STUDY IQ PUBLICATIONS

1st Edition

# SCIENCE & TECHNOLOGY

## FOR UPSC CSE & STATE PCS EXAMS

# From the Editorial Board

**Dear Aspirants,**

We are incredibly grateful for the wonderful response we received for our Polity, History, Economy, and Geography books. Inspired by this positive feedback, we are thrilled to announce the release of the First edition of our book titled 'Science and Technology'.

Science and Technology has gained prominence in the UPSC examination, both in Prelims and Mains stage. Its weightage in the exam has been steady; despite this, there is a dearth of consolidated and updated material on the same subject. Students have to rely on multiple sources making their preparation more difficult.

This book was created taking into account the concern and challenges which the students face during preparing for the subject. The book aims to tackle all these problems, and along with this, it improves students' knowledge base thus saving their precious time and eliminating many academic misunderstandings that they encounter.

**Special Features of this Book**

This book aims to make your preparation focused and relevant based on UPSC's current trend and pattern, it is revision-friendly, and up-to-date.

- The most highlighted feature of this book is that, that we have given General Science (Biology, Physics, Chemistry) in this book so that aspirants do not have to refer different resources and waste time in searching different sources.
- More than 100 pages of FREE Science and Technology, UPSC focused web content in the form of QR Code in the book. Scan them to access it free of cost.
- The requirements of the UPSC Civil Services Examination are the exclusive focus of this book.
- We have taken great care to ensure that the materials are written in a clear and easy-to-understand, so that students may learn and recall the concepts to their advantage.
- Wherever necessary, we've incorporated diagrams and pictorial representation of various technical concepts to make learning interactive and easy.
- We have incorporated the relevant previous year's questions at the end of each chapter so that the students can test their knowledge while understanding the trend of the question.

With all sincerity and humility, the Study IQ team wishes you the best in your preparation, and we hope this book will help you in your journey.

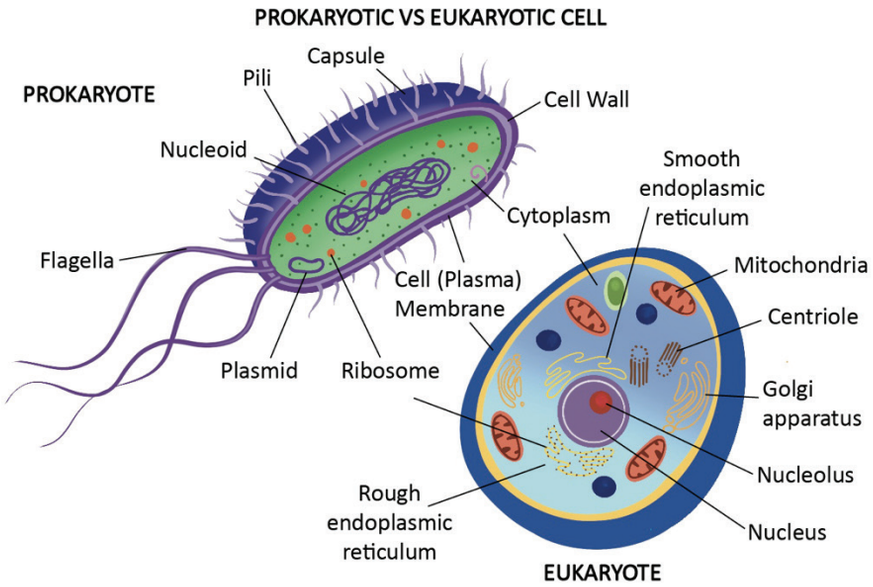
# Detailed Table of Contents

## UNIT 1 : GENRAL SCIENCE

# SAMPLE PAGES

- These organisms are grouped into the biological domain of Eukaryota. Eukaryotic cells are larger and more complex than prokaryotic cells.
- The transfer of nutrients and electrolytes into and out of the cells is observed by the plasma membrane. Additionally, it is in charge of cell-to-cell communication.
- They can reproduce both sexually and asexually.
- Plant and animal cells have some distinct differences. For instance, whereas animal cells lack chloroplasts, central vacuoles, and other plastids, plant cells do.

