTA)** for the **National Eligibility-cum-Entrance Test-Undergraduate (NEET-UG), 2026**, paper leak, saying the exam body sadly had not learnt its lesson even two years after the previous security breach in 2024.
सुप्रीम कोर्ट ने सोमवार को राष्ट्रीय परीक्षण एजेंसी (NTA) को राष्ट्रीय पात्रता सह प्रवेश परीक्षा-स्नातक (NEET-UG), 2026 के पेपर लीक के लिए सीधे जिम्मेदार ठहराया और कहा कि परीक्षा संस्था ने 2024 में हुई पिछली सुरक्षा चूक के दो वर्ष बाद भी कोई सबक नहीं सीखा।
- It had directed the constitution of a **committee headed by former Indian Space Research Organisation (ISRO) Chairman K. Radhakrishnan** to recommend changes in the way the NTA conducted the crucial annual exam for medical admissions across the country.
अदालत ने पूर्व भारतीय अंतरिक्ष अनुसंधान संगठन (ISRO) अध्यक्ष के. राधाकृष्णन की अध्यक्षता में समिति गठित करने का निर्देश दिया था, ताकि देशभर में मेडिकल प्रवेश के लिए आयोजित महत्वपूर्ण वार्षिक परीक्षा के संचालन में सुधार सुझाए जा सकें।
- The recommendations of the monitoring/high-powered committee included the **shift to a computer-based test (CBT) mechanism**.
निगरानी/उच्चाधिकार प्राप्त समिति की सिफारिशों में कंप्यूटर आधारित परीक्षा (CBT) प्रणाली की ओर बदलाव शामिल था।
- The doctors' body pointed out that, **unlike the Union Public Service Commission (UPSC) or the State Selection Commission (SSC), the NTA was not directly answerable to Parliament**.
डॉक्टरों के संगठन ने बताया कि संघ लोक सेवा आयोग (UPSC) या कर्मचारी चयन आयोग (SSC) के विपरीत, NTA सीधे संसद के प्रति जवाबदेह नहीं है।
- It operated under the **Ministry of Education**, shielding it from direct audits by the **Comptroller and Auditor General (CAG)**, and mandatory probes by Parliamentary Committees.
यह शिक्षा मंत्रालय के अधीन कार्य करता है, जिससे यह भारत के नियंत्रक एवं महालेखा परीक्षक (CAG) द्वारा प्रत्यक्ष ऑडिट और संसदीय समितियों की अनिवार्य जांच से बचा रहता है।
- "The recurrence proves that cosmetic administrative tweaks and expert committees like the **K. Radhakrishnan Committee** are inadequate without a fundamental legislative overhaul," the petition has contended.
"यह पुनरावृत्ति सिद्ध करती है कि के. राधाकृष्णन समिति जैसी विशेषज्ञ समितियाँ और सतही प्रशासनिक बदलाव, मूलभूत विधायी सुधार के बिना अपर्याप्त हैं," याचिका में कहा गया है।



Minister calls for report from CBSE as Class 12 exam results trigger concerns

Dharmendra Pradhan deposes IIT Madras and IIT Kanpur experts to assist the board; the expert team will examine the overall IT infrastructure robustness; complaints have been raised over the new **On-Screen Marking system, or OSM**, while the re-verification process has run into delays

SS II: Governance

Maitri Porecha
NEW DELHI

After multiple students complained about the new On-Screen Marking (OSM) system, which was introduced by the Central Board of Secondary Education (CBSE) for evaluating Class 12 answer papers this year, Union Minister for Education Dharmendra Pradhan stated that he had asked the CBSE for a detailed report on the glitches.

The CBSE has been in the eye of the storm recently with Class 12 students and parents complaining about the OSM system and the struggles they have faced in the re-evaluation process after the completion of the board examination. "The IIT [Indian Institute of Technology] Madras and IIT Kanpur will look into the technical glitch faced by the CBSE portal. Those who applied for revaluation will get a scanned copy. I've taken it seriously. The government is looking into it in detail," Mr. Pradhan stated.

"The expert team will examine the overall IT infrastructure robustness and assist in taking corrective measures to ensure

that login authentication, user access systems and payment gateways are accurate and in order," an official from the Ministry of Education explained.

On Monday, Congress general secretary (communications) Jairam Ramesh criticised the government for introducing the OSM system for Class 12 board examinations, which he said had thrown into chaos the academic futures of lakhs of children.

"He's portraying himself as some saviour by bringing in IIT-Kanpur to help address these technical issues. The question really is why these issues were not anticipated? Why did it take the minister so long to respond?" Mr. Ramesh said. "The Mantri Pradhan owes the country his resignation, and the Pradhan Mantri owes us answers to why this Minister - who is openly disrupting the future of India's students with his ineptitude - has been allowed to continue for so long."

OSM system

In the OSM system, instead of traditionally checking physical copies, the evaluators checked the scanned answer sheets on



The CBSE had rolled out the On-Screen Marking system for Class 12 evaluation this year. SHIV KUMAR PUSHPAKAR

screen. Officials in the Education Ministry confirmed that 98 lakh answer books were scanned and evaluated digitally. Experts said that each answer book had an average of 20 sheets, which means that nearly 1.96 crore pages were scanned in a compressed timeline, at centres with varying infrastructure and partially trained staff.

Several students who had applied for re-evaluation for their marks said they received wrong answer sheets. On Monday, a Delhi student was brutally trolled for taking to X to complain about the unexpectedly low marks he received in Physics. He alleged it may not merely be a "rechecking" issue but a

serious answer-sheet mismatch. "We applied for photocopies of my answer sheets. And I am shattered because the Physics answer sheet uploaded by the CBSE is not mine," a student said. CBSE officials told *The Hindu* that there was indeed a mix-up with regard to the student's Physics answer sheet and his original answer book was handed over to him.

Teachers' warning

The CBSE had been warned by teachers as early as February 2026 that evaluators had not received structured training in the OSM system. While the CBSE had promised that the OSM method of evaluation would lead to

greater transparency, speed, and accuracy, according to its own data, over 68,000 answer books had to be rescanned due to poor image quality, and over 13,500 were pulled for manual rechecking.

In the results announced earlier this month, Class 12 pass percentage dropped by three percentage points from last year to 85.20%. Having received lower than expected marks, students began applying in large numbers for re-evaluation on the portal, which opened on May 19 and almost immediately crashed due to the heavy traffic.

After encountering the glitch, students were stranded mid-process as the CBSE pulled out the application link from its website entirely. The portal then reopened on May 20.

Students who had paid fees on May 20 reported that payment was deducted but no confirmation was received. "Students were in dark even after 24 hours. Some were able to apply later, others still complained of the process not working. Login failures, application submission errors, download failures continued to be

reported," a parent told *The Hindu*. On May 21, the portal again slipped into maintenance mode. The CBSE extended the deadline for application twice to remedy the situation.

Students who managed to access their scanned answer sheets shared screenshots on social media of copies that appeared blurred, unreadable or having rotated pages. "Some scans showed overlapping elements - browser bars, timestamps - obscuring the actual written content. Students posed an obvious question - if we cannot read these copies, how did examiners evaluate them? Students identified answers that match official marking scheme, yet marks were deducted. Evaluators have complained of screen fatigue, poor scan resolution and missed answers during the OSM process," pointed out educationist and RTI activist Keshav Agarwal.

Many students received main answer booklets but supplementary sheets were absent. The CBSE has not commented on how evaluation quality was maintained when OSM system was allegedly defective.

26M. Minister calls for report from CBSE as Class 12 exam results trigger concerns

कक्षा 12 परीक्षा परिणामों पर चिंता के बीच मंत्री ने CBSE से रिपोर्ट मांगी

- After multiple students complained about the new **On-Screen Marking (OSM)** system, which was introduced by the **Central Board of Secondary Education (CBSE)** for evaluating **Class 12 answer papers this year**, **Union Minister for Education Dharmendra Pradhan** stated that he had asked the **CBSE** for a detailed report on the glitches.

इस वर्ष कक्षा 12 की उत्तर पुस्तिकाओं के मूल्यांकन हेतु **केंद्रीय माध्यमिक शिक्षा बोर्ड (CBSE)** द्वारा शुरू की गई नई **ऑन-स्क्रीन मार्किंग (OSM)** प्रणाली को लेकर कई छात्रों की शिकायतों के बाद, **केंद्रीय शिक्षा मंत्री धर्मेंद्र प्रधान** ने कहा कि उन्होंने **CBSE** से तकनीकी गड़बड़ियों पर विस्तृत रिपोर्ट मांगी है।

- The **CBSE** has been in the eye of the storm recently with **Class 12 students and parents** complaining about the **OSM** system and the struggles they have faced in the re-evaluation process after the completion of the board examination.

हाल के दिनों में **CBSE** विवादों के केंद्र में रहा है, जहाँ कक्षा 12 के छात्र और अभिभावक **OSM** प्रणाली तथा बोर्ड परीक्षा समाप्त होने के बाद पुनर्मूल्यांकन प्रक्रिया में आई कठिनाइयों की शिकायत कर रहे हैं।

- "The expert team will examine the overall IT infrastructure robustness and assist in taking corrective measures to ensure that login authentication, user access systems and payment gateways are accurate and in order," an official from the **Ministry of Education** explained.

शिक्षा मंत्रालय के एक अधिकारी ने बताया, "विशेषज्ञ टीम समग्र IT अवसंरचना की मजबूती की जांच करेगी



और यह सुनिश्चित करने हेतु सुधारात्मक कदमों में सहायता करेगी कि लॉगिन प्रमाणीकरण, उपयोगकर्ता पहुँच प्रणाली और भुगतान गेटवे सही एवं व्यवस्थित हों।”

OSM system

OSM प्रणाली

- In the **OSM** system, instead of traditionally checking physical copies, the evaluators checked the scanned answer sheets onscreen.
OSM प्रणाली में पारंपरिक रूप से भौतिक प्रतियाँ जांचने के बजाय, परीक्षकों ने स्कैन की गई उत्तर पुस्तिकाओं को स्क्रीन पर देखकर मूल्यांकन किया।
- Officials in the **Education Ministry** confirmed that 98 lakh answer books were scanned and evaluated digitally.
शिक्षा मंत्रालय के अधिकारियों ने पुष्टि की कि 98 लाख उत्तर पुस्तिकाओं को स्कैन कर डिजिटल रूप से मूल्यांकित किया गया।
- Experts said that each answer book had an average of 20 sheets, which means that nearly 1.96 crore pages were scanned in a compressed timeline, at centres with varying infrastructure and partially trained staff.
विशेषज्ञों ने बताया कि प्रत्येक उत्तर पुस्तिका में औसतन 20 पृष्ठ थे, जिसका अर्थ है कि लगभग 1.96 करोड़ पृष्ठ कम समय में ऐसे केंद्रों पर स्कैन किए गए जहाँ अवसंरचना अलग-अलग स्तर की थी और कर्मचारियों को आंशिक प्रशिक्षण मिला था।
- Several students who had applied for re-evaluation for their marks said they received wrong answer sheets.
कई छात्रों, जिन्होंने पुनर्मूल्यांकन के लिए आवेदन किया था, ने कहा कि उन्हें गलत उत्तर पुस्तिकाएँ प्राप्त हुईं।
- He alleged it may not merely be a “rechecking” issue but a serious answer-sheet mismatch.
उसने आरोप लगाया कि यह केवल “रीचेकिंग” का मामला नहीं बल्कि उत्तर पुस्तिका के गंभीर मिलान त्रुटि का मामला हो सकता है।
- CBSE officials told **The Hindu** that there was indeed a mix-up with regard to the student's Physics answer sheet and his original answer book was handed over to him.
CBSE अधिकारियों ने द हिंदू को बताया कि छात्र की भौतिकी उत्तर पुस्तिका को लेकर वास्तव में गड़बड़ी हुई थी और उसकी मूल उत्तर पुस्तिका उसे सौंप दी गई।

Teachers' warning

शिक्षकों की चेतावनी

- The **CBSE** had been warned by teachers as early as February 2026 that evaluators had not received structured training in the **OSM** system.
CBSE को फरवरी 2026 में ही शिक्षकों द्वारा चेतावनी दी गई थी कि परीक्षकों को OSM प्रणाली में व्यवस्थित प्रशिक्षण नहीं मिला है।
- While the **CBSE** had promised that the **OSM** method of evaluation would lead to greater transparency, speed, and accuracy, according to its own data, over 68,000 answer books had to be rescanned due to poor image quality, and over 13,500 were pulled for manual rechecking.
हालाँकि CBSE ने वादा किया था कि OSM मूल्यांकन पद्धति अधिक पारदर्शिता, गति और सटीकता लाएगी, लेकिन उसके अपने आँकड़ों के अनुसार, खराब छवि गुणवत्ता के कारण 68,000 से अधिक उत्तर पुस्तिकाओं को दोबारा स्कैन करना पड़ा और 13,500 से अधिक को मैन्युअल पुनः जांच के लिए निकाला गया।
- In the results announced earlier this month, Class 12 pass percentage dropped by three percentage points from last year to 85.20%.



इस महीने की शुरुआत में घोषित परिणामों में कक्षा 12 का उत्तीर्ण प्रतिशत पिछले वर्ष की तुलना में तीन प्रतिशत अंक गिरकर 85.20% रह गया।

- Having received lower than expected marks, students began applying in large numbers for re-evaluation on the portal, which opened on May 19 and almost immediately crashed due to the heavy traffic.
अपेक्षा से कम अंक मिलने के बाद छात्रों ने बड़ी संख्या में पुनर्मूल्यांकन के लिए पोर्टल पर आवेदन करना शुरू किया, जो 19 मई को खुला और भारी ट्रैफिक के कारण लगभग तुरंत क्रैश हो गया।
- After encountering the glitch, students were stranded mid-process as the CBSE pulled out the application link from its website entirely.
तकनीकी गड़बड़ी आने के बाद छात्र प्रक्रिया के बीच में फँस गए क्योंकि CBSE ने अपनी वेबसाइट से आवेदन लिंक पूरी तरह हटा दिया।
- Students who had paid fees on May 20 reported that payment was deducted but no confirmation was received.
20 मई को शुल्क जमा करने वाले छात्रों ने बताया कि भुगतान कट गया लेकिन कोई पुष्टि प्राप्त नहीं हुई।
- Login failures, application submission errors, download failures continued to be reported," a parent told **The Hindu**.
लॉगिन विफलता, आवेदन जमा करने में त्रुटियाँ और डाउनलोड विफलताएँ लगातार सामने आती रहीं," एक अभिभावक ने द हिंदू को बताया।
- Students who managed to access their scanned answer sheets shared screenshots on social media of copies that appeared blurred, unreadable or having rotated pages.
जिन छात्रों को अपनी स्कैन की गई उत्तर पुस्तिकाएँ मिलीं, उन्होंने सोशल मीडिया पर धुंधली, अपठनीय या घुमाए गए पृष्ठों वाली प्रतियों के स्क्रीनशॉट साझा किए।
- "Some scans showed overlapping elements — browser bars, timestamps — obscuring the actual written content.
"कुछ स्कैन में ओवरलैपिंग तत्व — ब्राउज़र बार, टाइमस्टैम्प — दिखाई दिए, जिससे वास्तविक लिखित सामग्री ढक गई।
- Evaluators have complained of screen fatigue, poor scan resolution and missed answers during the OSM process," pointed out educationist and RTI activist **Keshav Agarwal**.
परीक्षकों ने OSM प्रक्रिया के दौरान स्क्रीन थकान, खराब स्कैन रिज़ॉल्यूशन और उत्तर छूटने की शिकायत की है," शिक्षाविद् और RTI कार्यकर्ता केशव अग्रवाल ने बताया।
- Many students received main answer booklets but supplementary sheets were absent.
कई छात्रों को मुख्य उत्तर पुस्तिकाएँ मिलीं लेकिन पूरक शीट्स अनुपस्थित थीं।

GS Paper II: International Relations		26 May 2026
TOPICS COVERED		
26M	India-U.S. ties, Iran crisis in focus as Quad Foreign Ministers meet today क्वाड विदेश मंत्रियों की आज बैठक, भारत-अमेरिका संबंध और ईरान संकट केंद्र में	
26M	India and Australia – bridging the trade and trust barrier भारत और ऑस्ट्रेलिया – व्यापार और विश्वास की बाधा को पाटना	
26M	QUIZ	
26M	Cambodia's conscription law takes effect amid Thai tensions थाई तनाव के बीच कंबोडिया का अनिवार्य सैन्य सेवा कानून लागू	
26M	In Sudan's war economy, gold keeps flowing as miners risk mercury and collapse सूडान की युद्ध अर्थव्यवस्था में पारा और खदान धंसने के खतरे के बीच सोने का प्रवाह जारी	



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India-U.S. ties, Iran crisis in focus as Quad Foreign Ministers meet today

GS II: IR

NEWS ANALYSIS

Suhasini Haidar
NEW DELHI

Foreign Ministers of the Quad will meet for the first time in nearly a year, as External Affairs Minister S. Jaishankar hosts U.S. Secretary of State Marco Rubio, Australian Foreign Minister Penny Wong, and Japanese Foreign Minister Toshimitsu Motegi in Delhi on Tuesday at Delhi's Hyderabad House. The Foreign Ministers will also call on Prime Minister Narendra Modi, an External Affairs Ministry advisory said.

