Topics

- Five Eyes
- Reverse transcriptase
- Rayleigh scattering
- Chang'e -6
- Mains

By saurabh Pandey

THE HINDU

Target Mains -2024/25 -

Q "The race for lunar exploration has multiple objectives" Explain

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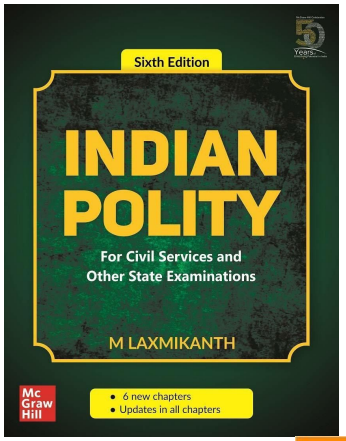

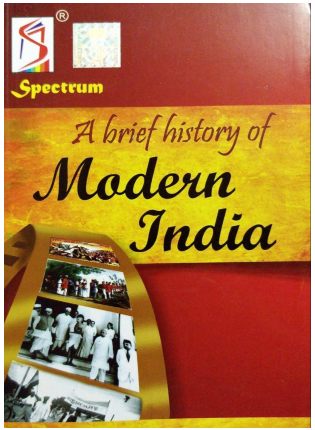

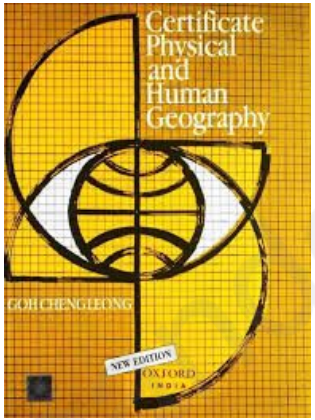

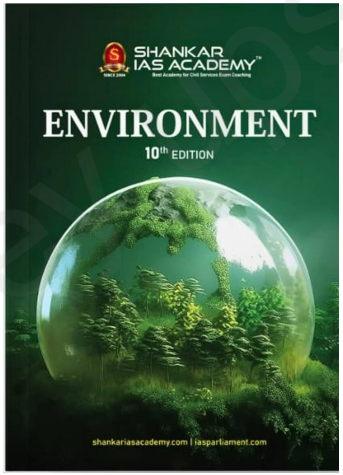

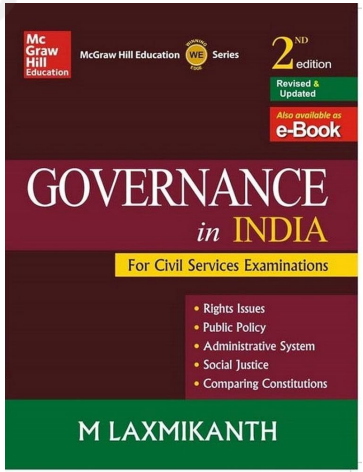

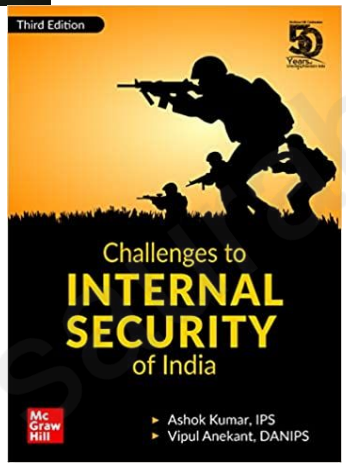

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Short on troops, Australia opens military to non-citizen residents from Five Eyes

Agence France-Presse
SYDNEY

Australia will allow non-citizens to join its armed forces, the government said on Tuesday, as the sparsely populated nation struggles to meet recruitment targets.

Defence Minister Richard Marles said that from July, looser eligibility criteria would allow "permanent residents who have been living in Australia for 12 months" to serve.

Citizens from Britain, Canada, New Zealand and the United States are being favoured, he added.

Thinly stretched: The Australian Defence Forces can today count on about 90,000 personnel, including reservists. AP

Australia has a coastline that would stretch one-and-a-bit times around the Earth, but a population of just 26 million.

Canberra has surged defence spending in recent years, buying fleets of submarines, jets and scores of fighting vehicles to meet mounting regional tensions. But it has struggled to find enough pilots, mariners and troops to operate and maintain them.