## Difference Between Prokaryotic and Eukaryotic Cells




| | Prokaryotic Cells | Eukaryotic Cells |
|---|---|---|
| **Meaning of name** | Pro = primitive/before<br>Karyon = nucleus | Eu = new/after<br>Karyon = nucleus |
| **Uni-/multicellular** | Unicellular (less complex) | Multicellular (more complex) |
| **Evolution** | 3.5 billion years ago (older type of cell) | 1.5 billion years ago |
| **Organelles** | Generally, none | Various ones with specialized functions |
| **Cell wall** | almost all have (murein) | fungi and plants (cellulose and chitin): none in animals |
| **Metabolism** | anaerobic and aerobic | mostly aerobic |
| **Genetic material** | Single circular double-stranded DNA | Complex chromosomes are often found in pairs, with each containing a single double-stranded DNA molecule and any associated proteins in the nucleus. |
| **Organisms** | Eubacteria and Arche bacteria | Protists, Fungi, Plants and Animals |
| **Location of genetic information** | Nucleoid region | Nucleus |
| **Mode of division** | Binary fission mostly; budding | Processes of mitosis and meiosis. Mitosis is common to all eukaryotes. |

| | Molecule | Element |
|---|---|---|
| **Break** | Can be broken down by chemical means. | Cannot be broken down by chemical means. |
| **Bond** | Have either covalent bonds or ionic bonds | Can form different types of chemical bonds depending on electron configurations and stability |
| **Atomic number** | Contain a unique atomic number | Can be either homo-nuclear or Hetero-nuclear |
| **Example** | Carbon dioxide, water, and ozone | Hydrogen, oxygen and copper. |

## ATOMICITY

Atomicity refers to the **number of atoms present in a molecule of a substance**. For eg.

- Atomicity of oxygen($O_2$) is 2, Atomicity of ozone($O_3$) is 3.
- $NH_3$ (Ammonia) has one nitrogen atom and three hydrogen atoms. Thus its atomicity is 1+3=4.

## TYPES OF ATOMICITY:

### Monatomic atomicity

Some substances exist as **molecules made up of just one atom**, such as noble gases like helium, neon, and argon. These substances are said to have a monatomic atomicity.

### Diatomic atomicity

Other substances exist as **molecules made up of two atoms of the same element**, such as oxygen gas ($O_2$) or nitrogen gas ($N_2$). These substances are said to have a diatomic atomicity.

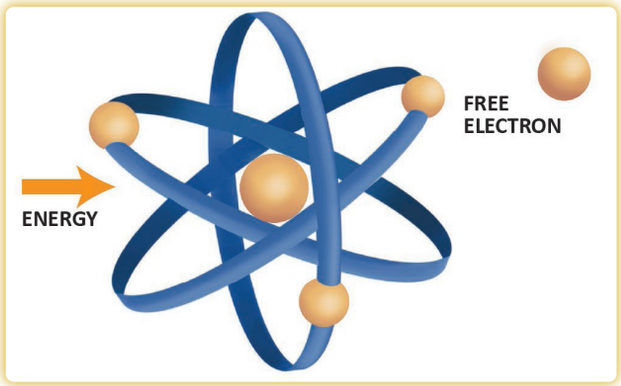
### Polyatomic atomicity

There are also substances that **exist as molecules made up of three or more atoms**, such as ozone ($O_3$) or sulfuric acid ($H_2SO_4$). These substances are said to have a polyatomic atomicity.

The atomicity of a substance can have an **effect on its physical and chemical properties**. For example, **diatomic gases like oxygen and nitrogen have different physical properties than monatomic noble gases**. Additionally, polyatomic molecules can have more complex chemical reactions and can often act as acids or bases due to the presence of multiple functional groups.

An ion is an **atom or a molecule that has a net electrical charge** because it has gained or lost one or more electrons. An ion that has lost electrons and has a positive charge is called a **cation**, while an ion that has gained electrons and has a **negative charge is called an anion**.

## ION




When an atom loses one or more electrons, it becomes positively charged because the number of protons in the nucleus is greater than the number of electrons in the electron cloud surrounding it. For example, a **sodium atom with 11 electrons can lose one electron to become a sodium ion with a positive charge of +1**.