The Ministers last met on July 1, 2025, when they updated the goals for the quadrilateral grouping, simplifying them to four areas: maritime and transnational security, economic prosperity and security, humanitarian assistance and emergency responses, and the launch

of the Quad Critical Minerals Initiative.

However, rapid developments, including the U.S.-Israel strikes on Iran and other actions by the Donald Trump administration, have posed questions over the viability of the grouping, and the Ministers will have their task cut out as they seek to renew their mandate.

In addition, they will discuss whether it is possible to hold the Quad Summit in India later this year, or take a decision to downgrade the grouping by meeting regularly only at the Foreign Minister level, as was the case prior to 2021, given India's difficulties in scheduling the summit in 2024 and 2025.

Trade tensions

In particular, tensions between India and the U.S. in the past year have led to a slowdown in ties, amid differences over the India-Pakistan conflict, strained

trade talks after the U.S. imposed a whopping 50% tariff on Indian goods, Mr. Trump's comments on India being a "dead economy", and immigration restrictions by the U.S. During his four-day visit to India, Mr. Rubio has faced some embarrassment and persistent questions from journalists over the U.S. President reposting an anti-immigrant rant describing India as a "hellhole".

"The President is a big fan of India, a big fan of Prime Minister Modi. I wouldn't be here if the President didn't want me to be here. He wouldn't have sent someone like Sergio [Gor] to be our Ambassador, someone who's very close to the President," Mr. Rubio told journalists on Monday.

"I mean, people say stupid stuff all the time on social media and in every country in the world, unfortunately," he added, in-

dicating "general" comments online.

Invitation to PM

Although Mr. Rubio conveyed an invitation to Mr. Modi to visit Washington in the next few months, it is Mr. Trump's turn to visit India, and Mr. Modi is in any case expected to travel to the U.S. for the G-20 Summit in December. Prior to that, his travel schedule has already filled up.

Prioritising the Quad may be more difficult given other engagements. In September, Chinese President Xi Jinping is expected to be in the U.S. to return Mr. Trump's visit to China, which will take precedence. Indications that Washington is seeking a more accommodating position with Beijing could cause concerns for the long-term future of the Indo-Pacific grouping that was set up to counter Chinese actions in the region.

26M. India-U.S. ties, Iran crisis in focus as Quad Foreign Ministers meet today

क्वाड विदेश मंत्रियों की आज बैठक, भारत-अमेरिका संबंध और ईरान संकट केंद्र में

- The Ministers last met on July 1, 2025, when they updated the goals for the quadrilateral grouping, simplifying them to four areas: maritime and transnational security, economic prosperity and security, humanitarian assistance and emergency responses, and the launch of the **Quad Critical Minerals Initiative**.

विदेश मंत्रियों की पिछली बैठक 1 जुलाई 2025 को हुई थी, जब उन्होंने चतुष्कोणीय समूह के लक्ष्यों को अद्यतन करते हुए उन्हें चार क्षेत्रों तक सीमित किया था: समुद्री और अंतरराष्ट्रीय सुरक्षा, आर्थिक समृद्धि और सुरक्षा, मानवीय सहायता एवं आपातकालीन प्रतिक्रिया, तथा क्वाड क्रिटिकल मिनेरल्स पहल का शुभारंभ।



India and Australia – bridging the trade and trust barrier

GS II: IR

Is a comprehensive India-Australia Free Trade Agreement (FTA) in the offing? With the Australian Foreign Minister Penny Wong in India for the Quad Foreign Ministers' meeting, there is anticipation that a Comprehensive Economic Cooperation Agreement (CECA) may be inked. This would expand the 2022 Economic Cooperation and Trade Agreement (ECTA) that had opened 100% of the Australian market to India while India reciprocated with roughly 70% market access covering nearly 91% of trade value. Canberra has since been pushing for parity, both privately and publicly. Meanwhile the West Asia crisis has forced upon India – in the words of the Chief Economic Adviser – a “balance of payments crisis stress test”, making trade expansion and courting investments an urgent necessity for the country.

India has been in a hurry over the past year to conclude trade agreements; geopolitical fragility and the unpredictability of tariff politics have pushed India to sign agreements with the EU, the U.S., New Zealand and the U.K. CECA fits neatly into this larger recalibration.

The problems with Australia

But with Australia, the trade situation is complicated. Since ECTA, bilateral merchandise trade doubled from \$12.2 billion in FY 2020-21 to \$24.1 billion in FY 2024-25. These gains, however, have not been evenly shared. Australian exports to India account for nearly two-thirds of the bilateral trade.

Even in services, where bilateral trade has crossed \$10 billion, Australia's higher education sector alone accounts for close to 60%. In contrast, investment tells the opposite story: as of 2024, Indian investment in Australia had touched nearly \$32 billion against Australia's cumulative FDI into India of about \$18 billion.

The bilateral relationship is thus beset by interconnected problems. Australia wants parity in market access. But the question for India is not whether India should simply concede more market access; it is whether India can trade some market access for a more balanced overall

**Vaibhav Jain**

Incoming delegate of the Australia-India Youth Dialogue

**Raja Karthikeya**

Former delegate of the Australia-India Youth Dialogue

An India-Australia trade deal must prioritise balance over parity

relationship. Australia's 2025 Economic Engagement Roadmap for India identified four bilateral 'superhighways': clean energy, education, tourism, and agribusiness. On the first three, there appears to be broad alignment but not on the fourth. Agriculture is where this bargain becomes most difficult. India has restricted access to its agricultural market in nearly all its major trade agreements. Despite being compelled to keep India's most vulnerable sectors (dairy, wheat, rice, sugar and chickpeas) outside ECTA, Australian farm exports to India have risen by nearly 90%, while Indian agricultural exports to Australia have grown more modestly by 35%.

This asymmetry reflects two very different agricultural realities. The average Indian farm is about 0.73 hectares; the average Australian farm exceeds 1,400 hectares. Agriculture contributes around 16% to India's GDP and 2.5% to Australia's. For Australia, agriculture is an export industry. For India, it is a livelihood that supports more than half of its population and remains the bedrock of its food security.

The notion of a “level playing field” between these two systems is hence a misframing of the problem. Indian farmers, even with subsidised inputs, remain structurally exposed to monsoon variability, fragmented landholdings and thin margins. Protecting the Indian market from cheap Australian imports, particularly wheat, is not a negotiating position; it is a political necessity. Yet, given the industrial scale of Australia's farming, Canberra will understandably push India to open up its market fully.

Using agriculture as an opportunity

Nonetheless, agricultural trade talks between the two countries need not become a zero-sum game. Agriculture can become the sector through which India converts Australia's demand for market access into a broader opportunity for institutional cooperation and investment. Two low-hanging fruits stand out.

First, the future of India-Australia agricultural trade must depend less on tariff concessions and

more on mutual recognition of biosecurity and phytosanitary standards. Building on the 2025 organic products arrangement, both countries can expand cooperation in digital certification, quarantine protocols and regulatory alignment. This would give Indian farmers a fairer shot at the Australian market even as India considers reciprocal access for Australian farmers.

Second, Australia's strategic opportunity in India may lie beyond agricultural commodities and in exporting the systems that make modern agriculture possible: precision farming technologies, cold-chain infrastructure, water management expertise and climate adaptation practices. India loses anywhere from 15% to 35% of its agricultural output to pests, disease and post-harvest inefficiencies every year. Australia's extensive experience in dealing with drought cycles, heat extremes and water scarcity is knowledge that would interest India.

However, this experience sharing must go hand-in-hand with real investments. Australian capital, technology and know-how must register a deeper presence inside India's agricultural sector – in storage facilities, logistics networks, farm-level tools and agri-technology partnerships between firms, universities and local governments. The recently launched India-Australia Smart Farm Network Initiative points in the right direction.

Need for complementarity

Agriculture is too politically important in India to be treated as just another line item in a trade schedule; equally, it is too economically important to be left outside the bilateral partnership altogether. Rather than making the new FTA one of absolute symmetry in market access alone, India and Australia should make it an agreement based on complementarity across trade and investment.

Should the diplomats succeed, the day when Chyawanprash and Vegemite sit on the same breakfast table in the two countries is not far.

The views expressed are personal

26M. India and Australia – bridging the trade and trust barrier

भारत और ऑस्ट्रेलिया – व्यापार और विश्वास की बाधा को पाटना

Is a comprehensive India-Australia Free Trade Agreement (FTA) in the offing?

क्या एक व्यापक भारत-ऑस्ट्रेलिया मुक्त व्यापार समझौता (FTA) होने की संभावना है?

- With the **Australian Foreign Minister Penny Wong** in India for the **Quad Foreign Ministers' meeting**, there is anticipation that a **Comprehensive Economic Cooperation Agreement (CECA)** may be inked.

क्वाड विदेश मंत्रियों की बैठक के लिए भारत आई ऑस्ट्रेलियाई विदेश मंत्री पेनी वॉंग की उपस्थिति में यह आशा व्यक्त की जा रही है कि एक व्यापक आर्थिक सहयोग समझौता (CECA) पर हस्ताक्षर हो सकते हैं।

- This would **expand the 2022 Economic Cooperation and Trade Agreement (ECTA)** that had opened **100% of the Australian market** to India while India reciprocated with roughly **70% market access** covering nearly **91% of trade value**.

यह 2022 के आर्थिक सहयोग और व्यापार समझौते (ECTA) का विस्तार होगा, जिसने भारत के लिए ऑस्ट्रेलियाई बाज़ार का 100% खोल दिया था, जबकि भारत ने लगभग 70% बाज़ार पहुँच प्रदान की थी, जो लगभग 91% व्यापार मूल्य को कवर करती थी।

- Meanwhile the **West Asia crisis** has forced upon India — in the words of the **Chief Economic Adviser** — a **“balance of payments crisis stress test”**, making **trade expansion and courting investments an urgent necessity for the country**.

इस बीच पश्चिम एशिया संकट ने भारत पर — मुख्य आर्थिक सलाहकार के शब्दों में — “भुगतान संतुलन संकट परीक्षण” थोप दिया है, जिससे व्यापार विस्तार और निवेश आकर्षित करना देश के लिए अत्यावश्यक बन गया है।



- India has been in a hurry over the past year to conclude trade agreements; geopolitical fragility and the unpredictability of **tariff politics** have pushed India to **sign agreements with the EU, the U.S., New Zealand and the U.K.**
पिछले एक वर्ष में भारत व्यापार समझौतों को शीघ्रता से अंतिम रूप देने में लगा हुआ है; भू-राजनीतिक अस्थिरता और टैरिफ राजनीति की अनिश्चितता ने भारत को यूरोपीय संघ, अमेरिका, न्यूजीलैंड और यूनाइटेड किंगडम के साथ समझौते करने के लिए प्रेरित किया है।

The problems with Australia ऑस्ट्रेलिया के साथ समस्याएँ

- Since **ECTA**, bilateral merchandise trade doubled from **\$12.2 billion in FY 2020-21 to \$24.1 billion in FY 2024-25.**
ECTA के बाद द्विपक्षीय वस्तु व्यापार वित्त वर्ष 2020-21 के 12.2 अरब डॉलर से बढ़कर वित्त वर्ष 2024-25 में 24.1 अरब डॉलर हो गया।
- Australian exports to India account for nearly **two-thirds** of the bilateral trade.
भारत को ऑस्ट्रेलिया का निर्यात द्विपक्षीय व्यापार का लगभग दो-तिहाई हिस्सा है।
- Even in **services**, where bilateral trade has crossed **\$10 billion**, Australia's **higher education sector** alone accounts for close to **60%**.
यहाँ तक कि सेवा क्षेत्र में भी, जहाँ द्विपक्षीय व्यापार 10 अरब डॉलर से अधिक हो चुका है, ऑस्ट्रेलिया का उच्च शिक्षा क्षेत्र अकेले लगभग 60% हिस्सेदारी रखता है।
- In contrast, investment tells the opposite story: as of **2024**, Indian investment in Australia had touched nearly **\$32 billion** against Australia's cumulative **FDI into India** of about **\$18 billion**. इसके विपरीत, निवेश की स्थिति अलग कहानी बताती है: 2024 तक ऑस्ट्रेलिया में भारतीय निवेश लगभग 32 अरब डॉलर तक पहुँच गया था, जबकि भारत में ऑस्ट्रेलिया का संचयी प्रत्यक्ष विदेशी निवेश (FDI) लगभग 18 अरब डॉलर था।
- Australia's **2025 Economic Engagement Roadmap for India** identified four bilateral '**superhighways**': **clean energy, education, tourism, and agribusiness**.
ऑस्ट्रेलिया के 2025 आर्थिक सहभागिता रोडमैप ने चार द्विपक्षीय 'सुपरहाईवे' चिन्हित किए हैं: स्वच्छ ऊर्जा, शिक्षा, पर्यटन, और कृषि-व्यवसाय।
- Despite being compelled to keep India's most vulnerable sectors (**dairy, wheat, rice, sugar and chickpeas**) outside **ECTA**, Australian farm exports to India have risen by nearly **90%**, while Indian agricultural exports to Australia have grown more modestly by **35%**.
भारत के सबसे संवेदनशील क्षेत्रों (डेयरी, गेहूँ, चावल, चीनी और चना) को ECTA से बाहर रखने के बावजूद, भारत को ऑस्ट्रेलियाई कृषि निर्यात लगभग 90% बढ़ गया है, जबकि ऑस्ट्रेलिया को भारतीय कृषि निर्यात केवल 35% बढ़ा है।
- The average Indian farm is about **0.73 hectares**; the average Australian farm exceeds **1,400 hectares**.
भारत में औसत कृषि भूमि लगभग 0.73 हेक्टेयर है, जबकि ऑस्ट्रेलिया में औसत कृषि भूमि 1,400 हेक्टेयर से अधिक है।
- Agriculture contributes around **16%** to India's GDP and **2.5%** to Australia's.
कृषि भारत के GDP में लगभग 16% तथा ऑस्ट्रेलिया के GDP में लगभग 2.5% योगदान देती है।
- For Australia, agriculture is an **export industry**.
ऑस्ट्रेलिया के लिए कृषि एक निर्यात उद्योग है।
- For India, it is a **livelihood** that supports more than half of its population and remains the **bedrock of its food security**.
भारत के लिए यह एक जीविका का साधन है, जो उसकी आधे से अधिक आबादी का समर्थन करता है तथा उसकी खाद्य सुरक्षा का आधार बना हुआ है।
- Indian farmers, even with subsidised inputs, remain structurally exposed to **monsoon variability, fragmented landholdings and thin margins**.