Experts warn too few Australians don a uniform to meet even current requirements, much less a beefier military of tomorrow.

The Australian Defence Forces can today count on about 90,000 personnel, including reservists, according to the Australian Strategic Policy Institute.

‘Five Eyes’

- **The ‘Five Eyes’ is a multilateral intelligence-sharing network shared by over 20 different agencies of five English-speaking countries — Australia, Canada, New Zealand, the United Kingdom and the United States.**
- **It is both surveillance-based and signals intelligence (SIGINT). Intelligence documents shared between the member countries are classified ‘Secret—AUS/CAN/NZ/UK/US Eyes Only,’ which gave the group its title ‘Five Eyes.’**

How did the alliance come into being?

- The alliance between the U.S. and the U.K. evolved around the Second World War to counter the Cold War Soviet threat.
- The two countries, which had successfully deciphered German and Japanese codes during the World War, forged a collaboration to share intelligence related to signals such as radio, satellite and internet communications.
- In the aftermath of the war in 1946, the alliance was formalised through an agreement for cooperation in signals intelligence.

- **The treaty called the British-U.S. Communication Intelligence Agreement, or BRUSA (now known as the UKUSA Agreement), was signed between the State-Army-Navy Communication Intelligence Board (STANCIB) of the U.S. and the London Signal Intelligence Board (SIGINT) of Britain.**
- **Its scope was limited to "communication intelligence matters only" related to "unrestricted" exchange of intelligence products in six areas: collection of traffic; acquisition of communication documents and equipment; traffic analysis; cryptanalysis; decryption and translation; and acquisition of information regarding communication organisations, practices, procedures, and equipment.**

- **The arrangement was later extended to ‘second party’ countries —Canada joined in 1948, while Australia and New Zealand became part of the alliance in 1956.**

How does the ‘Five Eyes’ network work?

- **The five partner countries share a broad range of information and access to their respective intelligence agencies. Initially, the partners are assigned respective SIGINT mandates.**

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A Canadian intelligence officer writes in a military journal (2020) that the US is responsible for Russia, northern China, most of Asia and Latin America; Australia covers southern China, Indo-China and its close neighbours, such as Indonesia; the UK is in charge in Africa and west of the Urals within the former Soviet Union; and New Zealand is responsible for the Western Pacific, while Canada handles the polar regions of Russia

The bacteria that write new genes to cope with infections

Columbia University researchers suggest that when *Klebsiella pneumoniae* bacteria are infected by bacteriophages, they take the help of reverse transcriptase to create a specific protein they called *Neo*. This protein could place the bacterial cell in suspended animation, thus stopping the infection in its tracks

Sridhar Sivasubbu
Vinod Scaria

A growth of Klebsiella pneumoniae bacteria developed from a positive blood culture. CHIARA MARRACCINI

Amid the unprecedented challenges presented by the COVID-19 pandemic, a once obscure enzyme found itself in the spotlight: reverse transcriptase. As laboratories worldwide rushed to develop reliable diagnostic tests, techniques using the enzyme became the gold standard to detect the SARS-2 virus, and a cornerstone of molecular diagnostics. This remarkable enzyme not only facilitated rapid and accurate testing; along with another powerful approach – genome-sequencing – it also helped track the virus's spread, paving the way for surveillance, better public healthcare, and vaccine development.

The discovery of reverse transcriptase is a story unto itself. Researchers in the labs of Howard Temin and David Baltimore independently discovered it and published their findings in back-to-back articles in the journal *Nature* in 1970. In his paper, Dr. Baltimore suggested that in the vesicular stomatitis virus, a protein called RNA polymerase was involved in reverse-translating RNA to DNA.

A molecular biology revolution

The discovery was transformative. The prevailing belief at the time was that in all living beings, hereditary information flowed only from DNA to RNA and from RNA to protein (a.k.a. the 'Central Dogma'). The discoveries of Drs. Temin and Baltimore et al. showed information could flow the other way, too, with RNA giving 'rise' to DNA. The name "reverse transcriptase" was, however, coined by the editor of *Nature*, in an article discussing the significant advance in an accompanying column.