When an atom gains one or more electrons, it becomes negatively charged because the number of electrons in the electron cloud is greater than the number of protons in the nucleus. For example, a **chlorine atom with 17 electrons can gain one electron to become a chloride ion with a negative charge of -1.**

Ions are essential in many chemical reactions and biological processes. For example, the transport of ions across cell membranes is critical for **nerve impulses, muscle contractions, and many other physiological functions.**

## VALENCY

**Valency**[2] refers to the **number of electrons an atom** can gain, lose or share to achieve a stable configuration. In other words, valency is a measure of the combining power of an element, and it determines the type and number of chemical bonds an element can form with other elements to create a molecule or a compound.

**Board of Governors:**

- It is one of the two policy-making bodies of the IAEA, along with the annual General Conference of IAEA Member States.

**IAEA Safeguards:**

- The objective of IAEA Safeguards is to deter the spread of nuclear weapons by the early detection of the misuse of nuclear material or technology. Safeguards are an essential component of the international security system.
- The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) is the centerpiece of global efforts to prevent the further spread of nuclear weapons. Under the Treaty's Article 3, each Non-Nuclear Weapons State is required to conclude a safeguards agreement with the IAEA.

## NUCLEAR POWER PLANT

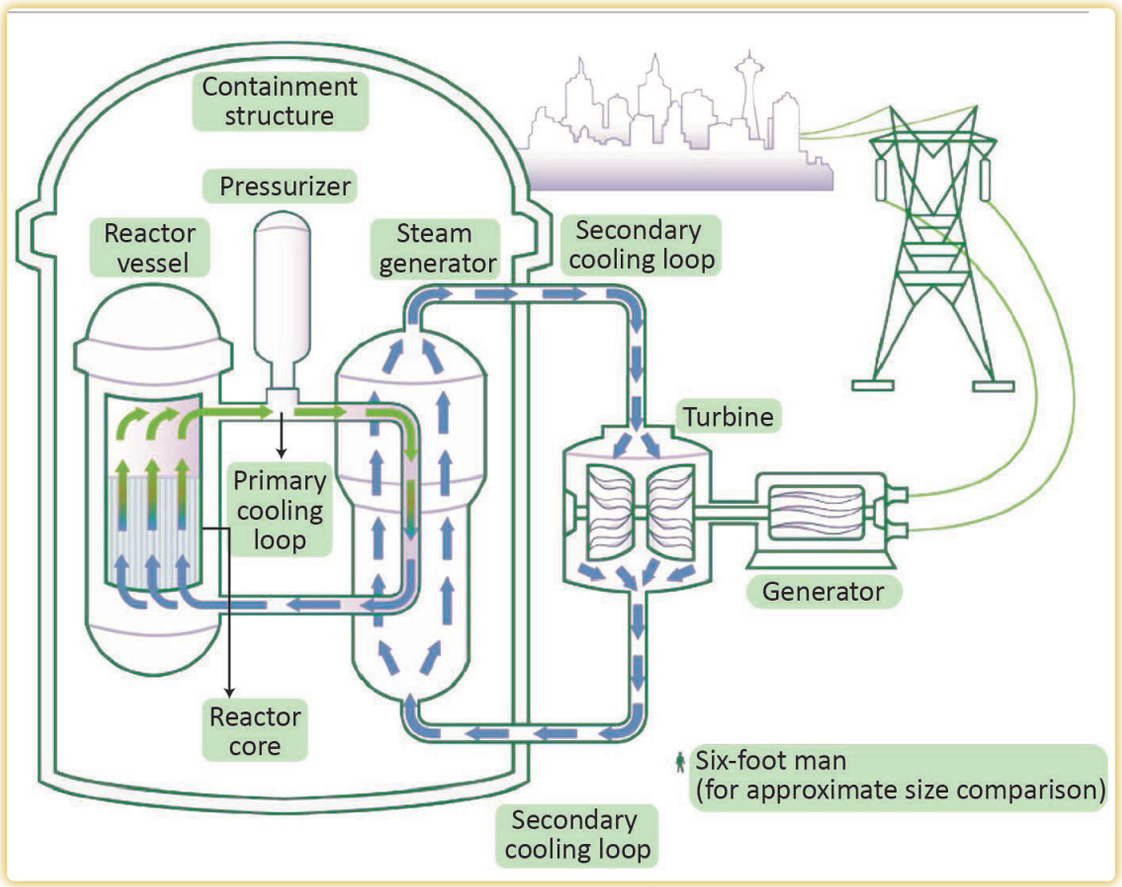
A nuclear reactor produces and controls the release of energy from splitting the atoms of certain elements. The released energy is used as heat to make steam to generate electricity.