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भारतीय किसान, सब्सिडीयुक्त इनपुट मिलने के बावजूद, संरचनात्मक रूप से **मानसूनी अनिश्चितता, खंडित भूमि स्वामित्व, और कम लाभ मार्जिन** के प्रति संवेदनशील बने रहते हैं।

- **Protecting the Indian market from cheap Australian imports, particularly wheat, is not a negotiating position; it is a political necessity.**
सस्ते ऑस्ट्रेलियाई आयातों, विशेषकर गेहूँ, से भारतीय बाज़ार की रक्षा करना केवल एक वार्तात्मक स्थिति नहीं है; यह एक राजनीतिक आवश्यकता है।
- **Agriculture can become the sector through which India converts Australia's demand for market access into a broader opportunity for institutional cooperation and investment.**
कृषि वह क्षेत्र बन सकती है जिसके माध्यम से भारत, ऑस्ट्रेलिया की बाज़ार पहुँच की माँग को व्यापक संस्थागत सहयोग और निवेश के अवसर में परिवर्तित कर सके।
- **Two low-hanging fruits stand out.**
दो प्रमुख सरल अवसर स्पष्ट रूप से सामने आते हैं।
- **First, the future of India-Australia agricultural trade must depend less on tariffs• concessions and more on mutual recognition of biosecurity and phytosanitary standards.**
प्रथम, भारत-ऑस्ट्रेलिया कृषि व्यापार का भविष्य टैरिफ रियायतों पर कम तथा जैव-सुरक्षा और पादप स्वास्थ्य मानकों की पारस्परिक मान्यता पर अधिक निर्भर होना चाहिए।
- **Building on the 2025 organic products arrangement, both countries can expand cooperation in digital certification, quarantine protocols and regulatory alignment.**
2025 जैविक उत्पाद व्यवस्था के आधार पर, दोनों देश डिजिटल प्रमाणीकरण, संगरोध प्रोटोकॉल, तथा **नियामकीय समन्वय** में सहयोग का विस्तार कर सकते हैं।
- **Second, Australia's strategic opportunity in India may lie beyond agricultural commodities and in exporting the systems that make modern agriculture possible: precision farming technologies, cold-chain infrastructure, water management expertise and climate adaptation practices.**
द्वितीय, भारत में ऑस्ट्रेलिया का रणनीतिक अवसर केवल कृषि वस्तुओं से आगे बढ़कर उन प्रणालियों के निर्यात में निहित हो सकता है जो आधुनिक कृषि को संभव बनाती हैं, जैसे — **सटीक कृषि तकनीक, कोल्ड-चेन अवसंरचना, जल प्रबंधन विशेषज्ञता, तथा जलवायु अनुकूलन पद्धतियाँ।**
- **India loses anywhere from 15% to 35% of its agricultural output to pests, disease and post-harvest inefficiencies every year.**
भारत प्रत्येक वर्ष अपनी कृषि उपज का लगभग **15% से 35%** हिस्सा कीटों, रोगों, तथा कटाई-पश्चात **अक्षमताओं** के कारण खो देता है।
- **Australia's extensive experience in dealing with drought cycles, heat extremes and water scarcity is knowledge that would interest India.**
सूखा चक्र, अत्यधिक गर्मी, तथा जल संकट से निपटने में ऑस्ट्रेलिया का व्यापक अनुभव ऐसा ज्ञान है जो भारत के लिए उपयोगी सिद्ध हो सकता है।
- However, this experience sharing must go hand-in-hand with real **investments.**
हालाँकि, इस अनुभव-साझाकरण के साथ वास्तविक **निवेश** भी समान रूप से आवश्यक हैं।
- **Australian capital, technology and know-how must register a deeper presence inside India's agricultural sector — in storage facilities, logistics networks, farm-level tools and agri-technology partnerships between firms, universities and local governments.**
ऑस्ट्रेलियाई **पूँजी, प्रौद्योगिकी, और विशेषज्ञता** को भारत के कृषि क्षेत्र में अधिक गहराई से उपस्थित होना चाहिए — जैसे **भंडारण सुविधाओं, लॉजिस्टिक्स नेटवर्क, कृषि-स्तरीय उपकरणों, तथा कंपनियों, विश्वविद्यालयों और स्थानीय सरकारों के बीच कृषि-प्रौद्योगिकी साझेदारियों** में।
- **Rather than making the new FTA one of absolute symmetry in market access alone, India and Australia should make it an agreement based on complementarity across trade and investment.**
नए **FTA** को केवल बाज़ार पहुँच में पूर्ण समानता तक सीमित रखने के बजाय, भारत और ऑस्ट्रेलिया को इसे व्यापार और निवेश में **परस्पर पूरकता** पर आधारित समझौता बनाना चाहिए।



2: Name the British politician and writer known for coining phrases like 'the pen is mightier than the sword' and 'It was a dark and stormy night' born on this date. **Ans: Edward Bulwer-Lytton**
 3: May 25 is observed as 'Africa Day' to commemorate the foundation of the Organization of African Unity on that date in 1963. It was founded in this National capital. **Ans: Addis Ababa (Ethiopia)**

African unity, end colonialism, and strengthen cooperation among African nations. In 2002, it evolved into the African Union.

26M. QUIZ: Africa Day

- Africa Day is observed every year on May 25 to mark the establishment of the Organization of African Unity in 1963 at Addis Ababa, Ethiopia.
- The organisation aimed to promote

Cambodia's conscription law takes effect amid Thai tensions

GS II: IR

Associated Press
PHNOM PENH

Cambodia's new conscription law, which establishes penalties of up to five years in prison for those who evade military service, has come into effect, Prime Minister Hun Manet said on Monday.

The law was signed on Saturday by Senate president Hun Sen in his capacity as acting head of state while King Norodom Sihamoni undergoes medical treatment for prostate cancer in China.

The initiative for a new conscription law followed significant border fighting with Thailand that flared twice last year, resulting in approximately 100 deaths and the displacement of hundreds of thousands of people.

Cambodian men aged 18 to 25 to serve two years in the military, while women may serve voluntarily

The new law replaces a 2006 statute that was never implemented and was considered outdated.

It now requires Cambodian men aged 18 to 25 to serve two years in the military, while women may serve voluntarily. Individuals summoned for service must appear within 30 days of receiving notice or be considered as evading duty, unless a valid excuse is provided.

Penalties for evasion vary according to whether Cambodia is at peace or at war.

During peacetime, an

individual may face six months to two years in prison and a fine of \$250 to \$1,000. During war or a foreign attack, the penalties increase to between two and five years in prison and a fine ranging from \$1,000 to \$2,500.

Exemptions

Exemptions to serving are granted to monks, priests, persons with disabilities and those with specialised skills in science and technology. After completing their required service, individuals become part of reserve forces until age 45.

The Prime Minister described the law as a foundation for cultivating the minds of Cambodian youth to love their nation, foster patriotism and develop a willingness to serve in the military.

26M. Cambodia's conscription law takes effect amid Thai tensions

थाई तनाव के बीच कंबोडिया का अनिवार्य सैन्य सेवा कानून लागू

- Cambodia's new conscription law, which establishes penalties of up to five years in prison for those who evade military service, has come into effect, Prime Minister Hun Manet said on Monday.

कंबोडिया का नया अनिवार्य सैन्य सेवा कानून, जिसमें सैन्य सेवा से बचने वालों के लिए पाँच वर्ष तक की जेल का प्रावधान है, लागू हो गया है, ऐसा प्रधानमंत्री हुन मानेट ने सोमवार को कहा।



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In Sudan's war economy, gold keeps flowing as miners risk mercury and collapse

CS II IR

Associated Press
DAGALO MAHAS

The men carried metal detectors as they scanned a mountainous area in northern Sudan in search of gold. One man knelt to examine the ground with a digging tool for the precious metal in an environment that lacks even the most basic safety measures.

They are unregulated miners working in a small-scale private gold mine in the northern town of Dalgo Mahas. The mine is one of thousands of small-scale and artisanal mines scattered across Sudan, part of a sector that is at the centre

of the devastating war that has at times pushed parts of the country into famine.

Gold has become a major source of funding for Sudan's treasury after the country lost over two-thirds of its oil revenues with the secession of South Sudan in 2011. The precious metal accounted for 70% of national revenues in the years that followed South Sudan's departure, providing the Sudanese government with much-needed foreign currency.

Most recently, gold has been at the centre of the ongoing war between the military and the paramilitary Rapid Support Forces. Large quantities of gold

have been smuggled out of the country to finance paramilitaries, who control gold-producing areas in Darfur and Kordofan, according to United Nations-commissioned experts.

The conflict has killed at least 59,000 people, according to the Armed Conflict Location & Event Data Project, a U.S.-based war tracking group that says its toll is almost certainly an underestimate, given the difficulties in reporting.

The war also created the world's largest humanitarian disaster, forcing over 10 million people to flee their homes. Many displaced people joined the mining industry in order to make



Miner Atta al-Khazin shows a gold nugget produced after processing ore at a mining site in Dalgo Mahas, Sudan's Northern State. AP

ends meet for their families.

"Gold mining is the only thing I can rely on," said Atta al-Khazin, a 28-year-old miner who abandoned his previous profession as a

farmer. "Due to the high oil prices, agriculture no longer covered expenses." Zahir Adam, a 35-year-old father from the Darfur city of el-Fasher who worked in gold mining for

more than a decade, said the sector has drawn many people since the war broke out over three years ago. They had "no other option," he said.

Low safety standards Sudan produced 70 tonne of gold last year, up from 64 tonne in 2024, according to official figures, making it one of Africa's top producers. Gold generated about \$1.8 billion in revenues in 2025, figures from the state-run Sudanese Mineral Resources Company showed.

Artisanal and small-scale gold mining accounts for the majority of gold extracted in the sprawling

country, where safety standards are largely ignored.

Artisanal miners like the men in Dalgo Mahas usually extract the gold, then crush the ore before applying toxic mercury to create the amalgam. The amalgam is then heated, usually on a stove, to evaporate the mercury and recover the gold. The process, which includes using hazardous chemicals, is also risky for people living near the mines.

The UN panel of experts said in their 2024 report that more than 50% of the gold mined in Sudan was not traded through formal channels but was smuggled out of the country.

Deadly mine collapses are not uncommon in Sudan, where safety standards are not widely applied. Last month, at least seven miners were killed in a mine collapse in the Red Sea province. Thirteen others were killed in another collapse in South Kordofan province in January.

A civilian transitional government that ruled the country for over a year after the military overthrow of longtime dictator Omar al-Bashir in April 2019 attempted to regulate the crucial industry.

However, its efforts were aborted by a military coup in October 2021, and the war that began in 2023.

26M. In Sudan's war economy, gold keeps flowing as miners risk mercury and collapse

सूडान की युद्ध अर्थव्यवस्था में पारा और खदान धंसने के खतरे के बीच सोने का प्रवाह जारी

- Gold has become a major source of funding for Sudan's treasury after the country lost over two-thirds of its oil revenues with the secession of **South Sudan** in 2011. 2011 में दक्षिण सूडान के अलग होने के बाद तेल राजस्व का दो-तिहाई हिस्सा खोने पर सोना सूडान के खजाने के लिए वित्तपोषण का प्रमुख स्रोत बन गया।
- The precious metal accounted for 70% of national revenues in the years that followed South Sudan's departure, providing the Sudanese government with much-needed foreign currency. दक्षिण सूडान के अलग होने के बाद के वर्षों में इस बहुमूल्य धातु ने राष्ट्रीय राजस्व का 70% हिस्सा प्रदान किया, जिससे सूडानी सरकार को अत्यंत आवश्यक विदेशी मुद्रा मिली।
- Most recently, gold has been at the centre of the ongoing war between the military and the paramilitary **Rapid Support Forces (RSF)**. हाल के समय में सोना सेना और अर्धसैनिक **रैपिड सपोर्ट फोर्स (RSF)** के बीच जारी युद्ध के केंद्र में रहा है।
- Large quantities of gold have been smuggled out of the country to finance paramilitaries, who control gold-producing areas in **Darfur and Kordofan**, according to **United Nations-commissioned experts**. संयुक्त राष्ट्र द्वारा नियुक्त विशेषज्ञों के अनुसार, बड़ी मात्रा में सोना देश से तस्करी कर बाहर भेजा गया है ताकि अर्धसैनिक बलों को वित्तपोषित किया जा सके, जो **दारफुर और कोर्दोफान** के सोना उत्पादक क्षेत्रों पर नियंत्रण रखते हैं।
- **Zahir Adam**, a 35-year-old father from the **Darfur city of el-Fasher** who worked in gold mining for more than a decade, said the sector has drawn many people since the war broke out over three years ago. **एल-फाशेर** शहर के 35 वर्षीय पिता **जाहिर आदम**, जिन्होंने एक दशक से अधिक समय तक सोने की खनन में काम किया, ने कहा कि तीन वर्ष पहले युद्ध शुरू होने के बाद इस क्षेत्र ने अनेक लोगों को आकर्षित किया है।
- Sudan produced 70 tonne of gold last year, up from 64 tonne in 2024, according to official figures, making it one of Africa's top producers. आधिकारिक आंकड़ों के अनुसार, सूडान ने पिछले वर्ष 70 टन सोने का उत्पादन किया, जो 2024 में 64 टन था, जिससे यह अफ्रीका के शीर्ष उत्पादकों में शामिल हो गया।
- Artisanal and small-scale gold mining accounts for the majority of gold extracted in the sprawling country, where safety standards are largely ignored. इस विशाल देश में निकाले गए अधिकांश सोने का स्रोत पारंपरिक और छोटे स्तर की खनन है, जहाँ सुरक्षा मानकों की व्यापक रूप से अनदेखी की जाती है।



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GS Paper III: Economy		26 May 2026
TOPICS COVERED		
26M	Why is the Indian rupee falling? भारतीय रुपया क्यों गिर रहा है?	
26M	Indian mobile market hit as global semicon industry faces 'severe cremation' वैश्विक सेमीकंडक्टर उद्योग में 'गंभीर मेमफ्लेशन' के कारण भारतीय मोबाइल बाजार प्रभावित	
26M	W. Asia crisis may push FY27 fertiliser subsidy over ₹3 lakh crore पश्चिम एशिया संकट से FY27 में उर्वरक सब्सिडी ₹3 लाख करोड़ से अधिक हो सकती है	
26M	Huawei's 'chip queen' in China's tech folklore चीन की तकनीकी लोककथाओं में Huawei की 'चिप क्वीन'	

PATRIOTIC IAS



Why is the Indian rupee falling?

How does a falling rupee affect India's economy? How does a currency's exchange rate shape its balance of payments? To what extent does Foreign Portfolio Investment influence demand for the rupee? What strategic role does the Reserve Bank of India play in preventing the rupee's depreciation?

EXPLAINER

Jayan Jose Thomas

The graph of the Indian rupee has been snaking sharply downward. The rupee-to-dollar exchange rate, or the rupees needed to purchase a U.S. dollar, crossed 96 in May this year. That rate was around 85 a year ago, indicating the rupee's decline in value since then.

Exchange rate is the price that a currency, such as the rupee, commands in the market, relative to the dollar or other currencies. Just as the market price of onions is determined by demand and supply, so is the price of a currency.

What is the impact of trade deficits on the rupee's value?

The demand for the rupee rises with India's exports and falls with imports. When firms in Ludhiana export garments, the dollars or euros they receive from foreign buyers are exchanged for rupees to pay workers and suppliers, thereby increasing demand for the rupee. On the other hand, Indian companies import oil by exchanging rupees for dollars, thereby reducing the demand for the rupee. Rupee demand also declines when we travel abroad and exchange rupees at the airport for the currency of our destination country.

Overall, if India's imports exceed exports, the foreign currency payments it must make to the rest of the world exceed the foreign currency payments it receives. That implies more rupees are exchanged for dollars than dollars are exchanged for rupees, leading to declines in the demand for, and the value of the rupee (requiring more rupees to purchase one dollar).

Thus, a currency's exchange rate is closely tied to the country's balance of (foreign currency) payments (to and from the rest of the world). India has consistently run a merchandise trade deficit, with imports of goods (especially oil) exceeding exports. The deficit in its merchandise trade account is partially offset by a surplus in India's invisibles. That is mainly thanks to foreign currency inflows from the export of services, particularly software, and to the large remittance inflows from migrant workers, especially in West Asian countries. Overall, India's current account, which is the sum of merchandise trade and the invisibles accounts, has been in deficit (Table 1).

The gap in the current account, between the foreign currency payments India owes to the rest of the world and the foreign currency payments it receives, has been bridged by inflows through the capital account, mainly foreign investment and loans. If the current account deficit is more than offset by a surplus in the capital account, the excess foreign currency received is added to the country's foreign exchange (or forex) reserves (Table 1).

How do capital outflows weaken the rupee?

A country's forex reserves are as valuable as a family's treasure trove. The reserves are tapped to pay for critical imports during periods of insufficient foreign currency inflows, and to defend the currency's value when capital outflows are too large (discussed below).

Foreign direct investment (FDI) is mostly in new or existing factories and businesses and, as a result, has some ties binding it to the host country. In comparison, foreign portfolio investment

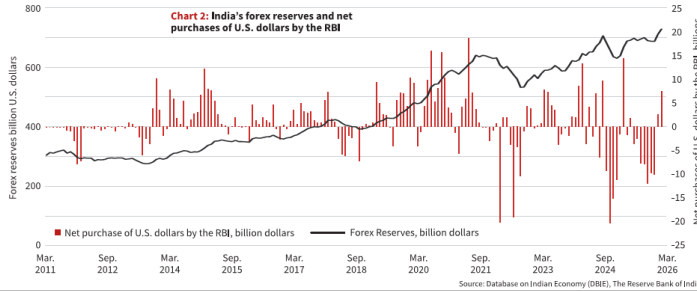
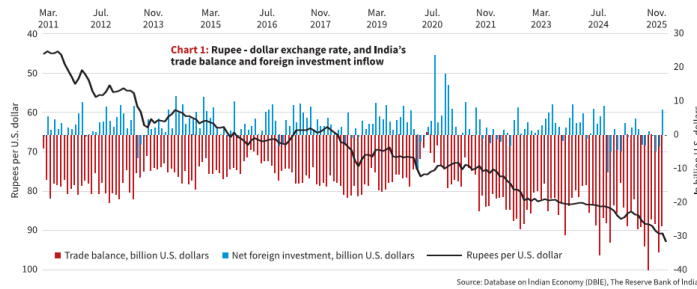
Mounting strain

Amid ongoing geopolitical tensions, the rupee has weakened sharply against the dollar. Global uncertainty, volatile capital flows and rising import costs have intensified pressure on India's balance of payments and forex reserves

	2023-24	2024-25
A. Current account	-26.1	-23.1
A1. Merchandise trade	-244.9	-286.9
A2. Invisibles	218.8	263.9
B. Capital account	89.4	16.6
B1. Foreign investment	54.2	4.52
B2. Loans	6.5	29.3
B3. Others	28.7	-17.2
C. Forex reserves (increase/-decrease)	-63.7	5

The Table shows the net values of the respective items. The merchandise trade balance is exports minus imports of goods; similarly, inflows minus outflows of foreign investment and other items.

Source: Database on Indian Economy (DBIE), The Reserve Bank of India.



(FPI), which involves purchases of stocks or bonds, is highly volatile and driven by speculation. Portfolio investors enter a country seeking quick financial returns and exit at the first sign of risk or when higher returns are offered elsewhere. When FPI surges in, the stock markets are on a roll; when it flows out, it leaves a trail of destruction. Capital outflows imply that investors withdraw their investments in rupee assets and exchange them for dollar assets, leading to a tumble in demand for the rupee and in its exchange rate.