The discovery's impact was also immediate. The ability of cells to create DNA copies from RNA revolutionised research methods in molecular biology, where researchers could reverse-transcribe messenger RNAs to pieces of DNA, clone that DNA into bacterial vectors, and study the function of the corresponding genes. In diagnostics, clinicians used reverse transcriptase to convert RNA to DNA and thus estimate the amount of viral material in a given sample. This technique quickly found wide application and use in the study of RNA viruses, including hepatitis B and the human immunodeficiency virus (HIV).

Indeed, the discovery of reverse transcriptase had a significant effect on the management and treatment of HIV infections, including Acquired Immunodeficiency Syndrome (AIDS), in the 1980s. A generation of antiviral agents that specifically targeted the reverse transcriptase enzyme helped convert an otherwise deadly disease to one that could be managed, translating to improving the long-term outcomes and survival of people living with AIDS.

Subsequent studies of the reverse transcriptase enzyme since the 1970s led to mechanistic insights into how viruses use this enzyme to replicate, as well.

Retroelements in the human genome

Reverse transcriptases also had a significant role in shaping the human genome.

The human genome is interspersed in many places with sequences, called elements, that appear to have originated from retroviruses. Thus, researchers call them retroelements. Evolutionary biologists believe these retroelements to have been transferred horizontally during the course of millions of years of evolution. (Horizontal gene transfer refers to genes 'jumping' between organisms rather than from parent to offspring.) And until recently, researchers also considered them to be "junk" elements: they were repeated through the genome and they seemingly did not confer any function to the human organism.

However, recent evidence has suggested that these retroelements could really have had a profound impact on human biology and evolution, and that they play important roles in a variety of physiological processes. In a recent paper in the journal *Nature Communications*, researchers extensively studied the expression of genes in different parts of the human brain from post-mortem brain samples. They reported that the expression of more than a thousand human endogenous retroviruses – a major class of retroelements in the human genome – could be associated with a risk of neuropsychiatric diseases in humans.

> Techniques using the reverse transcriptase enzyme became the gold standard to detect SARS-2 virus, and a cornerstone of molecular diagnostics

Retroelements in the human genome and bacterial reverse transcriptases have a common evolutionary history as well as share functional mechanisms. Bacterial reverse transcriptases – believed to be the precursors of their eukaryotic counterparts – exhibit analogous mechanisms.The discovery of reverse transcriptase activity across the different domains of life underscores the enzyme's fundamental role in both prokaryotic and eukaryotic systems as well as a remarkable evolutionary continuity and functional versatility.

How do *Klebsiella* create genes?

Researchers widely believed that bacterial reverse transcriptases were the precursors of their eukaryotic counterparts. They discovered the first reverse transcriptase in bacteria in 1989, with papers published back to back in the journals *Science* and *Cell*. In bacteria, as in the case of humans, retroelements are categorised as belonging to three broad groups: the Group II introns, the retrons, and the diversity generating retroelements.

In a preprint paper uploaded to the bioRxiv preprint server on May 8, researchers at Columbia University in New York, led by Stephen Tang and Samuel Sternberg, suggested that when the bacteria *Klebsiella pneumoniae* is infected by bacteriophages – viruses that infect bacteria – they use a non-coding RNA with specific motifs (or structures) that could bind to reverse transcriptase and instruct cells to create DNA. This DNA copy has multiple copies of a gene that can create a specific protein.

The researchers dubbed this protein '*Neo*' for "never-ending open-reading frame". It could place the bacterial cell in a state of suspended animation, blocking its replication, and thus stalling the replication of the invading bacteriophage as well. Thus, the infection is stopped in its tracks.

Recent discoveries – including the role of reverse transcriptase in bacterial defence against bacteriophages – hint at the potential of innovative applications in biotechnology and medicine, especially in the context of emerging antimicrobial resistance, the ability of disease-causing microbes to resist the effects of substances designed to incapacitate or kill them. Further exploring reverse transcriptases could also reveal novel mechanisms of genetic evolution and viral resistance, potentially leading to new therapeutic strategies and biotechnological tools.

(The authors are senior consultants at Vishwanath Cancer Care Foundation and adjunct professors at IIT Kanpur and Dr. D.Y. Patil Medical College, Hospital & Research Centre, Pune.)

