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THE ECONOMIC TIMES

GS - III - SCIENCE & TECHNOLOGY

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VARIOUS GLOBAL
DEVELOPMENTS IN QUANTUM
SCIENCE IN RECENT DECADE!



Learning Space

24 APR 2023

GS - III - SCIENCE & TECHNOLOGY

Science and Technology - developments and their applications and effects in everyday life Achievements of Indians in science & technology; indigenization of technology and developing new technology.

NEWS ARTICLE FOR REFERENCE

'Cabinet approves Rs. 6,000-cr National Quantum Mission' – Business Line – 20th April, 2023.

PROBABLE QUESTION

*What do you understand by Quantum Science?
Discuss various global developments across the world during the past ten years.*

KEY WORDS

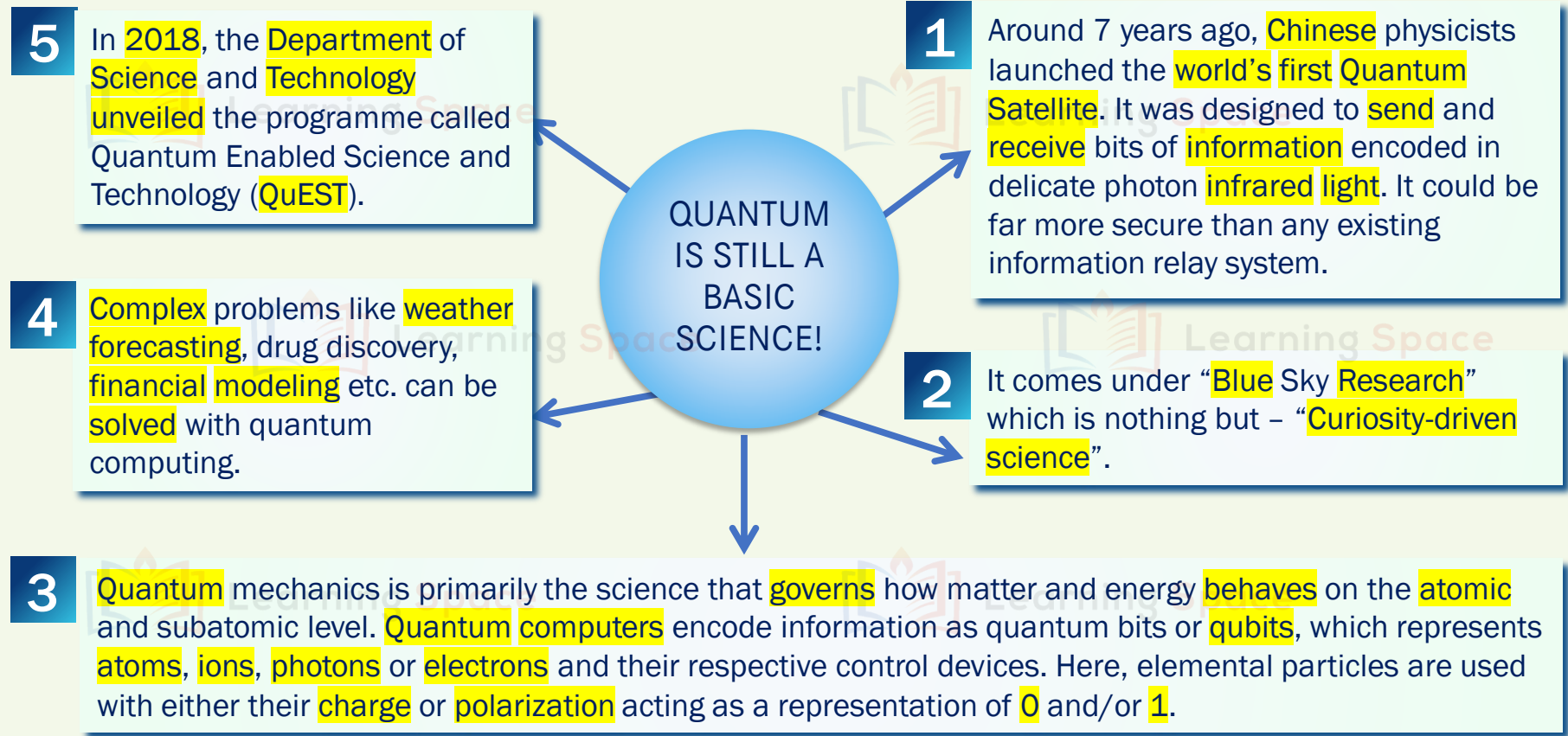
- National Quantum Mission
- Research and Development
- Quantum Computing
- Physical Qubit
- Topological Materials
- Fabrication
- Quantum Bits

UNION CABINET APPROVES NATIONAL QUANTUM MISSION

- The Union Cabinet approved the National Quantum Mission with an allocation of Rs. 6,003.65 crore.
- The six other nations carrying out Research and Development (R&D) in this segment are US, Canada, China, Austria, Finland and Scotland (UK).
- The Mission planned for an eight-year period, 2023-2031, and will mainly work towards strengthening India's research and development in the quantum arena alongside indigenously building quantum-based computers.
- These computers are far more powerful to perform the most complex problems in highly secure manner.

