



CLASSICAL PHYSICS AND MODERN PHYSICS

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ABSTRACT

Classical Physics focuses on macroscopic world. This was established before 20th century. All theories and Laws discovered before 20th century is termed as classical physics. Key areas of classical physics are electromagnetism, Thermodynamics and Mechanics. There are certain limitations in classical physics when working with microscopic objects like atom and subatomic particles. In these situations Quantum Mechanics and General theory of Relativity becomes necessary. There are many types in classical physics. Namely classical mechanics, Optics, Electromagnetism and Acoustics. On the other hand Modern physics is a branch of physics which works on Quantum Mechanics and theory of relativity. The discoveries made after 20th century in the Newtonian concepts is called Modern physics. Some of the lessons in it are Nuclear physics, Quantum Mechanics, Photoelectric effect, Bohr's atomic model, dual nature of matter and radiation. Galileo Galilei is known as the father of physics. He introduced in physics the experimental methods, the formulas for laws of motion and Inertia was given by him. Sir Issac Newton is known as the father of classical physics. The Gravitational Law and three laws of motion was discovered by him. He has contributed in the field of optics. Albert Einstein is known as the father of modern physics. He was famous for his ground breaking theories of General, special theory of relativity and photo electric effect.

Key words : Classical physics – Modern Physics – Photoelectric effect Relativity – Quantum Mechanics – Optics – Acoustics – Classical Mechanics.

INTRODUCTION

The classical Physics explains about the motion of bodies and what forces are acting on them. In physics there are four forces of nature they are electromagnetic force, strong Nuclear force, weak nuclear force and Gravity. Physics which deals with Newton's Laws of motion is called as classical Mechanics. Thermodynamics is the branch which states about the heat, work. energy and temperature. And their relationship is also explained. The study of electric charges and magnetism and their combination is termed as electro magnetism. The subjects like Acoustics, optics are also branches of classical physics. Though there are many branches in it the backbone of classical physics is the Isaac Newton's Laws of motion. The famous work of Newton is Principia, which explained in detail about the nature of entities, such as motions of objects and optics.

MAXWELL'S THEORY

The second major branch of classical physics is Maxwell's theory on electro magnetism. Maxwell's Equations contribute the most important laws of electricity and Magnetism. The theory states that electromagnetic wave speed is almost equal to the speed of light. And light is an electromagnetic wave. The variations in electrical field and Magnetic field leads to the propagation of electromagnetic waves or it is also called as light waves. Radiations does not need any medium for propagation. Some of other radiations are Radio waves, microwaves, infrared, ultraviolet, gamma rays and X-rays. Maxwell also discovered the Kinetic theory of gases, which gave rise to the field of thermodynamics. Statistical physics is the byproduct of

Maxwell's theory because it linked thermodynamics and Mechanics. Some of the drawbacks in Maxwell's theory gave rise to Quantum Mechanics. They are Black body radiation and the photoelectric effect. The Black body radiation was explained by Max plank and photoelectric effect was given by Albert Einstein.

Subject matter of classical physics

Classical physics subjects do not use quantum mechanics and relativity. The subjects are Sir Isaac Newton's laws of motion, classical electrodynamics which are Maxwell's Equations and classical thermodynamics, Newtonian mechanics is the main component of classical mechanics. The mathematical representation of force and momentum was given by Newton. Newton laid down three laws of motion. The first Law is about inertia, the second law is about acceleration and the third law is of action and reaction. He gave the principles of conservation of momentum and Angular momentum. The Law of Universal Gravitation was given by him. Newton mainly believed in the corpuscular theory of light. Optics is also one of the subject of classical physics. This field discusses about the properties of light. Some of the ideas in optics are physical optics which explains about Interference, diffraction, Polarization, Scattering and Propagation. The four basic Laws of Geometrical optics are Rectilinear propagation of light, the law of Independence of light rays, the law of reflection and the law of refraction of light. Acoustics is the Science of Sound, it explains about transmission, Control and production of both the audible and inaudible frequencies are dealt with. In classical physics, Ernst Chladni is considered as the father of acoustics. Pythagoras the greek philosopher is the originator of this field. The motion of objects on which forces are applied is called Mechanics. In Physics Dynamics deals with the forces and its motion. Force is an object's motion due to push. Mass is resistance exhibited by object in motion. Energy is capability to do work that is transferred or transformed. Dynamics considers the forces being applied on objects and caused motion. On the other hand Kinematics is the study which does not consider the forces acting upon it. Some examples of dynamics in life are pushing a door and pedaling or riding a bike.

