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CURRENT AFFAIRS

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GRAPHENE

This article covers "Daily Current Affairs" and the topic details "Graphene". The topic "Graphene" has relevance in the Science and technology section of the UPSC CSE exam.
Relevance:
For Prelims:
What is Graphene?
Properties of Graphene?
For mains
GS 3: Science and technology?
Importance of Graphene research and adoption in India?
Challenges in Graphene adoption for India?

Why in the news?

Researchers in the UK, led by Nobel laureate Andre Geim, have discovered another property of graphene – a single-atom-thick layer of carbon atoms bonded in a honeycomb pattern – that further distinguishes this 'wonder' material.

What is Graphene?

Graphene is a two-dimensional material consisting of a single layer of carbon atoms arranged in a hexagonal lattice. It is considered a remarkable substance due to its unique properties, which stem from its atomic structure and bonding.

Properties of Graphene?

- **Exceptional Strength:** Graphene is incredibly strong, even though it is only one atom thick. It has a tensile strength of around 130 gigapascals, making it one of the strongest known materials.
- **High Electrical Conductivity:** Graphene is an excellent conductor of electricity. Its electrons can move freely, allowing electric current to flow through it with minimal resistance. Graphene's electrical conductivity is about 100 times higher than that of copper.
- **Superior Thermal Conductivity:** Graphene exhibits exceptional thermal conductivity, meaning it can efficiently transfer heat. It outperforms most materials in terms of heat conduction, making it potentially useful in applications involving heat dissipation.
- **Flexibility:** Despite its strength, graphene is also remarkably flexible. It can be stretched and bent without easily breaking, which makes it suitable for applications where flexibility is required.

- **Transparency:** Graphene is highly transparent, allowing around 97.7% of visible light to pass through. This property makes it promising for applications in optoelectronics, such as transparent conductive coatings for touchscreens and solar cells.
- **Impermeability:** Graphene is an excellent barrier material. Its tightly packed carbon atoms create a nearly impermeable layer, preventing the passage of gases and liquids. This characteristic is valuable for applications in water filtration, gas separation, and packaging.
- **Large Surface Area:** Graphene has an enormous surface area-to-mass ratio due to its two-dimensional structure. This property makes it attractive for applications such as energy storage in supercapacitors and as a catalyst support for various chemical reactions.
- **Biocompatibility:** Graphene exhibits good biocompatibility, meaning it is generally well-tolerated by biological systems. This aspect makes it a promising material for biomedical applications, such as drug delivery systems, tissue engineering, and biosensors.
- **Optical Properties:** Graphene possesses unique optical properties. It absorbs only a small portion of light across a wide range of wavelengths. This characteristic, combined with its electrical conductivity, makes it a potential candidate for optoelectronic devices and photovoltaics.

Importance of Graphene research and adoption in India?
- **Technological Advancements:** Graphene, with its exceptional properties, has the potential to revolutionize various industries. By investing in graphene research, India can drive technological advancements and gain a competitive edge in sectors such as electronics, energy storage, sensors, and composite materials.
- **Energy Sector:** Graphene-based materials can contribute to more efficient and sustainable energy solutions. India, as a country with a growing energy demand, can benefit from graphene's high electrical conductivity, which can enhance the performance of batteries, supercapacitors, and solar cells. This can lead to improved energy storage systems and increased renewable energy utilization.
- **Water and Environmental Solutions:** Graphene's impermeability and large surface area make it suitable for water purification and filtration. In a country like India, which faces challenges in providing clean water to all its citizens, graphene-based membranes can help in developing efficient and affordable water treatment systems. Additionally, graphene's use in environmental sensors can aid in monitoring pollution levels and developing effective mitigation strategies.
- **Healthcare and Biomedical Applications:** Graphene's biocompatibility and unique properties make it promising for healthcare applications. India can leverage graphene research to develop innovative biomedical devices, drug delivery systems, tissue engineering scaffolds, and biosensors. This can contribute to improving healthcare outcomes, reducing medical costs, and advancing the biotechnology sector.
- **Job Creation and Economic Growth:** Investing in graphene research and fostering its adoption can create opportunities for skilled researchers, scientists, and engineers. It can lead to the establishment of graphene-based industries, attracting investments and generating employment. This can contribute to the overall economic growth and development of India.
- **Collaborative Research and International Cooperation:** Graphene research is a global endeavor, and India's active participation can foster collaborations with leading research institutions and industries worldwide. By being part of the global graphene research network, India can access knowledge, expertise, and resources, further enhancing its scientific and technological capabilities.