While traditional computing is wave-based, quantum computing is atom-based, faster and more secure.

VARIOUS DEVELOPMENTS PERTAINING TO QUANTUM SCIENCE IN RECENT DECADE



VARIOUS DEVELOPMENTS PERTAINING TO QUANTUM SCIENCE IN RECENT YEARS



9 Globally, there is some progress in quantum computing, quantum communication and quantum metrology using quantum devices. But, for the time being, quantum computing can be considered as a basic science and not applied yet.

8 The Government, in 2020 had announced the National Mission on Quantum Technologies and Applications (NMQTA) with a total outlay of Rs. 5,000 crore for a period of five years. As per that mission, Quantum Computers and Computing, Quantum Communication, Quantum key distribution, encryption, quantum devices and quantum sensing etc. are the thrust areas.

QUANTUM
IS STILL A
BASIC
SCIENCE!

6 Quantum bit or Qubit can exist in two states at the same time. That means, it can store 0 and 1 simultaneously. If one builds 2 qubits, they get hold of four values at once i.e., 11, 10, 01 and 00.

7 In future, the logical extension of quantum computers is quantum Internet. Here, computers don't just compute in isolation, but they also communicate with each other. Qubits not only requires a radical new concepts and technology, but also concerted efforts in physics, computer science and engineering to succeed.

Quantum metrology is the study of making high-resolution and highly sensitive measurements of physical parameters.

MORE ASPECTS ABOUT THE NATIONAL QUANTUM MISSION

QUANTUM IS STILL A BASIC SCIENCE!

14

Some of the applications of quantum computing include financial modeling and stock market, computational chemistry, drug targeting, advanced artificial intelligence, quantum stimulators for particle physics, weather forecasting and climate modelling etc.

10

Quantum computing can perform tasks using all permutations simultaneously. It takes advantage of subatomic particles to exist in more than one state at any time.

11

When one looks at the elite club of six with public-funded quantum initiatives, China allocated \$15.3 billion (2021-2025), EU \$7.2 billion and US \$1.2 billion. China also has the largest share of patents in quantum tech.

12

It is incidental to note that the ground-breaking research of 1970s and 1980s into the phenomenon of entanglement, was recognized with a Physics Nobel only in 2022. The Noble Laureates had shown that entangled particles (physically apart yet linked) can ferry information over massive distances.

13

USA and Japan came together through Competitiveness and Resilience (CoRe) partnership to collaborate on new age technologies such as 5G and quantum computing.

QCT allows a country to secure its critical infrastructure with quantum cryptography to make it "unhackable".

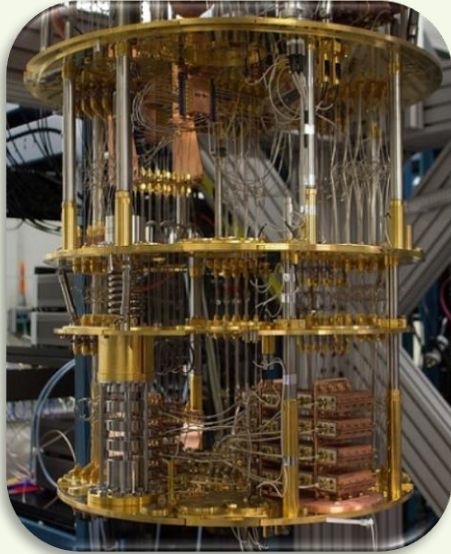
HOW DOES THE PRESENT DAY COMPUTING TAKE PLACE?



Eight bits make a “byte”. So, our computing is based on increasing the number of bytes into kilobytes, megabytes, gigabytes and so on. All the computing advances so far, including Artificial Intelligence programmes and driverless cars are ultimately reduced to the binary World of the bit!

- The present day computing is based on “Bits”. They can be in one of two electrical states, On or Off.
- When On, the bit takes a value of “1” and when Off, it takes value of “0”.
- Hence, the bit is confined to only one of two values, which we call one of two binaries. These binary digital electronic computers are based on transistors.
- All the tasks performed by a computer-like device, whether a simple calculator or a sophisticated computer are constrained by this Binary Rule.

EXISTENCE IN TWO STATES SIMULTANEOUSLY ... TRAIT OF QUBITS!



- Information is held in “Qubits”, that means, they can exist in two states at the same time.
- A qubit can store a “0” and “1” simultaneously, if you build two qubits they can hold four values at once; 11, 10, 01, and 00.
- So, adding more qubits can greatly increase the computing capability of such a machine.