THE GIST

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Reverse transcriptase

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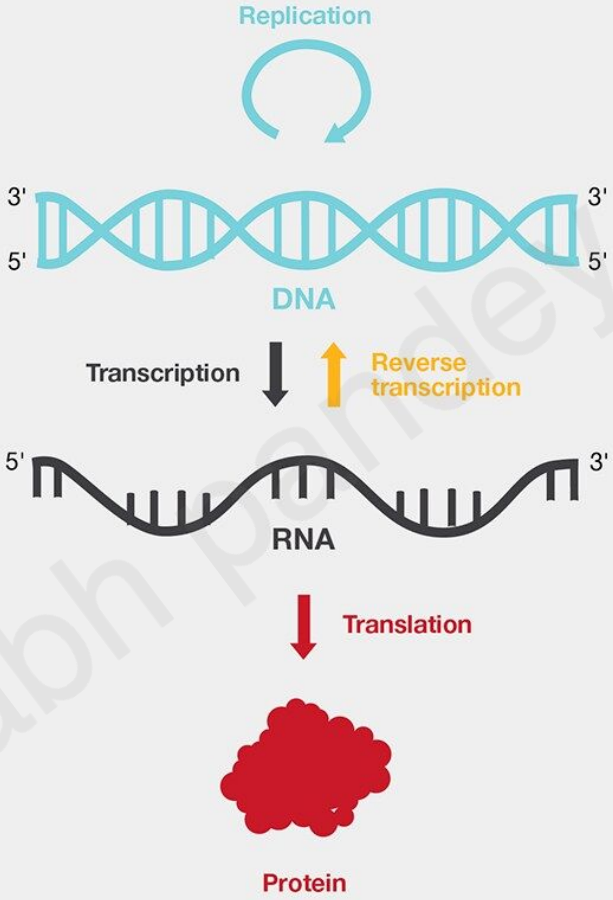

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QUESTION CORNER

The Sun never stops shining

Q: How can the sky glow even after sunset?
- Jaivanthika Karthikeyan

The sun may have set from our perspective — but hasn't yet from the perspective of the upper atmosphere.

The Sun still shines at the atmosphere, but at a sharp angle beneath the horizon. In this hour, we see the sky glow because molecules in the air scatter these sunlight in different directions, including ours. This is also why the evening sky appears red at the horizon.

Both this effect and the sky being blue-hued in daytime is the result of Rayleigh scattering — the scattering of sunlight by particles in the air that are much smaller than the light's wavelength.

As the Sun continues to set, a smaller amount of sunlight strikes the upper atmosphere. Nightfall truly kicks in only when the Sun is at least around 18 degrees beneath the horizon. The arrival of daylight happens in a similar process, in reverse. When the Sun is at least 18 degrees below the horizon in the east, the sky starts to turn reddish again near the horizon.

A city skyline against the twilight glow. DANIEL MOTA/UNSPLASH

When the star's position crosses the horizon (as seen by the observer), daylight breaks out and the day begins.

The sky can appear to glow even after the Sun has dipped 18 degrees below the horizon, due to other sources of light. These include the scattering of starlight by the atmosphere and — increasingly — light pollution.