**Main Components of a Nuclear Reactor:**

- **The Core**- It contains all the fuel and generates the heat required for energy production.
- **Fuel**- Uranium is the basic fuel that is used for the production of nuclear power.
- **Moderator**- It helps in the slowing down the speed of neutrons which are released from fission reaction. Heavy water or Graphite can be used as moderators.
- **Control Rods**: These are used to control the rate of reaction by using neutron-absorbing materials like cadmium or boron.
- **Coolant**: It passes through the core and absorbs the heat and transfer it into the turbines.
- **Turbines**: It transfers energy into the mechanical form.

### Types of Reactors

#### Light Water Reactor




*Light Water Reactor*

## What is Quantum Interference?

**As qubits exist in superposition**, they possess the inherent potential for quantum interference. Quantum interference refers to the probabilistic behaviour of qubits collapsing into specific states. However, in quantum computing, interference is both a blessing and a challenge.

**On one hand**, interference allows for complex computations and information processing by exploiting its constructive aspects. It enables the amplification of desired outcomes and facilitates the efficient execution of quantum algorithms.

**On the other hand**, interference can also lead to undesired outcomes and inaccuracies in the final results. To mitigate these issues, quantum computers employ techniques to minimize interference and enhance the reliability of computations.

## How do Quantum Computers work?

Quantum computers operate on the principles of quantum mechanics to process and manipulate information. Here is a brief overview of how quantum computers work:

- **Qubits:** The basic unit of information in quantum computing is the qubit. Unlike classical bits that represent 0 or 1, qubits can exist in a superposition of states, representing both 0 and 1 simultaneously. This superposition allows quantum computers to perform computations in parallel, increasing their computational power exponentially.
- **Quantum Gates:** Quantum gates are analogous to the logic gates in classical computing. They are operations performed on qubits to manipulate their states. These gates include operations like the Hadamard gate, which creates superposition, and the Pauli gates, which perform rotations in the quantum state.
- **Entanglement:** Quantum entanglement allows for the creation of correlations between qubits. When qubits become entangled, their states become interdependent, regardless of their spatial separation. Manipulating one qubit in an entangled pair instantly affects the state of the other qubit, enabling powerful computational capabilities.
- **Quantum Algorithms:** Quantum computers utilize quantum algorithms designed to take advantage of the unique properties of qubits. These algorithms, such as Shor's algorithm for factoring large numbers or Grover's algorithm for database search, exploit superposition, entanglement, and interference to perform computations more efficiently than classical counterparts in certain applications.
- **Quantum Measurement:** To obtain results from a quantum computation, qubits need to be measured. Measurement causes the collapse of the quantum state into a classical state, providing a specific outcome. The probability of obtaining a particular outcome is influenced by the quantum superposition and interference experienced by the qubits during the computation.

It's important to note that building and maintaining stable quantum systems is challenging due to factors like quantum noise and decoherence. Researchers and engineers work on developing error correction techniques and improving qubit stability to make quantum computers more reliable and scalable.

## Application of Quantum Computing

Quantum computing has the potential to revolutionise various fields and solve complex problems that are computationally infeasible for classical computers. Here are some potential applications of quantum computing:

- **Cryptography:** Quantum computers could break many of the encryption algorithms used today, posing a threat to conventional cryptographic systems. However, quantum cryptography can also provide enhanced security through methods such as quantum key distribution.
- **Optimization:** Quantum computing can optimize complex systems and processes, such as logistics planning, resource allocation, and portfolio optimization. It can efficiently handle large-scale optimization problems and provide faster and more accurate solutions.
- **Drug Discovery:** Quantum computers can simulate and analyze molecular interactions, enabling more efficient drug discovery processes. They can help identify potential drug candidates, optimize drug properties, and simulate the behavior of complex biological systems.
- **Material Science**: Quantum simulations can aid in designing and discovering new materials with specific properties. Quantum computers can predict material behavior, simulate chemical reactions, and contribute to the development of advanced materials for various industries.
- **Machine Learning**: Quantum machine learning algorithms can enhance pattern recognition, optimization, and data analysis tasks. Quantum