The periods of rapid depreciation of the Indian rupee have each been characterised by worsening of the trade account, FPI outflows, or both. These include April to September 2013 (when the rupee-to-dollar rate fell from 54.4 to 63.8); January to October 2018 (from 63.6 to 76.2); January to April 2020 (from 74.4 to 82.3); September 2024 to February 2025 (from 83.3 to 87.1); and the latest phase that began in May 2025 (from 85.2 to 96) (Chart 1). The recent losses in the

rupee have mainly been due to foreign investors withdrawing from India as they retreat to the safety of their home bases amid growing geopolitical tensions and higher U.S. interest rates.

The depreciation of the rupee imposes a high cost on the Indian economy. To purchase a barrel of oil at \$100, Indian companies now must pay ₹9,600, compared to ₹8,500 had the exchange rate remained at ₹85 per dollar. However, a depressed rupee can help boost exports: a shirt costing ₹1,200 can be sold in the U.S. market at \$12.5 now; if the exchange rate were ₹80 per dollar, the price would have been \$15. But rupee depreciation alone may not help much, given the range of supply and demand constraints weighing on Indian manufacturing.

What is the role of the RBI?

The Reserve Bank of India (RBI) intervenes to prevent the exchange rate from falling to very low levels. When foreign investors rush out by selling their rupee assets for dollars, the RBI props up

the rupee by selling some of the dollars (or treasury bonds) from its reserves. This raises the demand for rupee and slows its decline (as it did during October 2024-January 2025 and August-December 2025) (Chart 2). India's forex reserves remain sufficiently large: they stood at around USD 691.11 billion at the end of March 2026, enough to cover 10.8 months' worth of the country's imports (as of the end of December 2025). That is a mighty armoury the RBI can deploy to shield the rupee against impending speculative tides.

The ongoing geopolitical tensions and the threat of further oil price increases pose severe challenges. India could be at risk of paying more dollars per barrel of oil and more rupees per dollar. The country must take steps to regulate speculative capital outflows and reduce its dependence on oil imports.

(Jayan Jose Thomas is a Professor of Economics at the Indian Institute of Technology, Delhi, and a visiting researcher at the South Asia Institute of the University of Heidelberg.)

THE GIST

The rupee-to-dollar exchange rate crossed 96 in May this year. A currency's exchange rate reflects the price it commands in the market relative to the dollar and other currencies.

Exchange rate is closely tied to a country's balance of payments. India has consistently run a merchandise trade deficit, with imports — especially oil — exceeding exports.

The depreciation of the rupee imposes significant costs on the Indian economy. Therefore, the country must regulate speculative capital outflows and reduce its dependence on oil imports.

26M. Why is the Indian rupee falling?

भारतीय रुपया क्यों गिर रहा है?

- Thus, a currency's exchange rate is closely tied to the country's balance of payments (to and from the rest of the world).

अतः किसी मुद्रा की विनिमय दर देश के भुगतान संतुलन (विश्व के अन्य देशों को और उनसे प्राप्त भुगतानों) से घनिष्ठ रूप से जुड़ी होती है।



- India has consistently run a **merchandise trade deficit**, with imports of goods (especially oil) exceeding exports.
भारत लगातार **वस्तु व्यापार घाटे** का सामना करता रहा है, जहाँ वस्तुओं का आयात (विशेषकर तेल) निर्यात से अधिक रहा है।
- The deficit in its **merchandise trade account** is partially offset by a surplus in India's **invisibles**.
इसके **वस्तु व्यापार खाते** में घाटे की आंशिक पूर्ति भारत के **अदृश्य मदों** में अधिशेष द्वारा होती है।
- That is mainly thanks to foreign currency inflows from the export of **services**, particularly **software**, and to the large **remittance inflows** from migrant workers, especially in **West Asian countries**.
यह मुख्यतः **सेवाओं**, विशेषकर **सॉफ्टवेयर**, के निर्यात से प्राप्त विदेशी मुद्रा तथा प्रवासी श्रमिकों द्वारा भेजी गई बड़ी मात्रा में **विदेशी प्रेषण राशि**, विशेषकर **पश्चिम एशियाई देशों** से प्राप्त धनराशि, के कारण संभव होता है।
- Overall, India's **current account**, which is the sum of merchandise trade and the invisibles accounts, has been in deficit (Table 1).
समग्र रूप से, भारत का **चालू खाता**, जो वस्तु व्यापार और अदृश्य खातों का योग है, घाटे में रहा है।
- The **gap in the current account**, between the foreign currency payments India owes to the rest of the world and the foreign currency payments it receives, has been bridged by inflows through the **capital account**, mainly foreign investment and loans.
चालू खाते में वह अंतर, जो भारत द्वारा विश्व को किए जाने वाले विदेशी मुद्रा भुगतानों और प्राप्त विदेशी मुद्रा भुगतानों के बीच होता है, की पूर्ति **पूँजी खाते** के माध्यम से होने वाले प्रवाह, मुख्यतः विदेशी निवेश और ऋणों, द्वारा की जाती है।
- If the **current account deficit** is more than offset by a surplus in the **capital account**, the excess foreign currency received is added to the country's **foreign exchange (forex) reserves** (Table 1).
यदि **चालू खाते का घाटा**, **पूँजी खाते** के अधिशेष द्वारा अधिक मात्रा में संतुलित हो जाता है, तो प्राप्त अतिरिक्त विदेशी मुद्रा को देश के **विदेशी मुद्रा भंडार (फॉरेक्स रिज़र्व)** में जोड़ दिया जाता है।

How do capital outflows weaken the rupee?

पूँजी बहिर्प्रवाह रुपये को कैसे कमजोर करते हैं?

- **Foreign direct investment (FDI)** is mostly in new or existing factories and businesses and, as a result, has some ties binding it to the host country.
प्रत्यक्ष विदेशी निवेश (FDI) मुख्यतः नई अथवा मौजूदा फैक्ट्रियों और व्यवसायों में किया जाता है, जिसके कारण उसका मेजबान देश से कुछ स्थायी संबंध होता है।
- In comparison, **foreign portfolio investment (FPI)**, which involves purchases of stocks or bonds, is highly volatile and driven by speculation.
इसके विपरीत, **विदेशी पोर्टफोलियो निवेश (FPI)**, जिसमें शेयरों अथवा बॉन्डों की खरीद शामिल होती है, अत्यधिक अस्थिर तथा सट्टेबाजी से प्रेरित होता है।
- **Portfolio investors enter a country seeking quick financial returns and exit at the first sign of risk or when higher returns are offered elsewhere.**
पोर्टफोलियो निवेशक त्वरित वित्तीय लाभ की खोज में किसी देश में प्रवेश करते हैं और जोखिम के प्रथम संकेत अथवा अन्यत्र अधिक लाभ मिलने पर तुरंत बाहर निकल जाते हैं।
- **Capital outflows imply that investors withdraw their investments in rupee assets and exchange them for dollar assets, leading to a tumble in demand for the rupee and in its exchange rate.**
पूँजी बहिर्प्रवाह का अर्थ है कि निवेशक रुपये आधारित परिसंपत्तियों से अपना निवेश निकालकर उन्हें डॉलर आधारित परिसंपत्तियों में परिवर्तित कर देते हैं, जिससे रुपये की मांग और उसकी विनिमय दर में गिरावट आती है।



- The periods of rapid **depreciation** of the Indian rupee have each been characterised by worsening of the **trade account, FPI outflows**, or both.
भारतीय रुपये के तीव्र **अवमूल्यन** के प्रत्येक चरण की विशेषता **व्यापार खाते** की बिगड़ती स्थिति, **FPI बहिर्प्रवाह**, अथवा दोनों रही हैं।

What is the role of the RBI?

भारतीय रिज़र्व बैंक (RBI) की क्या भूमिका है?

- When foreign investors rush out by selling their rupee assets for dollars, the **RBI** props up the rupee by selling some of the dollars (or treasury bonds) from its reserves.
जब विदेशी निवेशक अपनी रुपये आधारित परिसंपत्तियों को बेचकर डॉलर खरीदते हुए बाहर निकलते हैं, तब **RBI** अपने भंडार से कुछ डॉलर (अथवा ट्रेज़री बॉन्ड) बेचकर रुपये को सहारा देता है।
- This raises the demand for rupee and slows its decline (as it did during October 2024-January 2025 and August-December 2025) (Chart 2).
इससे रुपये की मांग बढ़ती है और उसके अवमूल्यन की गति धीमी पड़ती है, जैसा कि अक्टूबर 2024-जनवरी 2025 तथा अगस्त-दिसंबर 2025 के दौरान हुआ।
- India's **forex reserves** remain sufficiently large: they stood at around **USD 691.11 billion** at the end of March 2026, enough to cover 10.8 months' worth of the country's imports (as of the end of December 2025).
भारत के **विदेशी मुद्रा भंडार** अभी भी पर्याप्त रूप से बड़े हैं। मार्च 2026 के अंत तक ये लगभग **691.11 अरब अमेरिकी डॉलर** थे, जो दिसंबर 2025 के अंत तक देश के 10.8 महीनों के आयात को पूरा करने के लिए पर्याप्त हैं।
- That is a mighty **armoury** the RBI can deploy to shield the rupee against impending speculative tides.
यह एक शक्तिशाली **आर्थिक शस्त्रागार** है, जिसका उपयोग RBI रुपये को संभावित सट्टात्मक दबावों से बचाने हेतु कर सकता है।



Indian mobile market hit as global semicon industry faces 'severe memflation'

India sees shortage of sub ₹10,000-₹15,000 phones as leading chips manufacturers divert capacities to meet humongous demand for high-bandwidth memory required to support AI infra

GS III: Economy
Mini Tejaswi
BENGALURU

The semiconductor industry globally is experiencing a severe structural 'memflation' (inflation caused by memory chips shortage), with skyrocketing prices leading to huge disruptions in price sensitive consumer electronics and mobile phone markets in India, said industry experts.

The key reason is that global wafer and advanced packaging capacities are increasingly being allocated toward high bandwidth memory (HBM) and AI infrastructure due to significantly higher demand and margins. A typical HBM takes 2-3x wafer capacity compared with a conventional DRAM.

This is making availability of conventional DRAM and NAND used in mainstream electronics tighter, according to India Electronics & Semiconductor Association (IESA).

Dynamic Random-Access Memory, or DRAM, is a type of computer memory used in PCs, laptops, and smartphones to temporarily store data that the processor needs to actively use. While NAND is a type of memory storage used in smartphones that retains data even without power.

Industry experts also confirmed that there is a shortage of sub ₹10,000 to



Off reach: The entry-level smartphone segment is under severe pressure due to rising memory chip costs. B. JOTHI RAMALINGAM

₹15,000 phones across the country as leading semiconductor (memory chips) manufacturers are diverting all their energies and production capacities away from standard consumer chips to meet the humongous demand for high-bandwidth memory required to support AI infrastructure.

India very vulnerable
B.V. Naidu, a foundational architect in India's semiconductor and Electronics System Design and Manufacturing (ESDM) ecosystem and a former president of IESA, India is extremely vulnerable to memory chip shortage due to its heavy reliance on electronic component imports and a consumer base driven by price elasticity.

"It seems global chip makers are prioritising premium brands such as

Apple and Samsung for standard memory allocation, leaving budget brands in India and in other geographies to starve of chip/component supply. This has resulted in a short supply of economy smartphones in India. Also, I was told prices of several brands of cellphones have gone up by at least 15-20%," Mr. Naidu said.

As per IESA, higher DRAM and NAND prices, combined with the shift to AI-enabled applications and larger storage needs, are making the sub ₹10,000 to ₹15,000 category increasingly difficult to sustain profitably.

"The market is witnessing a structural recalibration toward higher-value devices. That means, phone makers are prioritising premium phone production over entry level phones," explained Ashok

Chandak, president, IESA.

Confirming the trend, Rajeev Rajput, Senior Principal Analyst at Gartner, in a recent report said, "Memflation will destroy, or at least delay, non-AI demand into 2028, to varying degrees depending on the application. Technology suppliers should prepare for higher prices during the first half of 2026, followed by persistent but moderating price increases throughout the rest of the year." CIOs and IT leaders should be cautious about signing supply agreements with unfavourable pricing terms that extend beyond 2027, he warned.

Echoing a similar sentiment, Mr. Chandak said while capacity expansion announcements were underway globally, meaningful and substantial relief may take up to another two years because semiconductor capacity creation was highly capital-intensive and time-consuming.

"We expect the market to remain tight through 2026-2027, with gradual normalisation thereafter," he added.

On bill of materials (BOM) pressure and smartphone profitability, Mr. Chandak observed, memory pricing has become one of the biggest cost pressures in smartphone and entry level laptop manufacturing.

26M. Indian mobile market hit as global semicon industry faces 'severe memflation'

वैश्विक सेमीकंडक्टर उद्योग में 'गंभीर मेमफ्लेशन' के कारण भारतीय मोबाइल बाजार प्रभावित

- India sees shortage of sub ₹10,000-₹15,000 phones as leading chips manufacturers divert capacities to meet humongous demand for high-bandwidth memory required to support AI infra.

भारत में ₹10,000-₹15,000 से कम कीमत वाले फोन की कमी देखी जा रही है क्योंकि प्रमुख चिप निर्माता AI



अवसंरचना के समर्थन हेतु आवश्यक हाई-बैंडविड्थ मेमोरी की भारी मांग को पूरा करने के लिए अपनी उत्पादन क्षमता को मोड़ रहे हैं।

- The **semiconductor industry** globally is experiencing a severe structural “**memflation**” (inflation caused by memory chips shortage), with skyrocketing prices leading to huge disruptions in price sensitive consumer electronics and mobile phone markets in India, said industry experts.

वैश्विक स्तर पर **सेमीकंडक्टर उद्योग** गंभीर संरचनात्मक “**मेमफ्लेशन**” (मेमोरी चिप की कमी से उत्पन्न महंगाई) का सामना कर रहा है, जिसके कारण कीमतों में भारी वृद्धि हुई है और भारत के मूल्य-संवेदनशील उपभोक्ता इलेक्ट्रॉनिक्स एवं मोबाइल फोन बाजारों में बड़ा व्यवधान पैदा हुआ है, ऐसा उद्योग विशेषज्ञों ने कहा।

- The key reason is that global wafer and advanced packaging capacities are increasingly being allocated toward high bandwidth memory (HBM) and AI infrastructure due to significantly higher demand and margins.

मुख्य कारण यह है कि वैश्विक वेफर और उन्नत पैकेजिंग क्षमता को बढ़ती हुई मांग और अधिक लाभ मार्जिन के कारण हाई-बैंडविड्थ मेमोरी (HBM) और AI अवसंरचना की ओर अधिक आवंटित किया जा रहा है।

- **Dynamic Random-Access Memory (DRAM)** is a type of computer memory used in PCs, laptops, and smartphones to temporarily store data that the processor needs to actively use.

डायनेमिक रैंडम-एक्सेस मेमोरी (DRAM) एक प्रकार की कंप्यूटर मेमोरी है जिसका उपयोग PCs, लैपटॉप और स्मार्टफोन्स में उस डेटा को अस्थायी रूप से संग्रहित करने के लिए किया जाता है जिसकी प्रोसेसर को सक्रिय रूप से आवश्यकता होती है।

- While **NAND** is a type of memory storage used in smartphones that retains data even without power.

वहीं **NAND** एक प्रकार का मेमोरी स्टोरेज है जिसका उपयोग स्मार्टफोन्स में किया जाता है और यह बिजली न होने पर भी डेटा को सुरक्षित रखता है।

W. Asia crisis may push FY27 fertiliser subsidy over ₹3 lakh crore

GS III: Economy
Prabhudatta Mishra
 NEW DELHI

India's fertiliser subsidy bill could exceed ₹3 lakh crore in FY27, nearly double the Budget Estimate of ₹1.71 lakh crore, as the West Asia crisis drives up global prices of urea, LNG and other key inputs, official sources have told *businessline*.

The sharp escalation in subsidy requirements comes amid concerns over disruptions in the Strait of Hormuz and rising dependence on costly imports. Officials said the subsidy burden, earlier estimated at below ₹2 lakh crore before the geopolitical flare-up, has ballooned after the surge in global fertiliser and energy prices.