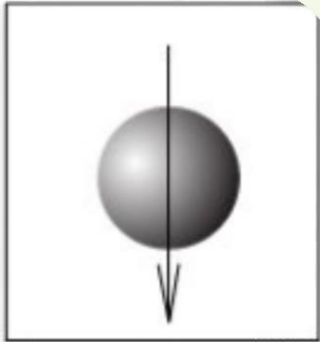
Quantum Computing exploit the properties of quantum mechanics, which is the science that governs how matter behaves on the atomic scale!

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QUANTUM SUPERPOSITION

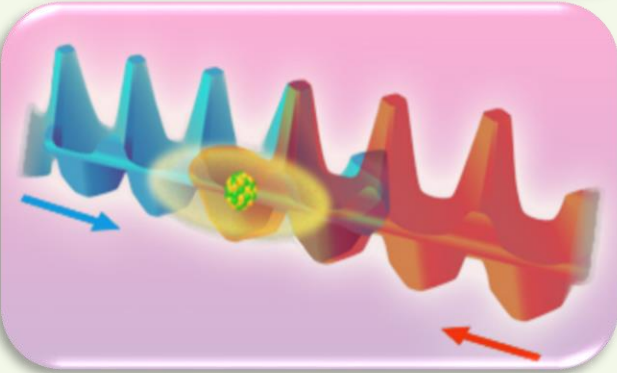


Unobserved photon exists in all possible states.



Measured photon is only in one state (spin = down).

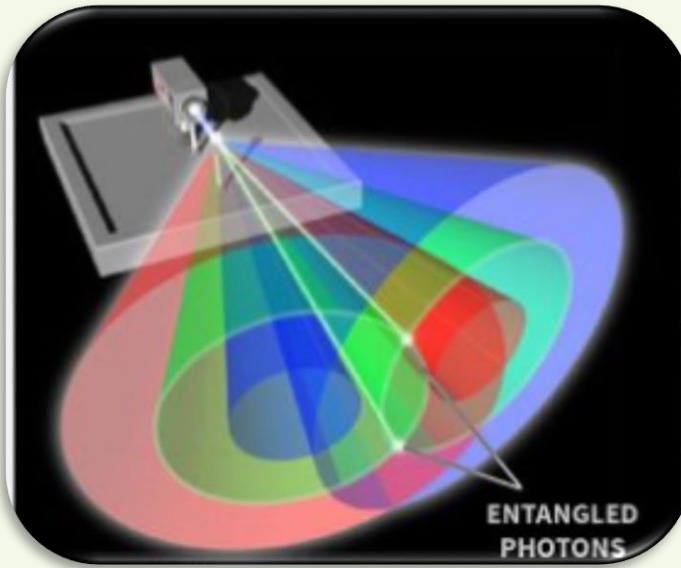
- Superposition means the state of being in more than one state at once. subatomic particles can exist in more than one state at any time.
- Operations in quantum computers can be done more quickly based on the principle - how these subatomic particles behave. Hence, quantum superposition is the ability of the quantum system to be in multiple states at the same time, until it is measured.
- An unobserved photon exists in all possible states simultaneously. But, when observed or measured, it exists only in one state. Hence, superposition gives quantum computers their inherent parallelism - it can work on a million computations at once, while a classical computer cannot do.



TWO IMPORTANT PROPERTIES HOLDS QUANTUM SCIENCE A HUGE PROMISE!

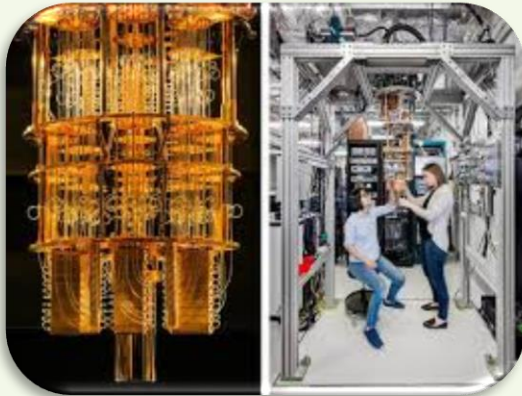
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QUANTUM ENTANGLEMENT



- Quantum entanglement is nothing but interaction of two particles with each other even when they are remote to each other. When one particle is measured the other particle also gets measured or somehow probed. It is the philosophy of teleportation that is observed in particles.
- Hence, the quantum state of each particle cannot be described independently of the state of others, even when the particles are separated by a large distance.

LET US SUMMARISE, THE ADVANTAGES OF QUANTUM COMPUTERS!



- The speed and capability will increase.
- They require less physical space.
- Energy requirements will be reduced.
- Real world problems can be tackled faster by quantum computers.
 - ✓ For example, from the database of a million social media profiles, if one had to look for a particular individual, quantum computers can do much faster in comparison to classical computers.
- Moreover, it can tackle complex problems that are beyond the scope of a classical computer. It can simulate several classical computers working in parallel.

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