- Karthik Vinod, intern with The Hindu

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Rayleigh scattering

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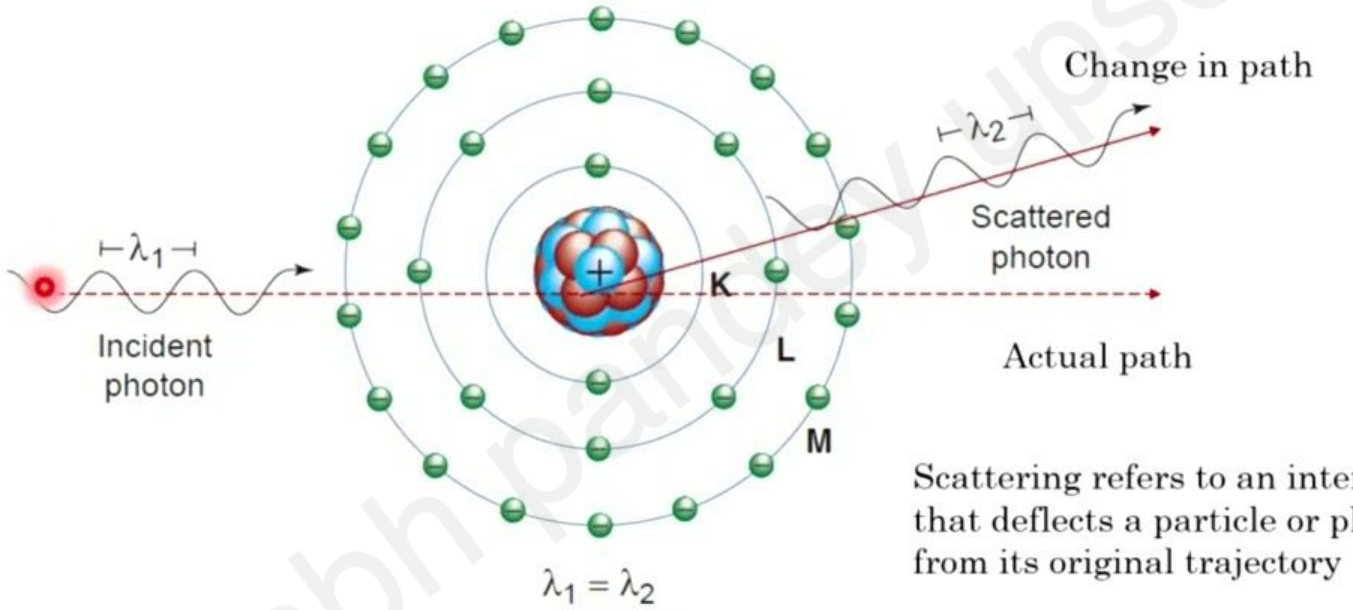
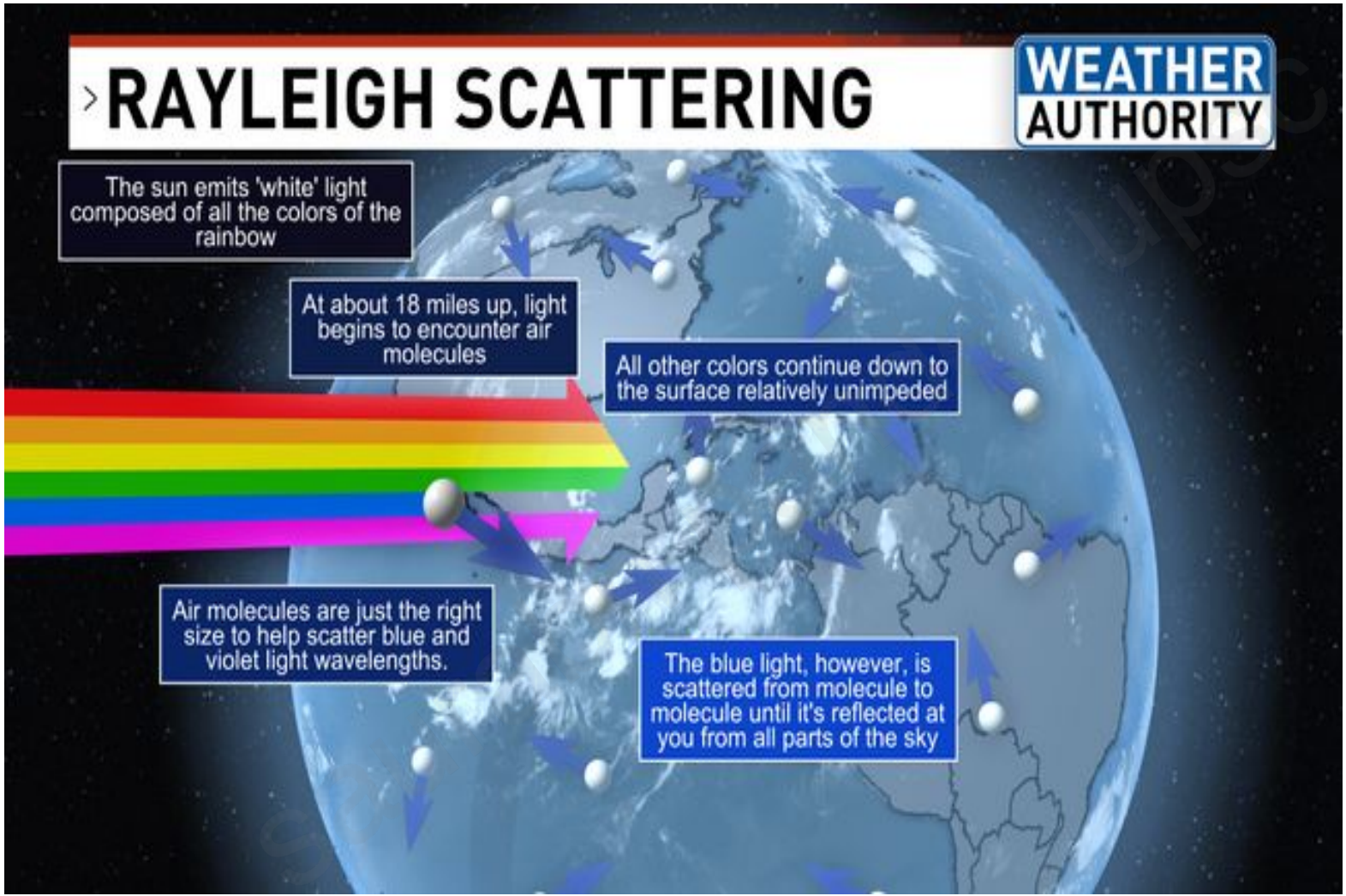
Rayleigh Scattering