“If the current situation persists through the Kharif season, the subsidy could cross ₹3 lakh crore. If elevated prices and supply disruptions continue into the Rabi season, it may even touch ₹3.5 lakh crore,” a senior official said. In the FY27 Budget, Finance Minister Nirmala Sitharaman had provided ₹1.7 lakh crore of fertiliser subsidy that includes ₹1.16 lakh crore for urea sector (both domestic and imported) and ₹54,000 crore for phosphorus and potash sector. In 2025-26, the fertiliser subsidy was pegged at ₹1.86 lakh crore (Revised Estimate)

Speaking at a SIDBI event in Mumbai on Monday, Ms. Sitharaman said that there has been an “unimaginable jump” in the global fertiliser prices after the West Asia crisis. Echoing Prime Minister Narendra Modi's austerity call, she asked people to focus



Recent Indian urea import tender found prices further jumping to \$935-959 a tonne.

on ‘3Fs’ – fuel, fertiliser and forex – in the current scenario. Within a span of roughly 40 days during the recent crisis, global urea prices reportedly surged by nearly 65%, rising from around \$482 per tonne in late February 2026 to nearly \$795 per tonne in early April. Recent Indian urea import tender (floated by IPL) found prices further jumping to \$935-959 per tonne. In the case of LNG, the principal feedstock for urea production, prices have risen from nearly \$10.4/MMBtu in late February to around \$17.4/MMBtu by early-May, 2026 after peaking nearly \$25.4/MMBtu during early-March. Releasing a paper titled “Ensuring India's Fertiliser Security Amid Rising Geopolitical Risks”, authored by ICRIER's Ashok Gulati and others on Monday, NITI Aayog Member K.V. Raju urged the thinktank to suggest an implementable actions plan.

“Do not come back in 10 to 12 months saying the government did not do this or that. Kharif sowing is about to start, and recommendations must address this year, this current season,” Mr. Raju told ICRIER. (The writer is with *The Hindu businessline*)

India very vulnerable भारत अत्यंत संवेदनशील

- **B.V. Naidu**, a foundational architect in India's semiconductor and **Electronics System Design and Manufacturing (ESDM)** ecosystem and a former president of **IESA**, said India is extremely vulnerable to memory chip shortage due to its heavy reliance on electronic component imports and a consumer base driven by **price elasticity**.

भारत के सेमीकंडक्टर और इलेक्ट्रॉनिक्स सिस्टम डिज़ाइन एंड मैनुफैक्चरिंग (ESDM) पारिस्थितिकी तंत्र के प्रमुख वास्तुकार तथा **IESA** के पूर्व अध्यक्ष **बी.वी. नायडू** ने कहा कि इलेक्ट्रॉनिक घटकों के आयात पर भारी निर्भरता और मूल्य-संवेदनशील उपभोक्ता आधार के कारण भारत मेमोरी चिप की कमी के प्रति अत्यंत संवेदनशील है।

26M. W. Asia crisis may push FY27 fertiliser subsidy over ₹3 lakh crore

पश्चिम एशिया संकट से FY27 में उर्वरक सब्सिडी ₹3 लाख करोड़ से अधिक हो सकती है

- India's fertiliser subsidy bill could exceed ₹3 lakh crore in FY27, nearly double the Budget Estimate of ₹1.71 lakh crore, as the West Asia crisis drives up global prices of urea, LNG and other key inputs.

आधिकारिक सूत्रों ने बिज़नेसलाइन को बताया कि पश्चिम एशिया संकट के कारण

यूरिया, LNG और अन्य प्रमुख इनपुट की वैश्विक कीमतों में वृद्धि होने से भारत का उर्वरक सब्सिडी बिल FY27 में ₹3 लाख करोड़ से अधिक हो सकता है, जो बजट अनुमान ₹1.71 लाख करोड़ का लगभग दोगुना है।

- If elevated prices and supply disruptions continue into the Rabi season, it may even touch ₹3.5 lakh crore.”

यदि ऊँची कीमतें और आपूर्ति व्यवधान रबी मौसम तक जारी रहते हैं, तो यह ₹3.5 लाख करोड़ तक पहुँच सकती है,” एक वरिष्ठ अधिकारी ने कहा।

- In the FY27 Budget, Finance Minister Nirmala Sitharaman had provided ₹1.7 lakh crore of fertiliser subsidy that includes ₹1.16 lakh crore for urea sector (both domestic and imported) and ₹54,000 crore for phosphorus and potash sector.

FY27 बजट में वित्त मंत्री निर्मला सीतारमण ने उर्वरक सब्सिडी के लिए ₹1.7 लाख करोड़ का प्रावधान किया था, जिसमें यूरिया क्षेत्र (घरेलू और आयातित दोनों) के लिए ₹1.16 लाख करोड़ और फॉस्फोरस तथा पोटाश क्षेत्र के लिए ₹54,000 करोड़ शामिल थे।

- In 2025-26, the fertiliser subsidy was pegged at ₹1.86 lakh crore (Revised Estimate).

2025-26 में उर्वरक सब्सिडी का संशोधित अनुमान ₹1.86 लाख करोड़ रखा गया था।

- In the case of LNG, the principal feedstock for urea production, prices have risen from nearly \$10.4/MMBtu in late February to around \$17.4/MMBtu by early-May, 2026 after peaking nearly \$25.4/MMBtu during early-March.

यूरिया उत्पादन के प्रमुख फीडस्टॉक LNG के मामले में कीमतें फरवरी के अंत में लगभग \$10.4/MMBtu से बढ़कर मई 2026 की शुरुआत तक लगभग \$17.4/MMBtu हो गईं, जबकि मार्च की शुरुआत में यह लगभग \$25.4/MMBtu तक पहुँच गई थीं।

Huawei's 'chip queen' in China's tech folklore

GS III Economy

Reuters
SHANGHAI/BEIJING

When He Tingbo was put in charge of Huawei's chip development in 2003, the young engineer was handed an annual budget of \$400 million and a mandate that would eventually put her at the centre of China's most consequential technology effort.

More than two decades later, He, often described in Chinese technology circles as Huawei's "chip queen", has become one of the company's most important executives and a symbol of China's determination to survive U.S. sanctions and build a self-reliant semiconductor business.

He is president of Huawei's semiconductor business and director of its



Top talent: Huawei logo is seen at the Porte de Versailles exhibition centre in Paris, France. REUTERS

Scientist Committee. She is also one of only two women on Huawei's 17-member board, alongside Meng Wanzhou, the daughter of founder Ren Zhengfei and Huawei's rotating chairwoman.

Her latest public appearance on Monday, a keynote address titled "New

Semiconductor Path in Practice" at the IEEE International Symposium on Circuits and Systems in Shanghai, places her at the centre of a global debate over what comes after Moore's Law.

For decades, chip progress was driven by shrinking transistors and packing

more of them onto a single chip, making computers faster, cheaper and more energy efficient, a pattern known as Moore's Law. But as semiconductor scaling approaches lithographic and atomic limits, Moore's Law has become less effective, forcing the industry to find new ways to boost performance.

Huge challenge

For Huawei, that challenge arrived earlier and more brutally than for many rivals. U.S. sanctions beginning in 2019 cut the company off key foreign chip technologies and leading-edge manufacturing, threatening its businesses from smartphones to telecommunications equipment.

New U.S. curbs subsequently put many of Hua-

wei's domestic partners and competitors in a similar predicament, increasing the importance of post-Moore's Law semiconductor technologies.

He introduced on Monday what Huawei calls the Tau Scaling Law, a principle the Chinese technology company says can guide chip development as Moore's Law weakens.

Mass production

Huawei said her team has spent the past six years applying it and has mass-produced 381 chips based on the approach.

The principle argues that the semiconductor industry should shift its focus from shrinking transistors to speeding up transmission speeds across devices, circuits, chips and computing systems.

He's career has largely tracked Huawei's global rise, its years of struggle following U.S. sanctions, and then a rebirth as the core driver of China's mission to become a high-tech juggernaut.

Born in 1969 in Changsha in the southern province of Hunan, she joined Huawei in 1996 as an engineer after earning a dual bachelor's degree in semiconductor physics and communication engineering and also a master's degree from Beijing University of Posts and Telecommunications.

In 2004, the company formally established HiSilicon, its chip design unit, which He helped build from a small internal department into one of the world's broadest semiconductor operations.

26M. Huawei's 'chip queen' in China's tech folklore

चीन की तकनीकी लोककथाओं में Huawei की 'चिप क्वीन'

- For decades, chip progress was driven by shrinking transistors and packing more of them onto a single chip, making computers faster, cheaper and more energy efficient, a pattern known as Moore's Law.

दशकों तक चिप प्रगति ट्रांजिस्टर्स के छोटे होने और एक ही चिप पर अधिक संख्या में लगाए जाने से संचालित होती रही, जिससे कंप्यूटर तेज, सस्ते और अधिक ऊर्जा-कुशल बने; इस प्रवृत्ति को मूर का नियम कहा जाता है।



- But as semiconductor scaling approaches lithographic and atomic limits, **Moore's Law** has become less effective, forcing the industry to find new ways to boost performance.
लेकिन जैसे-जैसे सेमीकंडक्टर स्केलिंग लिथोग्राफिक और परमाणु सीमाओं के करीब पहुँच रही है, **मूर का नियम** कम प्रभावी होता जा रहा है, जिससे उद्योग को प्रदर्शन बढ़ाने के नए तरीके खोजने पड़ रहे हैं।

Huge challenge

विशाल चुनौती

- For **Huawei**, that challenge arrived earlier and more brutally than for many rivals.
Huawei के लिए यह चुनौती कई प्रतिद्वंद्वियों की तुलना में पहले और अधिक कठोर रूप में आई।
- **U.S. sanctions** beginning in 2019 cut the company off key foreign chip technologies and leading-edge manufacturing, threatening its businesses from smartphones to telecommunications equipment.
2019 से शुरू हुए **अमेरिकी प्रतिबंधों** ने कंपनी को प्रमुख विदेशी चिप तकनीकों और अत्याधुनिक निर्माण क्षमताओं से वंचित कर दिया, जिससे स्मार्टफोन से लेकर दूरसंचार उपकरणों तक उसके व्यवसाय प्रभावित हुए।
- **New U.S. curbs** subsequently put many of Huawei's domestic partners and competitors in a similar predicament, increasing the importance of post-**Moore's Law** semiconductor technologies.
इसके बाद नए अमेरिकी प्रतिबंधों ने Huawei के कई घरेलू साझेदारों और प्रतिस्पर्धियों को भी समान कठिनाई में डाल दिया, जिससे पोस्ट-**मूर लॉ** सेमीकंडक्टर तकनीकों का महत्व बढ़ गया।
- He introduced on Monday what Huawei calls the "**Tau Scaling Law**", a principle the Chinese technology company says can guide chip development as **Moore's Law** weakens.
सोमवार को उन्होंने Huawei द्वारा प्रस्तुत "**Tau Scaling Law**" को पेश किया, जिसे चीनी प्रौद्योगिकी कंपनी ने ऐसा सिद्धांत बताया जो **मूर के नियम** के कमजोर पड़ने के समय चिप विकास का मार्गदर्शन कर सकता है।

Mass production

बड़े पैमाने पर उत्पादन

- Huawei said her team has spent the past six years applying it and has mass-produced **381 chips** based on the approach.
Huawei ने कहा कि उनकी टीम ने पिछले छह वर्षों से इस सिद्धांत को लागू किया है और इसके आधार पर **381 चिप्स** का बड़े पैमाने पर उत्पादन किया है।
- **The principle argues that the semiconductor industry should shift its focus from shrinking transistors to speeding up transmission speeds across devices, circuits, chips and computing systems.**
यह सिद्धांत कहता है कि सेमीकंडक्टर उद्योग को ट्रांजिस्टरों को छोटा करने के बजाय उपकरणों, सर्किटों, चिप्स और कंप्यूटिंग प्रणालियों में ट्रांसमिशन गति बढ़ाने पर ध्यान केंद्रित करना चाहिए।
- Born in **1969** in **Changsha** in the southern province of **Hunan**, she joined Huawei in 1996 as an engineer after **earning a dual bachelor's degree in semiconductor physics and communication engineering** and also a master's degree from **Beijing University of Posts and Telecommunications**.
दक्षिणी प्रांत **हुनान** के **चांगशा** में **1969** में जन्मी हे ने सेमीकंडक्टर भौतिकी और संचार इंजीनियरिंग में दोहरी स्नातक डिग्री तथा **बीजिंग यूनिवर्सिटी ऑफ पोस्ट्स एंड टेलीकम्युनिकेशंस** से मास्टर डिग्री प्राप्त करने के बाद 1996 में Huawei में इंजीनियर के रूप में कार्य शुरू किया।
- In 2004, the company formally established **HiSilicon**, its chip design unit, which He helped build from a small internal department into one of the world's broadest semiconductor operations.
2004 में कंपनी ने औपचारिक रूप से अपनी चिप डिजाइन इकाई **HiSilicon** की स्थापना की, जिसे हे ने एक



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छोटे आंतरिक विभाग से विकसित कर दुनिया के सबसे व्यापक सेमीकंडक्टर संचालन में बदलने में महत्वपूर्ण भूमिका निभाई।

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TOPICS COVERED		
26M	Physicists are finding new ways to make electrons act strangely भौतिक विज्ञानी इलेक्ट्रॉनों को असामान्य रूप से व्यवहार करने के नए तरीके खोज रहे हैं।	
26M	Tech needed to create matter from light in place प्रकाश से पदार्थ उत्पन्न करने के लिए आवश्यक प्रौद्योगिकी अब उपलब्ध है।	
26M	The physics of thermometers, temperatures and cold atoms थर्मामीटर, तापमान और शीत परमाणुओं का भौतिकी विज्ञान	

PATRIOTIC IAS



Physicists are finding new ways to make electrons act strangely

Science advances when scientists recreate what they find in nature in new conditions; that is how we got air travel, lasers, nuclear power, antibiotics, and semiconductors; something similar maybe happening with quantum materials — materials whose properties arise from quantum physics effects

By Vasudevan Mukundh

For most of the last two centuries, we have not had to think much about electricity. At the start of this period, we were just beginning to understand what it was. And towards the end, climate change and renewable energy have rendered it a constant thought in our minds. But for many decades in between, we could take it for granted.

Electricity, most of the time, was just something behind a switch. If you flipped the switch, electrons would move through a wire. If you raised the voltage, more current would flow.

But today, there is another way in which some people are thinking about electrons — a way that could, someday, change the future.

Scientists have found that inside some materials, in extreme conditions, electricity behaves in highly unusual ways. The electrons stop being independent particles and begin moving together. They flow around edges with uncanny precision. Most of all, the particles seem split up into pieces, each apparently carrying a fraction of an electron's charge.

From ramp to staircase
 Physics has made many weird discoveries — but a real contender for its weirdest find is the fractional quantum Hall effect (FQHE), which is where electrons behave in those strange ways.

Recently, physicists were able to make it even stranger by recreating it without one of the conditions they believed to be indispensable for it.

In 1879, the U.S. physicist Edwin Hall found something odd. If electricity flows through a metal plate when a magnetic field is pointing perpendicular to the plate, the current experiences a sideways push. (One reason this was odd was that J.J. Thompson would not discover the electron 18 years later.) Scientists later explained why: the magnetic field pushes moving charges sideways, causing electric charge to pile up on the plate's edges, creating a voltage across the metal. This came to be called the Hall effect. The compass in your smartphone uses it to point north.

As usual, the rise of quantum mechanics complicated the picture. In the early 1980s, physicists were studying very clean materials at temperatures just a fraction above absolute zero, using magnetic fields.

When they increased the strength of the field beyond a point, the resistance the current was experiencing — called the Hall resistance — stopped changing smoothly.

Instead, it took discrete values. For example, when before it could change from 1 to 1.1 to 1.2 to 1.3 and so on, now it could change only to 1 or 2 or 3 or so on, like climbing stairs rather than being able to use the ramp. In other words, physicists found the resistance became quantised. And they called it the integer quantum Hall effect.

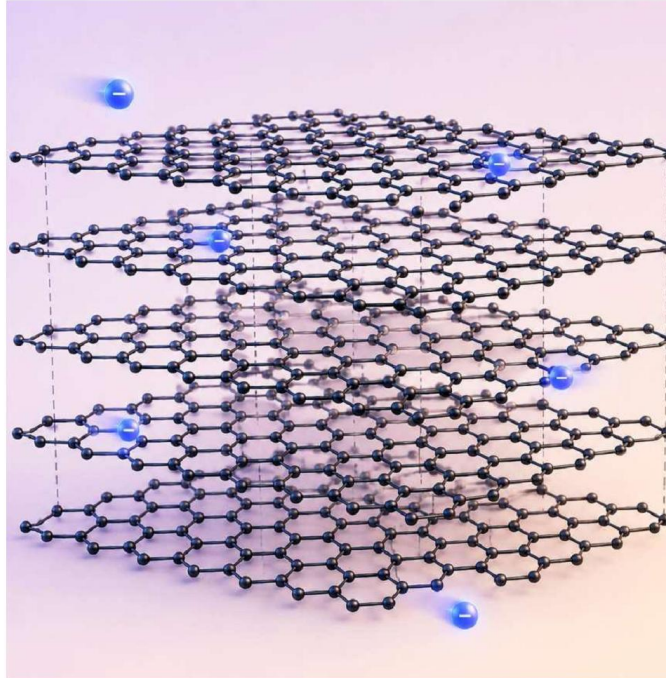
Once again, they soon found an explanation. Normally, the electrons in a material can have a range of energies. But when there is a strong magnetic field acting on them, the range becomes a set of levels, called Landau levels. And the electrons can occupy only these levels. This is like when before a bunch of people in a room could lie down where they wanted — on one of the four beds or on the floor in between — now they could only occupy the beds. In this condition, the material becomes an insulator on the inside and a very good conductor on its boundaries.