Challenges in Graphene adoption for India?

- **High Cost of Production:** The current methods for producing high-quality graphene are expensive, limiting its widespread adoption. India needs to invest in research and development to develop cost-effective and scalable production methods to make graphene more accessible.
- **Limited Infrastructure and Expertise:** Establishing infrastructure for large-scale graphene production, characterization, and application development requires substantial investment. India needs to develop research facilities, specialized equipment, and skilled manpower to support graphene-related research and development.
- **Lack of Standardization:** Graphene lacks standardized production and characterization protocols. The absence of standardized methods makes it challenging to compare and replicate results, hindering the progress of graphene research and commercialization efforts.
- **Environmental and Health Concerns:** Graphene's potential environmental and health impacts are still being studied. It is essential to assess the potential risks associated with graphene production, use, and disposal to ensure its safe adoption. I
- **Limited Awareness and Collaboration:** There is a need to increase awareness and understanding of graphene among industries, researchers, policymakers, and potential end-users in India.
- **Intellectual Property Protection:** Protecting intellectual property rights related to graphene-based innovations is crucial for encouraging research and commercialization.

Way Forward?

- **Investment in Research and Development:** The government should allocate funds to support graphene research and development initiatives. This includes funding for both fundamental research on graphene properties and applied research for developing graphene-based applications. Encouraging public-private partnerships can also attract industry investment in graphene research.
- **Development of Infrastructure:** Establishing specialized research facilities and infrastructure for graphene production, characterization, and testing is crucial. This includes setting up graphene synthesis laboratories, advanced characterization facilities, and pilot-scale production facilities. Developing shared research infrastructure can lower costs and foster collaboration among researchers and industry.
- **Standardization and Quality Control:** Standardization protocols should be developed for graphene production, characterization, and application testing. This will enable reliable and reproducible results, ensuring the quality of graphene-based products. Collaboration with international standardization organizations and adopting best practices will be beneficial.
- **Education and Skill Development:** Encouraging educational institutions to incorporate graphene-related courses and research programs can help develop a skilled workforce. Providing training and workshops on graphene synthesis, characterization, and applications can enhance the expertise of researchers and industry professionals. Collaboration with international institutions and experts can also facilitate knowledge exchange and skill development.
- **Industry Collaboration and Technology Transfer:** Encouraging collaboration between academia and industry is vital for technology transfer and commercialization. Creating platforms for knowledge exchange, such as industry-academia partnerships, technology transfer offices, and innovation clusters, can facilitate the transition of graphene research into practical applications.

- **Regulatory Framework and Intellectual Property Protection:** Developing a regulatory framework that addresses environmental and health concerns associated with graphene is necessary. It is important to establish guidelines for graphene production, handling, and disposal to ensure safety. Additionally, a robust intellectual property protection system should be in place to encourage innovation and protect graphene-related inventions.
- **Promotion of Startups and Entrepreneurship:** Creating an ecosystem that supports graphene startups and entrepreneurs is crucial. This involves providing access to funding, incubation centers, and mentoring programs. Initiatives such as startup challenges, grants, and technology transfer platforms can encourage entrepreneurship and commercialization of graphene-based technologies.
- **Awareness and Outreach:** Conducting awareness campaigns, workshops, and conferences to disseminate knowledge about graphene's potential and applications is essential. Encouraging participation in international conferences and collaborations will help showcase India's research and attract global attention. Engaging with policymakers and stakeholders can also raise awareness and garner support for graphene initiatives.

Source:

Q.1 Which of the following statements regarding graphene is correct?
(a) Graphene is a two-dimensional material composed of a single layer of carbon atoms arranged in a hexagonal lattice.
(b) Graphene is a three-dimensional material with a layered structure consisting of carbon nanotubes.
(c) Graphene is a polymer made up of a chain of interconnected carbon rings.
(d) Graphene is a metal alloy consisting of a mixture of carbon and silicon.
Answer: (a)

Q.2 Which of the following statements about graphene is/are correct? Choose the correct option:
1. Graphene is a two-dimensional material consisting of a single layer of carbon atoms arranged in a hexagonal lattice.
2. Graphene has a low electrical conductivity compared to copper.
3. Graphene possesses exceptional thermal conductivity.
4. Graphene is highly permeable to gases and liquids.
Options:
(a) 1 Only
(b) 1 and 3 only
(c) 1 and 4 only
(d) 2 and 3 only
Answer: (b)

Q.3 Discuss the potential applications and challenges associated with the adoption of graphene in India. How can India leverage graphene's unique properties to address societal and industrial needs?