Scattering refers to an interaction that deflects a particle or photon from its original trajectory

■ **FIGURE 3-6** Rayleigh scattering. The diagram shows that the incident photon λ_1 interacts with an atom and the scattered photon λ_2 is being emitted with the same wavelength and energy. Rayleigh scattered photons are typically emitted in the forward direction fairly close to the trajectory of the incident photon. *K*, *L*, and *M* are electron shells.


RAYLEIGH SCATTERING
WEATHER AUTHORITY
The sun emits 'white' light composed of all the colors of the rainbow
At about 18 miles up, light begins to encounter air molecules
All other colors continue down to the surface relatively unimpeded
Air molecules are just the right size to help scatter blue and violet light wavelengths.
The blue light, however, is scattered from molecule to molecule until it's reflected at you from all parts of the sky

BIG SHOT

This photo released on Tuesday by the China National Space Administration (CNSA) shows the ascender and lander captured by China's Chang'e-6 lunar probe after it landed on the moon. A module of the Chinese lunar probe successfully took off from the far side of the Moon on Tuesday carrying samples back to Earth, state media reported. AFP

Chang'e -6

- **The Chang'e-6 probe was launched last month and its lander touched down on the far side of the Moon on Sunday. It used a drill and robotic arm to dig up soil on and below the Moon's surface,**
- **After successfully gathering its samples, the Chang'e-6 unfurled China's national flag for the first time on the far side of the Moon.**
- **probe's landing site was the South Pole-Aitken Basin, an impact crater created more than 4 billion years ago, which is 13km (8 miles) deep and has a diameter of 2,500km (1,500 miles).**

- **China's Moon programme is part of a growing rivalry with the United States – still the leader in space exploration – and others, including Japan and India.**
- **China has put its own space station – the Tiangong – into orbit and regularly sends crews there.**
- **The emerging global power aims to put a person on the Moon before 2030, which would make it the second nation after the US to do so.**

Far side of the moon ??

- The far or "dark" side of the moon - which faces away from Earth - is technically challenging to reach due to its distance, and its difficult terrain of giant, deep craters and few flat surfaces.
- Space officials have had to use a satellite to direct and maintain communications with the Chang'e-6 craft.