Ocean of electrons
 Then, in 1982, physicists found the strangest thing of them all. Sometimes, the Hall resistance occurred only in whole-number steps (1, 2, 3, ...) but sometimes it could occur as fractions: 1/3, 2/5, 3/7, etc. This was FQHE.

(The fraction here refers to the multiple of the material's natural Hall resistance. For example, if the natural resistance is 50 Ω, a fractional Hall resistance of 2/5 implies a measured resistance of 20 Ω.)

At first glance, this should be impossible: electrons are indivisible particles — you cannot break them up into smaller pieces — and each electron carries a fixed amount of electric charge. Yet the Hall resistance seemed to be changing in fractions, as though the current were being carried by objects with only a fraction of an electron's charge. What then was 1/3?

The answer came from quantum



Usually, electrons in a material can zip past each other without also pushing each other apart. But in pentalayer graphene (depicted here), the electrons have such low kinetic energy that the particles' mutual repulsion becomes the dominant interaction between them. IMAGE CREATED WITH CHATGPT 5.2

mechanics. When many electrons come together to interact strongly, they form a collective quantum state — a sort of liquid state in which it is impossible to distinguish individual electrons. This is like an ocean; you cannot isolate the single water droplet you dropped in it. And much like waves in the ocean — where no single droplet travels to the shore but the water as a whole has a moving pattern — a part of the collective quantum state can behave as if it possesses only a fraction of an electron's charge.

Physicists generally call these parts quasiparticles. In this particular case, the quasiparticles are very unusual. They were of a type called anyons. Which meant they would also have a very unusual property: they would be much more robust than other particles (or quasiparticles) at storing information.

'Faking' a field
 However, there is a big practical problem. The FQHE gives rise to anyonic quasiparticles.

But to create the effect, physicists need to apply a very strong magnetic field to the material — sometimes even stronger than the one in a hospital MRI scanner. And the material had to be very clean (i.e. almost entirely free of impurities) and held at close to absolute zero.

Try as they might for no less than four decades, physicists found that this was the only way to create the FQHE. Obviously this is not practical. FQHE — but especially that anyons it gives rise to — could help quantum computers of the future protect information from noise, which is one of the enterprise's hardest unsolved problems today.

In 2025, Microsoft said it had built a quantum computing chip that created anyons using a different technique, and used them to store and manipulate information.

(However, many scientists doubt the company's claims; among other concerns, questions linger about whether the chip really contains anyons and the means by which that can be verified.)

A sandwich for electrons
 One breakthrough came in 2024. It was based on doing something really clever, if also very sophisticated: if a strong magnetic field organises a material's electrons in unusual patterns, could the field's role be 'faked' from within the

Scientists have found that inside some materials, in extreme conditions, electricity behaves in highly unusual ways. The electrons stop being independent particles and begin moving together like a fluid

material itself?

Turns out the answer is 'yes' if the material is graphene. Graphene is a sheet of carbon atoms arranged in a honeycomb pattern. Since the 2000s, physicists have found that if you stack one layer of graphene on another and turn it by a small angle — i.e. twisted bilayer graphene — the electrons in the stack behave oddly.

The grid of atoms in this structure forms what is called a moiré superlattice, which essentially significantly slows the electrons down. When the electrons slowed down, they formed a (strongly) collective quantum state — the kind of state that gave rise to the FQHE earlier. But this time there was no magnetic field; the moiré superlattice had recreated the field's requisite effects.

Twisted bilayer graphene has many odd electronic properties. However, it does not slow electrons down enough to create a sufficiently robust collective quantum state.

Usually, electrons in a material are zipping around with enough kinetic energy for them to ignore their mutual repulsion. This does not mean they clump together — more like they can zip past each other without also pushing each other apart.

On the other hand, the FQHE demands that the electrons' mutual repulsion must be the stronger force. For that, the electrons need to slow down beyond a specific point, and twisted bilayer graphene was not really creating the conditions for that.

Enter pentalayer graphene. After many experiments, physicists found that when they added more graphene layers to the stack, the electrons slowed down more.

With five layers — with each layer turned by a small angle relative to the one below — placed atop a substrate of hexagonal boron nitride, the electrons' kinetic energy dropped enough for electron-electron interactions to become dominant.

(Aside: If the electrons are repelling each other in this state, how come they

form a collective quantum state instead of flying apart? When electrons are repelling each other but are also confined, they do not have the luxury of flying apart. Instead, they organise themselves better, leading to the collective quantum state — sort of like a negotiated settlement where they agree to not antagonise each other.)

Quantum materials

In 2024, a team led by Long Ju at the Massachusetts Institute of Technology reported that it had detected FQHE in pentalayer graphene. They called it the FQHE — the 'A' stood for anomalous, meaning it had been achieved without using a magnetic field.

The team reported observing Hall resistance like 2/3 and 3/5.

They concluded that the moiré superlattice created by five layers of graphene had produced the requisite structural features mimicking the effects of a magnetic field.

The experimental observation of FQHE does not mean the underlying science is ready for real-world use. With or without magnetic fields, physicists still need the material to be ultra-clean and work with it at very low temperature.

They also need to get the angles at which the graphene layers are turned relative to the substrate very close.

Even a small deviation can destroy the ideal moiré superlattice properties required to slow and confine the electrons.

Finally, the FQHE also appears only when the material contains the 'right' number of electrons, which physicists can control by applying the right amount of voltage.

Since then, by fine-tuning these controls, physicists have found ways to create more robust FQHE states.

Many of them keep going because of the value the anyonic quasiparticles hold for more advanced quantum computers — and indeed a whole world of physics that was previously locked behind powerful yet expensive magnets.

But more than that, science also advances when scientists recreate what they find in nature in new conditions. That is how we got air travel, lasers, nuclear power, antibiotics, and semiconductors.

Something similar may be happening now with quantum materials — materials whose properties arise from quantum physics effects.

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26M. Physicists are finding new ways to make electrons act strangely

भौतिक विज्ञानी इलेक्ट्रॉनों को असामान्य रूप से व्यवहार करने के नए तरीके खोज रहे हैं।

• Science advances when scientists recreate what they find in nature in new conditions; that is how we got air travel, lasers, nuclear power, antibiotics, and semiconductors; something similar maybe happening with quantum materials — materials whose properties arise from quantum physics effects.

विज्ञान तब आगे बढ़ता है जब वैज्ञानिक प्रकृति में जो खोजते हैं, उसे नई परिस्थितियों में पुनः निर्मित करते हैं; इसी प्रकार हमें वायु यात्रा, लेज़र, नाभिकीय ऊर्जा, प्रतिजैविक, और अर्धचालक प्राप्त हुए; इसी प्रकार की कोई प्रक्रिया संभवतः क्वांटम पदार्थों के साथ भी हो रही है — ऐसे पदार्थ जिनके गुण क्वांटम भौतिकी के प्रभावों से उत्पन्न होते हैं।

• Scientists have found that inside some materials, in extreme conditions, electricity behaves in highly unusual ways.

वैज्ञानिकों ने पाया है कि कुछ पदार्थों के भीतर, अत्यधिक परिस्थितियों में, विद्युत अत्यंत असामान्य प्रकार से व्यवहार करती है।

• The electrons stop



being independent particles and begin moving together.

इलेक्ट्रॉन स्वतंत्र कणों के रूप में कार्य करना बंद कर देते हैं और एक साथ गति करने लगते हैं।

From ramp to staircase

ढलान से सीढ़ियों तक

- **Physics** has made many weird discoveries — but a real contender for its weirdest find is the **fractional quantum Hall effect (FQHE)**, which is where electrons behave in those strange ways.
भौतिकी ने अनेक विचित्र खोजें की हैं — किन्तु उसकी सबसे विचित्र खोजों में एक वास्तविक दावेदार **फ्रैक्शनल क्वांटम हॉल प्रभाव (FQHE)** है, जिसमें इलेक्ट्रॉन उन असामान्य तरीकों से व्यवहार करते हैं।
- If electricity flows through a metal plate when a magnetic field is pointing perpendicular to the plate, the current experiences a sideways push.
यदि किसी धातु की प्लेट से विद्युत प्रवाहित हो रही हो और उस पर एक चुंबकीय क्षेत्र लंबवत दिशा में लगाया जाए, तो धारा पार्श्व दिशा में धक्का अनुभव करती है।
- (One reason this was odd was that **J.J. Thompson** would not discover the electron 18 years later.)
(यह विचित्र इसलिए भी था क्योंकि **जे.जे. थॉम्पसन** ने इलेक्ट्रॉन की खोज इसके 18 वर्ष बाद की थी।)
- Scientists later explained why: the **magnetic field pushes moving charges sideways, causing electric charge to pile up on the plate's edges, creating a voltage across the metal.**
वैज्ञानिकों ने बाद में इसका कारण स्पष्ट किया: **चुंबकीय क्षेत्र** गतिशील आवेशों को पार्श्व दिशा में धकेलता है, जिससे विद्युत आवेश प्लेट के किनारों पर एकत्रित हो जाता है और धातु के आर-पार वोल्टेज उत्पन्न होता है।
- **This came to be called the Hall effect.**
इसे **हॉल प्रभाव** कहा जाने लगा।
- The **compass in your smartphone uses it to point north.**
आपके स्मार्टफोन का कंपास उत्तर दिशा बताने के लिए इसी सिद्धांत का उपयोग करता है।
- As usual, the rise of **quantum mechanics** complicated the picture.
सामान्यतः की भाँति, **क्वांटम यांत्रिकी** के विकास ने इस विषय को और अधिक जटिल बना दिया।
- **In the early 1980s, physicists were studying very clean materials at temperatures just a fraction above absolute zero, using magnetic fields.**
1980 के प्रारम्भिक वर्षों में, भौतिकविद अत्यंत स्वच्छ पदार्थों का अध्ययन **परम शून्य** से थोड़ा अधिक तापमान पर चुंबकीय क्षेत्रों की सहायता से कर रहे थे।
- **When they increased the strength of the field beyond a point, the resistance the current was experiencing — called the Hall resistance — stopped changing smoothly.**
जब उन्होंने चुंबकीय क्षेत्र की तीव्रता को एक सीमा से अधिक बढ़ाया, तो धारा द्वारा अनुभव किया जा रहा प्रतिरोध — जिसे **हॉल प्रतिरोध** कहा जाता है — सुचारु रूप से बदलना बंद हो गया।
- Instead, it took discrete values.
इसके स्थान पर, उसने पृथक मान ग्रहण करने प्रारम्भ कर दिए।
- **For example, when before it could change from 1 to 1.1 to 1.2 to 1.3 and so on, now it could change only to 1 or 2 or 3 or so on, like climbing stairs rather than being able to use the ramp.**
उदाहरण के लिए, जहाँ पहले यह 1 से 1.1, 1.2, 1.3 आदि तक परिवर्तित हो सकता था, अब यह केवल 1, 2, 3 आदि मान ही ग्रहण कर सकता था, मानो ढलान के स्थान पर सीढ़ियाँ चढ़ी जा रही हों।
- **In other words, physicists found the resistance became quantised.**
दूसरे शब्दों में, भौतिकविदों ने पाया कि प्रतिरोध **क्वांटित** हो गया था।
- And **they called it the integer quantum Hall effect.**
और उन्होंने इसे **इंटीजर क्वांटम हॉल प्रभाव** नाम दिया।



- Once again, they soon found an explanation.
एक बार पुनः, उन्होंने शीघ्र ही इसका स्पष्टीकरण खोज लिया।
- Normally, the electrons in a material can have a range of energies.
सामान्यतः, किसी पदार्थ में इलेक्ट्रॉनों के पास ऊर्जा के विभिन्न मान हो सकते हैं।
- But when there is a strong magnetic field acting on them, the range becomes a set of levels, called Landau levels.
किन्तु जब उन पर एक प्रबल चुंबकीय क्षेत्र कार्य करता है, तो यह ऊर्जा-सीमा कुछ निश्चित स्तरों में परिवर्तित हो जाती है, जिन्हें लैंडाउ स्तर कहा जाता है।
- In this condition, the material becomes an insulator on the inside and a very good conductor on its boundaries.
इस अवस्था में, पदार्थ भीतर से एक कुचालक तथा अपनी सीमाओं पर अत्यंत उत्तम चालक बन जाता है।

Ocean of electrons

इलेक्ट्रॉनों का महासागर

- Sometimes, the Hall resistance occurred only in whole-number steps (1, 2, 3, ...) but sometimes it could occur as fractions: 1/3, 2/5, 3/7, etc.
कभी-कभी हॉल प्रतिरोध केवल पूर्णांकों (1, 2, 3, ...) में प्रकट होता था, किन्तु कभी-कभी यह भिन्नो के रूप में भी प्रकट होता था: 1/3, 2/5, 3/7 आदि।
- At first glance, this should be impossible: electrons are indivisible particles — you cannot break them up into smaller pieces — and each electron carries a fixed amount of electric charge.
प्रथम दृष्टि में, यह असंभव प्रतीत होना चाहिए: इलेक्ट्रॉन अविभाज्य कण हैं — आप उन्हें छोटे भागों में विभाजित नहीं कर सकते — और प्रत्येक इलेक्ट्रॉन एक निश्चित विद्युत आवेश वहन करता है।
- The answer came from quantum mechanics when many electrons come together to interact strongly, they form a collective quantum state — a sort of liquid state in which it is impossible to distinguish individual electrons.
जब अनेक इलेक्ट्रॉन एक साथ आकर प्रबल रूप से परस्पर क्रिया करते हैं, तो वे एक सामूहिक क्वांटम अवस्था निर्मित करते हैं — एक ऐसी द्रव अवस्था, जिसमें व्यक्तिगत इलेक्ट्रॉनों को अलग-अलग पहचानना असंभव हो जाता है।
- This is like an ocean: you cannot isolate the single water droplet you dropped in it.
यह महासागर के समान है: आप उसमें डाली गई एकल जल-बूँद को अलग नहीं कर सकते।
- And much like waves in the ocean — where no single droplet travels to the shore but the water as a whole has a moving pattern — a part of the collective quantum state can behave as if it possesses only a fraction of an electron's charge.
और महासागर की तरंगों की भाँति — जहाँ कोई एकल बूँद तट तक नहीं पहुँचती, बल्कि संपूर्ण जल एक गतिशील पैटर्न बनाता है — सामूहिक क्वांटम अवस्था का एक भाग ऐसा व्यवहार कर सकता है मानो उसके पास इलेक्ट्रॉन के आवेश का केवल एक अंश हो।
- Physicists generally call these parts quasiparticles.
भौतिकविद सामान्यतः इन भागों को क्वाज़ीपार्टिकल्स कहते हैं।
- They were of a type called anyons.
वे एनीऑन्स नामक प्रकार के थे।

'Faking' a field

क्षेत्र का 'अनुकरण' करना



- The **FQHE** gives rise to anyonic quasiparticles.
एफक्यूएचई एनीऑनिक क्वाज़ीपार्टिकल्स को उत्पन्न करता है।
- But to create the effect, physicists need to apply a very strong magnetic field to the material — sometimes even stronger than the one in a hospital **MRI scanner**.
किन्तु इस प्रभाव को उत्पन्न करने के लिए, भौतिकविदों को पदार्थ पर अत्यंत प्रबल चुंबकीय क्षेत्र लागू करना पड़ता है — कभी-कभी अस्पताल के एमआरआई स्कैनर से भी अधिक शक्तिशाली।
- And the material had to be very clean (i.e. almost entirely free of impurities) and held at close to **absolute zero**.
और पदार्थ को अत्यंत शुद्ध (अर्थात लगभग पूर्णतः अशुद्धियों से मुक्त) तथा परम शून्य के निकट तापमान पर रखना पड़ता था।
- **FQHE** — but especially the **anyons** it gives rise to — could help **quantum computers** of the future protect information from noise, which is one of the enterprise's hardest unsolved problems today.
एफक्यूएचई — विशेषकर इससे उत्पन्न होने वाले एनीऑन्स — भविष्य के क्वांटम कंप्यूटरों को सूचना को शोर से सुरक्षित रखने में सहायता कर सकते हैं, जो आज इस क्षेत्र की सबसे कठिन अनसुलझी समस्याओं में एक है।
- It was based on doing something really clever, if also very sophisticated: **if a strong magnetic field organises a material's electrons in unusual patterns, could the field's role be 'faked' from within the material itself?**
यह एक अत्यंत चतुर, यद्यपि अत्यधिक जटिल, विचार पर आधारित था: यदि एक प्रबल चुंबकीय क्षेत्र किसी पदार्थ के इलेक्ट्रॉनों को असामान्य पैटर्न में व्यवस्थित करता है, तो क्या उस क्षेत्र की भूमिका का 'अनुकरण' स्वयं पदार्थ के भीतर से किया जा सकता है?
- **Graphene** is a sheet of carbon atoms arranged in a honeycomb pattern.
ग्रेफीन कार्बन परमाणुओं की एक परत है, जो मधुमक्खी के छत्ते जैसी संरचना में व्यवस्थित होती है।
- Since the 2000s, physicists have found that **if you stack one layer of graphene on another and turn it by a small angle — i.e. twisted bilayer graphene — the electrons in the stack behave oddly.**
सन् 2000 के दशक से, भौतिकविदों ने पाया है कि यदि ग्रेफीन की एक परत को दूसरी परत के ऊपर रखकर उसे थोड़े कोण पर घुमा दिया जाए — अर्थात ट्विस्टेड बाइलेयर ग्रेफीन — तो उस संरचना के इलेक्ट्रॉन असामान्य व्यवहार करने लगते हैं।
- **The grid of atoms** in this structure forms what is called a **moiré superlattice**, which essentially significantly slows the electrons down.
परमाणुओं का जाल इस संरचना में वह बनाता है जिसे मोइर सुपरलैटिस कहा जाता है, जो मूलतः इलेक्ट्रॉनों को अत्यधिक धीमा कर देता है।
- **Twisted bilayer graphene** has many odd electronic properties.
ट्विस्टेड बाइलेयर ग्राफीन में अनेक विचित्र इलेक्ट्रॉनिक गुण होते हैं।
- However, it does not slow electrons down enough to create a sufficiently robust collective quantum state.
हालाँकि, यह इलेक्ट्रॉनों को इतना धीमा नहीं करता कि एक पर्याप्त रूप से सुदृढ़ सामूहिक क्वांटम अवस्था निर्मित हो सके।
- On the other hand, the **FQHE** demands that the electrons' mutual repulsion must be the stronger force.
दूसरी ओर, **FQHE** की आवश्यकता होती है कि इलेक्ट्रॉनों का पारस्परिक प्रतिकर्षण अधिक शक्तिशाली बल हो।
- Enter **pentalayer graphene**.
अब प्रवेश होता है पेंटालेयर ग्राफीन का।
- With five layers — with each layer turned by a small angle relative to the one below — placed atop a substrate of **hexagonal boron nitride**, the electrons' kinetic energy dropped enough for electron-electron interactions to become dominant.