Rishabh

INDIA RANKINGS 2023

This article covers "Daily Current Affairs" and the topic details "India Rankings 2023". The topic "India Rankings 2023" has relevance in the Governance section for the UPSC CSE exam.
Relevance of the topic "India Rankings 2023":
For Prelims:
What are India Rankings 2023?
For Mains:
GS 2: Governance
What is the status of Higher Education in India?
What is the significance of India Rankings 2023?
What are the issues with India Rankings 2023?
Way forward

Why in the news?
The Minister of State for Education and External Affairs released the India Ranking. This marks a crucial step toward evaluating and recognizing the performance and quality of various institutions in India.

What are India Rankings 2023?
The India Rankings 2023 refer to the latest edition of the rankings released by the Ministry of Education in India. These rankings are a part of the National Institutional Ranking Framework (NIRF) developed by the Ministry to assess and evaluate higher educational institutions across the country. The rankings provide insights into the performance and quality of various institutions in different categories.

Key Highlights of India Rankings 2023:
1. IIT Madras retains its 1st position in the Overall Category for the fifth consecutive year and in Engineering for the eighth consecutive year.
2. IISc Bengaluru tops the Universities Category for the eighth consecutive year and the Research Institutions Category for the third consecutive year.
3. IIM Ahmedabad ranks first in the Management subject for the fourth consecutive year.
4. AIIMS, New Delhi holds the top position in the Medical category for the sixth consecutive year and improves its overall ranking from 9th to 6th position.
5. NIPER, Hyderabad ranks first in the Pharmacy category, surpassing Jamia Hamdard.

What are the parameters taken by India Rankings to evaluate ?
The India Rankings 2023 take into consideration multiple parameters to evaluate institutions. They include:
1. Teaching
2. Learning
3. Research
4. Graduation outcomes
5. Outreach and inclusivity, and
6. Infrastructure.

What is the significance of India Rankings 2023?

1. The ranking provides a comprehensive and objective assessment of institutions to help students, parents, and policymakers make informed decisions about higher education options.
2. The rankings serve as a tool for institutions to identify areas of improvement and strive for excellence in various aspects of their functioning.
3. They also promote healthy competition among institutions and encourage them to enhance their performance and quality standards.
4. They aid in promoting transparency, accountability, and excellence in the Indian education system.
5. They help the stakeholders in understanding the relative strengths and weaknesses of institutions and foster an environment of continuous improvement and growth in the higher education sector.

What are the issues with India Rankings 2023?

1. Limited Scope: Rankings may not capture the full diversity and specialisation of Indian higher education, focusing more on traditional parameters.
2. Subjectivity of Parameters: Some evaluation criteria can be subjective, leading to inconsistencies and biases in rankings.
3. Data Accuracy and Availability: Rankings heavily rely on accurate and uniformly reported data, which can be a challenge across institutions.
4. Inadequate Inclusivity Measures: Efforts to promote diversity and inclusion may not be fully captured in the rankings.
5. Overemphasis on Quantifiable Metrics: Rankings prioritise quantifiable metrics, potentially disadvantaging smaller institutions excelling in non-quantitative areas.
6. Lack of Long-Term Perspective: Rankings provide a snapshot and may not fully reflect an institution's long-term impact and sustainability.

Way forward

It is important to consider rankings alongside other factors such as academic programs, faculty expertise, student experiences, and alumni networks for informed decisions about higher education.

Source:
https://www.pib.gov.in/PressReleseDetail.aspx?PRID=1930027

PRELIMS QUESTIONS

Q.1 Consider the following statements about the objective of the National Institutional Ranking Framework (NIRF).

1. To promote research collaboration among Indian universities
2. To evaluate the financial resources of higher education institutions
3. To provide a comprehensive ranking of higher education institutions in India
4. To determine the eligibility criteria for admissions in Indian universities

Select the correct answer from the code given below:

1. 1 only
2. 2 only
3. 3 only
4. None of the above

Answer: (c)

Q.2 Which of the following parameters are considered by the India Rankings 2023 to evaluate educational institutions?
1. Teaching and learning methods
2. Research output and collaborations
3. Graduation Outcomes and employability
4. Outreach and inclusivity initiatives

Select the correct answer from the code given below:
1. 1 only
2. 1 and 2 only
3. 1 and 3 only
4. All of the above

Answer: (d)

Mains Question
1. **Critically analyse the role of India Ranking 2023 in the improvement of the outcomes of the institutions in India.**

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Mohit Pratap Singh

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