China makes first landing on the far side of the moon

Near side, always faces Earth

Far side, always away from Earth

Landing in the South Pole-Aitken Basin

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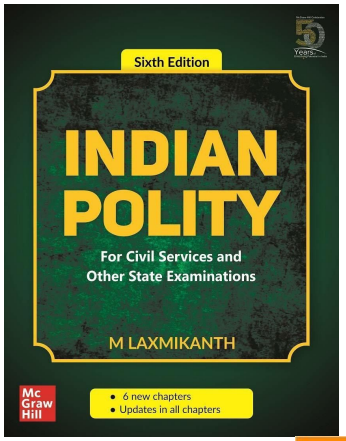

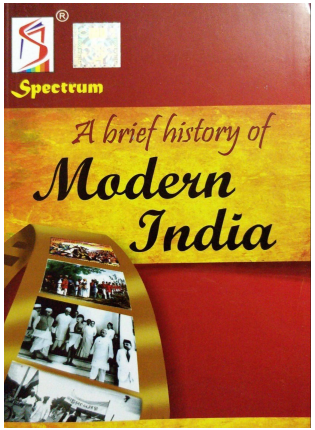

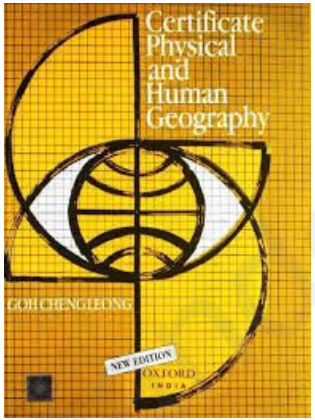

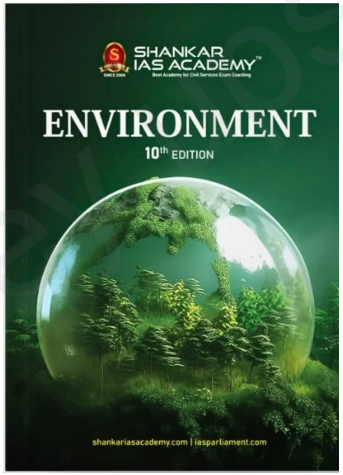

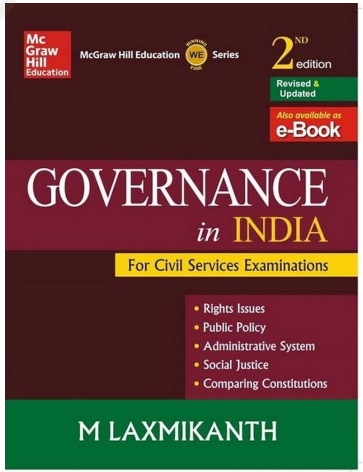

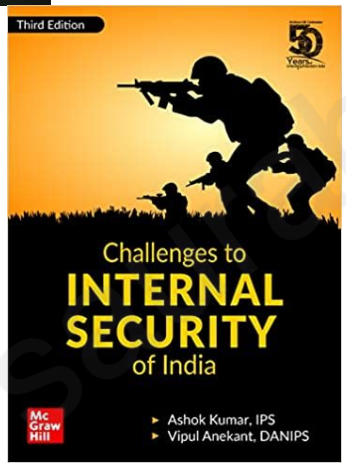

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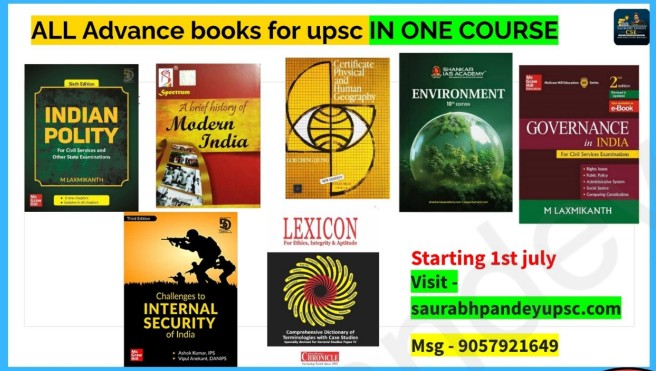

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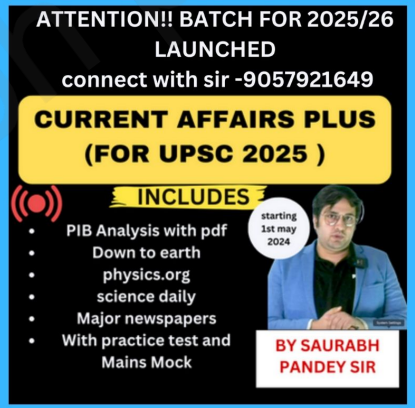

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