TELEGRAM CHANNEL: <https://t.me/patrioticIAS>

YOUTUBE CHANNEL: <https://www.youtube.com/@PatrioticIAS>

CONTACT: 9971932488



पाँच परतों के साथ — जहाँ प्रत्येक परत नीचे वाली परत की तुलना में एक छोटे कोण पर घुमाई गई थी — और उन्हें हेक्सागोनल बोरॉन नाइट्राइड के सबस्ट्रेट पर रखा गया, तब इलेक्ट्रॉनों की गतिज ऊर्जा इतनी कम हो गई कि इलेक्ट्रॉन-इलेक्ट्रॉन अंतःक्रियाएँ प्रमुख हो गईं।

- When electrons are repelling each other but are also confined, they do not have the luxury of flying apart.

जब इलेक्ट्रॉन एक-दूसरे को प्रतिकर्षित करते हैं लेकिन साथ ही सीमित भी होते हैं, तब उनके पास अलग होकर दूर जाने का विकल्प नहीं होता।

- Instead, they organise themselves better, leading to the collective quantum state — sort of like a negotiated settlement where they agree to not antagonise each other.

इसके बजाय, वे स्वयं को अधिक व्यवस्थित कर लेते हैं, जिससे सामूहिक क्वांटम अवस्था उत्पन्न होती है — मानो किसी समझौते की तरह, जहाँ वे एक-दूसरे को परेशान न करने पर सहमत हों।

Quantum materials

क्वांटम पदार्थ

- In 2024, a team led by Long Ju at the Massachusetts Institute of Technology reported that it had detected FQHE in pentalayer graphene.

वर्ष 2024 में, मैसाचुसेट्स इंस्टीट्यूट ऑफ टेक्नोलॉजी में लॉन्ग जू के नेतृत्व वाली एक टीम ने बताया कि उसने पेंटालेयर ग्राफीन में FQHE का पता लगाया है।

- They called it the FQAHE — the 'A' stood for anomalous, meaning it had been achieved without using a magnetic field.

उन्होंने इसे FQAHE नाम दिया — जहाँ 'A' का अर्थ anomalous था, अर्थात् इसे चुंबकीय क्षेत्र का उपयोग किए बिना प्राप्त किया गया था।

- With or without magnetic fields, physicists still need the material to be ultra-clean and work with it at very low temperature.

चुंबकीय क्षेत्रों के साथ या बिना, भौतिकविदों को अभी भी पदार्थ को अत्यंत स्वच्छ रखना पड़ता है और अत्यधिक निम्न तापमान पर कार्य करना पड़ता है।

- Many of them keep going because of the value the anyonic quasiparticles hold for more advanced quantum computers — and indeed a whole world of physics that was previously locked behind powerful yet expensive magnets.

उनमें से अनेक इस शोध को जारी रखे हुए हैं क्योंकि एनीऑनिक क्वाज़ीपार्टिकल्स उन्नत क्वांटम कंप्यूटरों के लिए अत्यधिक महत्व रखते हैं — और वास्तव में भौतिकी की एक पूरी दुनिया के लिए, जो पहले शक्तिशाली किंतु महंगे चुंबकों के पीछे सीमित थी।



Tech needed to create matter from light in place

GS III: S&T
Vasudevan Mukundan

Matter can become energy. You might have seen this in the film *Oppenheimer* or in videos of nuclear explosions. Just as the nuclei fuse, a blinding light fills the air and sky, so bright that simply closing your eyelids does not help.

Physics allows physicists to do the opposite as well: to create matter from light. The problem is the scale at which the required technologies need to work. Scientists need to pack a great quantity of light into a really small volume of space, and hold it there for long enough for the light to 'condense' into matter.

Specifically, scientists need to create extremely intense electromagnetic fields (photons are packets of electromagnetic energy).

Recently, researchers from Germany, Ireland, the U.K., and the U.S. reported clearing a key technical hurdle on the path to doing so. Their findings were published in *Nature*.

Scientists need to pack a great quantity of light into a really small volume of space, and hold it there for long enough for the light to 'condense' into matter

(फोटॉन विद्युतचुंबकीय ऊर्जा के पैकेट होते हैं)।

- The theory that describes how light and matter interact is called **quantum electrodynamics (QED)**.

वह सिद्धांत जो यह वर्णित करता है कि प्रकाश और पदार्थ किस प्रकार परस्पर क्रिया करते हैं, उसे **क्वांटम इलेक्ट्रोडायनमिक्स (QED)** कहा जाता है।

- But at extremely high energy, QED predicts that a sufficiently powerful electromagnetic field can stir up a pair of subatomic particles from the vacuum.

किन्तु अत्यंत उच्च ऊर्जा पर, QED यह भविष्यवाणी करता है कि पर्याप्त रूप से शक्तिशाली विद्युतचुंबकीय क्षेत्र निर्वात से उप-परमाण्विक कणों की एक जोड़ी उत्पन्न कर सकता है।

- The electric field in the laser light set the electrons oscillating back and forth at nearly the speed of light.

लेजर प्रकाश में उपस्थित विद्युत क्षेत्र ने इलेक्ट्रॉनों को प्रकाश की गति के लगभग बराबर आगे-पीछे दोलित करना प्रारम्भ कर दिया।

The theory that describes how light and matter interact is called quantum electrodynamics (QED). Normally, empty space appears empty. But at extremely high energy, QED predicts that a sufficiently powerful electromagnetic field can stir up a pair of subatomic particles from the vacuum. The problem? The strength of the electromagnetic field required far outpaces what current technologies can achieve.

In the new study, the researchers used a different technique. They fired an extremely intense laser pulse at a polished target, immediately parting the atoms in its surface of all their electrons. The electric field in the laser light set the electrons oscillating back and forth at nearly the speed of light. This caused the target's surface to reflect the laser pulse in multiple copies at higher frequencies, called harmonics. Physicists have hoped to further compress these harmonics and focus them into small spots. Such coherent harmonic focusing (CHF) would make the harmonics extremely intense, approaching the levels required to create matter.

But while the idea has been around for two decades, physicists have struggled to realise it efficiently. Previous experiments produced harmonics but with much less energy than in the original pulse.

A pulse's intensity increases from the leading point to its middle, roughly. The time taken for the pulse's peak intensity to enter the target is called its rise time. The authors of the new study reduced the rise time to well under one-trillionth of a second. At peak performance, then, the experiment generated enough energy within the 12th to 47th harmonics to show for the first time that the efficiency required by theory may be within reach.

The authors have stressed that they have not yet demonstrated the final focused state, only that the essential technical ingredients are now in place. At the next generation laser facilities that the U.K. and China, among others, are currently building, the technique is projected to reach an intensity of 10²⁰ W per sq. cm – the threshold where QED effects become apparent.

"The reward would be access to a new regime of physics, where light becomes strong enough to tear down the vacuum and create particles from nothing," Alexander Pukhov, of the University of Dusseldorf and who helped lay the foundations of CHF, told *Physics*.

26M. Tech needed to create matter from light in place प्रकाश से पदार्थ उत्पन्न करने के लिए आवश्यक प्रौद्योगिकी अब उपलब्ध है।

- **Matter can become energy.** पदार्थ ऊर्जा में परिवर्तित हो सकता है।

You might have seen this in the film *Oppenheimer* or in videos of nuclear explosions.

आपने संभवतः इसे फिल्म *ओपेनहाइमर* या परमाणु विस्फोटों के वीडियो में देखा होगा।

- **Physics** allows physicists to do the opposite as well: to **create matter from light**.

भौतिकी भौतिकविदों को इसका विपरीत करने की भी अनुमति देती है: अर्थात् प्रकाश से पदार्थ का निर्माण करना।

- **Scientists need to pack a great quantity of light into a really small volume of space, and hold it there for long enough for the light to 'condense' into matter.**

वैज्ञानिकों को अत्यधिक मात्रा में प्रकाश को अंतरिक्ष के अत्यंत छोटे आयतन में संकेंद्रित करना होगा, और उसे वहाँ इतना समय तक बनाए रखना होगा कि वह प्रकाश पदार्थ में 'संघनित' हो सके।

- Specifically, **scientists need to create extremely intense electromagnetic fields** (photons are packets of electromagnetic energy).

विशेष रूप से, वैज्ञानिकों को अत्यंत तीव्र विद्युतचुंबकीय क्षेत्रों का निर्माण करना होगा



- This caused the target's surface to reflect the laser pulse in multiple copies at higher frequencies, called **harmonics**.
इसके कारण लक्ष्य की सतह ने लेज़र पल्स को उच्च आवृत्तियों पर अनेक प्रतियों में परावर्तित किया, जिन्हें **हार्मोनिक्स** कहा जाता है।
- Physicists have hoped to further compress these harmonics and focus them into small spots. भौतिकविद इन हार्मोनिक्स को और अधिक संपीड़ित कर उन्हें छोटे बिंदुओं पर केंद्रित करने की आशा रखते हैं।
- Such **coherent harmonic focusing (CHF)** would make the harmonics extremely intense, approaching the levels required to create matter.
ऐसा **कोहेरेंट हार्मोनिक फोकसिंग (CHF)** हार्मोनिक्स को अत्यंत तीव्र बना देगा, जो पदार्थ निर्माण के लिए आवश्यक स्तरों के निकट पहुँच जाएगा।
- At the next generation laser facilities that the **U.K. and China**, among others, are currently building, the technique is projected to reach an intensity of **10^{29} W per sq. cm — the threshold where QED effects become apparent.**
अगली पीढ़ी की लेज़र सुविधाओं में, जिन्हें **यूनाइटेड किंगडम और चीन** सहित अन्य देश वर्तमान में निर्मित कर रहे हैं, इस तकनीक के **10^{29} वाट प्रति वर्ग सेंटीमीटर** की तीव्रता तक पहुँचने का अनुमान है — वह सीमा जहाँ QED प्रभाव स्पष्ट होने लगते हैं।
- “The reward would be access to a new regime of physics, where light becomes strong enough to tear down the vacuum and create particles from nothing,” **Alexander Pukhov**, of the **University of Dusseldorf** and who helped lay the foundations of CHF, told Physics.
“इसका प्रतिफल भौतिकी के एक नए क्षेत्र तक पहुँच होगा, जहाँ प्रकाश इतना शक्तिशाली हो जाएगा कि वह निर्वात को भंग कर शून्य से कणों का निर्माण कर सके,” **डसेलडॉर्फ विश्वविद्यालय के अलेक्ज़ेंडर पुखोव**, जिन्होंने CHF की आधारशिला रखने में सहायता की थी, ने Physics को बताया।

The physics of thermometers, temperatures and cold atoms

We use different devices to measure temperature. The science behind them, and concepts such as absolute zero and cold atoms, reveal the complex physics underlying the measurement of heat and temperature

SS III: S&T
 Adhip Agarwala

People from Bengaluru should not be allowed to complain about their weather turning hot. The other day, as a *namma* friend called to express disappointment over their daytime temperatures reaching as high as 33 degrees, I wondered in what Awadhi words should I inform her about the pleasant 42 degrees here in Kanpur. The baked earth, the breezily burning air and the blindingly bright sunny afternoons are clearly things she would not be missing.

Even while you drink a glass of *nimbu paani* to cool yourself, have you ever wondered: what does a 'degree' really mean? By that I don't mean your qualifications, but just the temperature. Also have you ever thought how does one even measure it?

Units of temperature

The standard unit of temperature is called Celsius, named after Swedish physicist Anders Celsius who designed some of the early thermometers. But there is a fundamental catch with measuring temperature. While we can feel anxiously hot or depressingly cold depending on the weather or global news, one challenge in measuring temperature is defining the zero for it. After all, unlike the number of gas cylinders or valid ID cards - can you really count them on your fingers, and say when you have 'zero'?

To define this zero - we use one of our common day magical materials - water. So, how does water help decide this? To proceed, we need to understand what temperature really is.

Temperature is a way of estimating how hot something is. Now when we heat a material, what we are really doing is making the atoms and molecules of that material more and more restless. They shake more and more vigorously as we pump in energy. Similarly when we cool something we make the atoms more sluggish, that is, we take away their energy. Not very different from us. So can we really continue to heat or cool something as long as we want?

Turns out the answer is no. For a while, the material may decide to get heated or cooled, but at some point it may decide to completely change its character. This is called a phase transition. You see this everyday. When water is kept in a refrigerator, it would first start cooling and appear as - just colder water.

But at some point, it won't cool as a liquid - but will start turning into ice, which as we know is a solid. This "temperature" at which water turns to ice was named 'zero' degree Celsius.

Similarly, when water is heated, it gets hotter and hotter until it starts boiling and turning into vapour. After this particular "temperature" after which the water cannot get hot anymore - was named '100' degrees Celsius.

Therefore the zero and 100 of temperature was marked and divided into a hundred divisions so that we can measure everything else in these units. It is on this scale that our body temperature is 37 degrees Celsius. There is another popular scale - Fahrenheit, where zero and 100 is marked using a different protocol. On that scale our body temperature is supposed to be 98.6 degrees Fahrenheit. In 1948 physicists



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finally decided to use Celsius as a standard unit.

Now that we have defined zero and 100 of temperature, the next question is how do we measure it? Here comes another magical material - mercury, no - not the planet.

Mercury thermometers

Mercury is a metal, like iron or aluminium, i.e., which conducts current and shines, but unlike our metallic utensils or spoons, it is in a liquid state. Now most metals expand a bit when heated. This is because the atoms within the materials tend to get away from each other when they are hot. But one of the most amazing properties of mercury is that it expands only as much as it is heated. Think of it like a rod whose length changes depending on how hot it is. So we have found the measurement trick.

The idea is simple: put mercury in a glass bulb attached to a tube. Keep the bulb in a bucket of ice. See the level of mercury in the tube and mark it as zero. Now put the same bulb in boiling hot water. Mercury will expand and the level will rise in the tube. Mark that new level as 100. Use your favourite scale to equally divide the distance between the two marks into 100 divisions. And you have a thermometer. Now you can put this thermometer in your favourite soup, or soil, or your mouth to measure how much

the mercury expands to tell you what the temperature is!

In fact, this is how regular thermometers used to look until a few years ago, when phones were still non-smart. Most of the school going students today may not have seen these thermometers. They could easily break for no good fault of ours and would lead to a huge hue and cry from the adults nearby.

But in any case, mercury thermometers, then, could be found in every household. But as the quantity of greenhouse gases, global temperatures, homes, gadgets, and governments changed - our thermometers changed too.

Digital thermometers

So to measure temperature, one basically needs a material which changes its behavior depending on how hot something is, and whose change of behavior can be measured accurately. After all, measuring something correctly is fundamental to all of science. This branch of physics which specialises in the principles behind measurements is called metrology.

With advances in condensed matter physics - the physics of materials - physicists created a new class of materials called semiconductors in the 1950s. Semiconductors are neither metals (i.e.

conductors) like aluminum or copper, nor insulators (i.e. things which do not conduct current) like glass or wood. Hence the prefix "semi". They conduct a small amount of current, but the amount of current they carry can increase if the temperature rises.

This is because semiconductors have a rather interesting arrangement of atoms and electrons.

In metals, electrons move freely from atom to atom, like a soup - so they can easily conduct electricity whenever a battery is attached. In insulators, the electrons are tightly bound to the atoms. So even when a battery is put - they refuse to budge. In semiconductors, electrons are loosely bound to the atoms. They mostly stay close to atoms, but when the atoms become agitated due to heat, they shake off these electrons. These "free" electrons can now move and create an electrical current.

Now when a battery is attached to a semiconductor and if the temperature rises, the atoms shake more vigorously and more electrons are made free. So the hotter the surrounding is, more current will be generated and if we can measure that current we can find what the temperature is!

This is what happens in a digital thermometer which you find in your homes now - with 70 years of technological progress, humans have perfected the art of measuring changes in currents and voltages.

Absolute zero and cold atoms

Now, even while water turns to ice at zero degree Celsius - the atoms in the ice are still shaking, though more slowly. Now if we continue to take away their energy even further, is there a point where it can essentially have "no" energy? What temperature would that mean?

That temperature is now defined as the Absolute zero - in another unit called Kelvin (K): the scientific unit of measuring temperatures. In terms of Celsius, this means -273 degrees Celsius.

When temperatures fall to just a few Kelvins, they become even harder to measure. We cannot use our mercury or semiconductor to measure them, since the properties of these thermometers themselves would change completely.

In fact, even atoms themselves become very funny at these temperatures and we need to use the whole power of quantum mechanics to understand them. Study of such atoms at ultra-low temperatures is cold-atomic physics.

Bose and his condensate

Atoms, in general, can be considered as one of the two types of personalities. One: 'fermions' type, where they do not like to stay together in one room. And another: 'bosons' where they like to all stay together whenever given a chance. 'Bosons' is named after Satyendra Nath Bose, an Indian physicist. In 1924, he first theoretically predicted the statistical behaviour of these 'bosons'.

Many cold atoms are bosonic in nature and when they reach temperatures very close to zero Kelvin they form an exotic phase of matter called the Bose-Einstein Condensate (BEC), named after Bose and Albert Einstein. In 2001, three U.S. scientists Eric A. Cornell, Wolfgang Ketterle and Carl E. Wieman were awarded the Nobel Prize in Physics for achieving the BEC in experiments at a temperature of 20 nanokelvin (nK). 1 nK is 0.000000001 Kelvin, just slightly above Absolute zero.

So, the next time when the heat bothers you, whether in Bangalore or Kanpur, and you call a friend to complain about the rising temperatures - don't forget to express gratitude to the long, illustrious line of thermometers that have accurately measured temperatures for you.

(Adhip Agarwala is an Assistant Professor of Physics at IIT Kanpur)

26M. The physics of thermometers, temperatures and cold atoms थर्मामीटर, तापमान और शीत परमाणुओं का भौतिकी विज्ञान

- The science behind them, and concepts such as **absolute zero and cold atoms**, reveal the complex **physics** underlying the measurement of **heat and temperature**.



इनके पीछे का विज्ञान, तथा परम शून्य और शीत परमाणुओं जैसी अवधारणाएँ, ऊष्मा और तापमान के मापन के आधारभूत जटिल भौतिकी विज्ञान को उजागर करती हैं।

Units of temperature

तापमान की इकाइयाँ

- The standard unit of temperature is called **Celsius**, named after Swedish physicist **Anders Celsius** who designed some of the early thermometers.
तापमान की मानक इकाई को **सेल्सियस** कहा जाता है, जिसका नाम स्वीडिश भौतिक विज्ञानी **एंडर्स सेल्सियस** के नाम पर रखा गया, जिन्होंने प्रारंभिक थर्मामीटरों में से कुछ का निर्माण किया था।
- **Temperature is a way of estimating how hot something is.**
तापमान किसी वस्तु के कितना गर्म होने का अनुमान लगाने का एक तरीका है।
- **Now when we heat a material, what we are really doing is making the atoms and molecules of that material more and more restless.**
जब हम किसी पदार्थ को गर्म करते हैं, तब वास्तव में हम उस पदार्थ के परमाणुओं और अणुओं को अधिकाधिक गतिशील बना रहे होते हैं।
- **Similarly when we cool something we make the atoms more sluggish, that is, we take away their energy.**
इसी प्रकार, जब हम किसी वस्तु को ठंडा करते हैं, तब हम उसके परमाणुओं को अधिक सुस्त बना देते हैं, अर्थात् उनकी ऊर्जा कम कर देते हैं।
- **For a while, the material may decide to get heated or cooled, but at some point it may decide to completely change its character.**
कुछ समय तक पदार्थ गर्म या ठंडा होता रहता है, किन्तु एक बिंदु पर वह अपना स्वरूप पूर्णतः बदल सकता है।
- **This is called a phase transition.**
इसे **अवस्था परिवर्तन** कहा जाता है।
- **But at some point, it won't cool as a liquid - but will start turning into ice, which as we know is a solid.**
किन्तु एक बिंदु पर वह द्रव के रूप में ठंडा नहीं होगा, बल्कि **बर्फ** में परिवर्तित होने लगेगा, जो कि एक ठोस पदार्थ है।
- **This "temperature" at which water turns to ice was named 'zero' degree Celsius.**
जिस "तापमान" पर जल बर्फ में परिवर्तित होता है, उसे 'शून्य' डिग्री सेल्सियस कहा गया।
- **Similarly, when water is heated, it gets hotter and hotter until it starts boiling and turning into vapour.**
इसी प्रकार, जब जल को गर्म किया जाता है, तब वह अधिकाधिक गर्म होता जाता है और अंततः उबलकर **वाष्प** में परिवर्तित होने लगता है।
- **After this particular "temperature" after which the water cannot get hot anymore – was named '100' degrees Celsius.**
उस विशेष "तापमान", जिसके बाद जल और अधिक गर्म नहीं हो सकता, को '100' डिग्री सेल्सियस कहा गया।
- **Therefore the zero and 100 of temperature was marked and divided into a hundred divisions so that we can measure everything else in these units.**
अतः तापमान के शून्य और 100 बिंदुओं को चिह्नित कर उनके बीच सौ भागों में विभाजित किया गया, ताकि अन्य सभी तापमानों को इन इकाइयों में मापा जा सके।
- **It is on this scale that our body temperature is 37 degrees Celsius.**
इसी पैमाने पर हमारे **शरीर का तापमान** 37 डिग्री सेल्सियस माना जाता है।
- There is another popular scale — **Fahrenheit**, where zero and 100 is marked using a different protocol.
एक अन्य लोकप्रिय पैमाना — **फारेनहाइट** — भी है, जिसमें शून्य और 100 को एक भिन्न पद्धति द्वारा निर्धारित किया जाता है।



- On that scale our body temperature is supposed to be 98.6 degrees Fahrenheit.
उस पैमाने पर हमारे शरीर का तापमान 98.6 डिग्री फारेनहाइट माना जाता है।

Mercury thermometers

पारा थर्मामीटर

- **Mercury** is a metal, like iron or aluminium, i.e., which conducts current and shines, but unlike our metallic utensils or spoons, it is in a liquid state.
पारा लोहे या एल्युमिनियम की भाँति एक धातु है, अर्थात् यह विद्युत का संचालन करता है और चमकता है, किन्तु हमारे धातु के बर्तनों या चम्मचों के विपरीत यह द्रव अवस्था में होता है।
- **Now most metals expand a bit when heated.**
अधिकांश धातुएँ गर्म करने पर कुछ मात्रा में फैलती हैं।
- This is because the atoms within the materials tend to get away from each other when they are hot.
ऐसा इसलिए होता है क्योंकि पदार्थों के भीतर उपस्थित परमाणु गर्म होने पर एक-दूसरे से दूर जाने लगते हैं।
- **But one of the most amazing properties of mercury is that it expands only as much as it is heated.**
किन्तु पारे का एक अत्यंत अदभुत गुण यह है कि वह उतना ही फैलता है जितना उसे गर्म किया जाता है।
- **Think of it like a rod whose length changes depending on how hot it is.**
इसे ऐसी छड़ के समान समझिए जिसकी लंबाई उसके तापमान के अनुसार बदलती रहती है।
- The idea is simple: **put mercury in a glass bulb attached to a tube.**
विचार अत्यंत सरल है: एक नली से जुड़े काँच के बल्ब में पारा भर दीजिए।
- **Keep the bulb in a bucket of ice.**
बल्ब को बर्फ से भरी बाल्टी में रखिए।
- **Use your favourite scale to equally divide the distance between the two marks into 100 divisions.**
अब अपनी पसंदीदा मापनी का उपयोग करके इन दोनों चिहनों के बीच की दूरी को समान रूप से 100 भागों में विभाजित कर दीजिए।

Digital thermometers

डिजिटल थर्मामीटर

- **So to measure temperature, one basically needs a material which changes its behavior depending on how hot something is, and whose change of behavior can be measured accurately.**
अतः तापमान मापने के लिए मूलतः ऐसे पदार्थ की आवश्यकता होती है, जिसका व्यवहार ताप के अनुसार बदलता हो और जिसके व्यवहार में परिवर्तन को सटीक रूप से मापा जा सके।
- **This branch of physics which specialises in the principles behind measurements is called metrology.**
भौतिकी की वह शाखा जो मापन के सिद्धांतों का अध्ययन करती है, **मेट्रोलॉजी** कहलाती है।
- With advances in **condensed matter physics** — the physics of materials — physicists created a new class of materials called **semiconductors** in the 1950s.
संघनित पदार्थ भौतिकी — अर्थात् पदार्थों की भौतिकी — में प्रगति के साथ, भौतिक वैज्ञानिकों ने 1950 के दशक में पदार्थों की एक नई श्रेणी विकसित की जिसे **अर्धचालक (सेमीकंडक्टर)** कहा गया।
- **Semiconductors are neither metals (i.e. conductors) like aluminum or copper, nor insulators (i.e. things which do not conduct current) like glass or wood.**
अर्धचालक न तो एल्युमिनियम या ताँबे जैसी धातुएँ (अर्थात् चालक) होते हैं और न ही काँच या लकड़ी जैसे कुचालक।
- **In metals, electrons move freely from atom to atom, like a soup - so they can easily conduct electricity whenever a battery is attached.**



धातुओं में इलेक्ट्रॉन सूप की भाँति एक परमाणु से दूसरे परमाणु तक स्वतंत्र रूप से गति करते हैं, इसलिए बैटरी जोड़ते ही वे आसानी से विद्युत का संचालन करते हैं।

- **In insulators, the electrons are tightly bound to the atoms.**
कुचालकों में इलेक्ट्रॉन परमाणुओं से अत्यधिक दृढ़ता से जुड़े रहते हैं।
- **So even when a battery is put - they refuse to budge.**
इसलिए बैटरी लगाने पर भी वे हिलने से इंकार कर देते हैं।
- **In semiconductors, electrons are loosely bound to the atoms.**
अर्धचालकों में इलेक्ट्रॉन परमाणुओं से अपेक्षाकृत ढीले रूप से जुड़े होते हैं।
- **They mostly stay close to atoms, but when the atoms become agitated due to heat, they shake off these electrons.**
वे सामान्यतः परमाणुओं के निकट रहते हैं, किन्तु जब ताप के कारण परमाणु उत्तेजित हो जाते हैं, तब वे इन इलेक्ट्रॉनों को मुक्त कर देते हैं।
- **Now when a battery is attached to a semiconductor and if the temperature rises, the atoms shake more vigorously and more electrons are made free.**
अब जब किसी अर्धचालक से बैटरी जोड़ी जाती है और तापमान बढ़ता है, तब परमाणु अधिक तीव्रता से कंपन करने लगते हैं और अधिक इलेक्ट्रॉन मुक्त हो जाते हैं।
- **So the hotter the surrounding is, more current will be generated and if we can measure that current we can find what the temperature is!**
अतः परिवेश जितना अधिक गर्म होगा, उतनी अधिक धारा उत्पन्न होगी और यदि हम उस धारा को माप लें, तो तापमान ज्ञात कर सकते हैं।
- **This is what happens in a digital thermometer.**
यही प्रक्रिया आज घरों में पाए जाने वाले डिजिटल थर्मामीटर में होती है।

Absolute zero and cold atoms

परम शून्य और शीत परमाणु

- **That temperature is now defined as the Absolute zero - in another unit called Kelvin (K): the scientific unit of measuring temperatures.**
उस तापमान को अब परम शून्य कहा जाता है, जिसे केल्विन (K) नामक एक अन्य इकाई में व्यक्त किया जाता है, जो तापमान मापन की वैज्ञानिक इकाई है।
- **In terms of Celsius, this means -273 degrees Celsius.**
सेल्सियस पैमाने पर इसका अर्थ -273 डिग्री सेल्सियस होता है।
- **When temperatures fall to just a few Kelvins, they become even harder to measure.**
जब तापमान कुछ ही केल्विन तक गिर जाता है, तब उसे मापना और भी कठिन हो जाता है।
- **We cannot use our mercury or semiconductors to measure them, since the properties of these thermometers themselves would change completely.**
हम इन्हें मापने के लिए पारा अथवा अर्धचालकों का उपयोग नहीं कर सकते, क्योंकि इन थर्मामीटरों के गुण स्वयं ही पूर्णतः बदल जाते हैं।
- **In fact, even atoms themselves become very funny at these temperatures and we need to use the whole power of quantum mechanics to understand them.**
वास्तव में, इन तापमानों पर परमाणु स्वयं भी अत्यंत विचित्र व्यवहार करने लगते हैं और उन्हें समझने के लिए हमें क्वांटम यांत्रिकी की सम्पूर्ण शक्ति का उपयोग करना पड़ता है।
- **Study of such atoms at ultra-low temperatures is cold-atomic physics.**
अत्यंत निम्न तापमानों पर ऐसे परमाणुओं के अध्ययन को शीत-परमाणु भौतिकी कहा जाता है।

Bose and his condensate

बोस और उनका संघनित पदार्थ



- **Atoms, in general, can be considered as one of the two types of personalities.**
सामान्यतः परमाणुओं को दो प्रकार के स्वभावों में वर्गीकृत किया जा सकता है।
- **One: 'fermions' type, where they do not like to stay together in one room.**
एक प्रकार 'फर्मियॉन' है, जिसमें वे एक ही स्थान पर साथ रहना पसंद नहीं करते।
- **And another: 'bosons' where they like to all stay together whenever given a chance.**
दूसरा प्रकार 'बोसॉन' है, जिसमें अवसर मिलने पर वे सभी एक साथ रहना पसंद करते हैं।
- **'Bosons' is named after Satyendra Nath Bose, an Indian physicist.**
'बोसॉन' का नाम भारतीय भौतिक विज्ञानी सत्येन्द्र नाथ बोस के नाम पर रखा गया है।
- **In 1924, he first theoretically predicted the statistical behaviour of these 'bosons'.**
1924 में उन्होंने पहली बार इन 'बोसॉनों' के सांख्यिकीय व्यवहार की सैद्धांतिक भविष्यवाणी की थी।
- **Many cold atoms are bosonic in nature and when they reach temperatures very close to zero Kelvin they form an exotic phase of matter called the Bose-Einstein Condensate (BEC), named after Bose and Albert Einstein.**
अनेक शीत परमाणु बोसॉन प्रकृति के होते हैं और जब वे शून्य केल्विन के अत्यंत निकट तापमान तक पहुँचते हैं, तब वे पदार्थ की एक विलक्षण अवस्था बनाते हैं जिसे बोस-आइंस्टीन संघनन (BEC) कहा जाता है, जिसका नाम बोस और अल्बर्ट आइंस्टीन के नाम पर रखा गया है।
- **In 2001, three U.S. scientists Eric A. Cornell, Wolfgang Ketterle and Carl E. Wieman were awarded the Nobel Prize in Physics for achieving the BEC in experiments at a temperature of 20 nanoKelvins (nK).**
2001 में तीन अमेरिकी वैज्ञानिक एरिक ए. कॉर्नेल, वोल्फगैंग केटरले और कार्ल ई. वाइमैन को 20 नैनोकेल्विन (nK) तापमान पर प्रयोगों में BEC प्राप्त करने के लिए भौतिकी का नोबेल पुरस्कार प्रदान किया गया।
- **1 nK is 0.000000001 Kelvin, just slightly above Absolute zero.**
1 nK, 0.000000001 केल्विन के बराबर होता है, जो परम शून्य से केवल थोड़ा ही अधिक है।

Essay	26 May 2026
TOPICS COVERED	
26M	QUIZ

Questions and answers to the previous day's daily quiz: 1: In 1895, this famous English writer was convicted for gross indecency and for practicing homosexual acts sentenced to serve two years in prison. **Ans: Oscar Wilde**
 2: Name the British politician and writer known for coining phrases like 'the pen is mightier than the sword' and 'It was a dark and stormy night' born on this date. **Ans: Edward Bulwer-Lytton**
 3: May 25 is observed as 'Africa Day' to commemorate the foundation of the Organization of African Unity on that date in 1963. It was founded in this National capital. **Ans: Addis Ababa (Ethiopia)**

literature, he served in British politics and contributed significantly to Victorian literary culture and popular fiction.

26M. QUIZ: "The pen is mightier than the sword"

- Edward Bulwer-Lytton was a famous British novelist, dramatist, and politician of the nineteenth century.
- He is widely known for coining the expression "The pen is mightier than the sword" in his 1839 play Richelieu, highlighting the power of ideas and writing over violence.
- He also wrote the phrase "It was a dark and stormy night" in his novel Paul Clifford. Besides