QUANTUM PHYSICS

This field of physics deals with atomic and subatomic levels of matter and energy. The nature, the construction and the properties of subatomic particles of matter and light are studied. The Quantum physics has a set of principles which are used in this field. These principles are wave-particle Duality, Probability, Superposition, Uncertainty and Entanglement. In the wave – particle duality subatomic particles like electrons and photons which are carriers of light, behave both as particle and wave depending on how they are measured. Probability principle states that the particle cannot be detected exactly at a specific place. But only the probability of it appearing at a specific position can be detected. It is measured by an quantity called wave function. Superposition states that there are many possible states for an event and it exhibits a single state only when it is measured. Uncertainty explains that certain physical properties like position and momentum cannot be measured precisely, so there is limit in measuring them simultaneously. Entanglement means when two entangled particles like photons are separated they share the information between them. Quantum physics has branches in it they are Quantum Mechanics, Quantum Electrodynamics, Quantum field theory and Quantum statistics. Max Planck is famously known as the father of Quantum theory of physics. He stated that energy travelled in packets or quanta, he introduced the constant which is known as the Planck's constant and it is denoted as h . The formula equated energy with the frequency of light [$E=hr$]. Some of the other scientists in this field are Erwin Schrodinger, Neil's Bohr, Heisenberg and many others. Albert Einstein can also be added in the list of Quantum mechanics Scientists; because though he did not accept Quantum mechanics he was one among the physicists who developed this field of physics.

Quantum Physics is a marvel and elegant subject. Physicists always wonder at the complex principle of Quantum Physics. Stephen Hawking has once stated that scientific progression in the future will be based purely on the concepts of Quantum Physics. The discovery of the wave – particle duality was a tremendous achievement which brought an end to the conservative pattern of thinking. Maxwell's equation on electromagnetism combined the two separate entities into one that is electricity and Magnetism. Later Michelson Morley experiment confirmed that light is an electromagnetic wave and the speed of light is a constant and the presence of ether in space was proved to be false. Max Planck discovered that light waves travel in discrete packets of energy or Quanta of energy and they are termed as the Quanta. The atomic model discovered by Neil's Bohr was a milestone. It established the fact that electron which goes around the nucleus,

occupies only certain specified orbits and the shells in which the electron moves around is denoted by a formula given by Planck constant h . The uncertainty principle was discovered in 1924 by Werner Heisenberg. He explained that certain properties of an electron cannot be measured accurately. Due to particle wave nature of electron there is a limit to which its position and velocity can be measured. If the position of an electron is predicted accurately then its velocity can be measured less accurately. If the velocity is measured accurately then its position cannot be ascertained accurately. The impact of Heisenberg's uncertainty principle made Albert Einstein, who was very deterministic, to state the famous quotation that "God does not play Dice".

This discovery of the Exclusion principle made by Wolfgang Pauli was brilliant step in the field of Quantum Mechanics. This principle states that no two electron in an atom can occupy the same shell or quantum state. The electron Jumps from its state, it is said to be excited. Later this principle was generalized and not only electrons but particles with half integer spin which are called the Fermions obey this rule of the Pauli's Exclusion Principle. Whereas the other set of particles which are called Bosons, do not obey the Pauli's Exclusion principle. They occupy the shell of an atom in more than one number. Bosons are class of particles which has the Integer Spin. The discoveries of Heisenberg uncertainty principle and the Pauli's Exclusion Principle gave new scope to the field of Modern physics. The introduction of the De-Broglie waves or matter waves is also considered to be a turning point in Modern Physics. Schrodinger gave the equation for the wave function, $\psi(\mathbf{r}, t)$ denotes the probability distribution for finding the electron inside the cloud. When an observer is observing, the electron or measuring it, the electron's wave function disappears and the electron act as a discrete particle. The collapse of the wave function and the electron's decision to act as a particle is very peculiar and gives a metaphysical status to Quantum physics. Another important personality who developed the Quantum mechanics and derived the Quantum Electro dynamics (QED) was Paul Dirac. He also discovered that every field should have its corresponding Quanta Particle. His contributions to the field of Quantum Mechanics are Dirac field, Fermi Dirac statistics, Negative probability, Path integral formulation and virtual particles. Physicist Murray Gell-Mann designed the field of Quantum Chromo dynamics. He was the one who coined the word Quark in the field of particle physics. Richard Feynman received Noble Prize in Physics for his principle of Least Action.

American theoretical physicist Steven Weinberg discovered Quantum turbulence, Quantum Electrodynamics, symmetry breaking theory and Quantum Gravity. Physicist Abdus Salam is known for Higg's Mechanism, strong gravity, Preon and Wand Bosons. Stephen Hawking was constantly working on the field of Quantum gravity and Grand unified theory termed as GUT. Hawking suggests some of the newly constructed theories which are close to unification of two pillars of physics are string theory, super string theory, super gravity (SUGRA) super symmetry (SUSY), the M-theory, Minimal super gravity grand unification theories (MSUGRA GUT) and the Grand unification theory.

RELATIVITY THEORIES

Albert Einstein's great works are General theory of Relativity, special theory of relativity and photo electric effect. The special theory of relativity states that the laws of physics are same in all non-accelerating frames of reference and that the speed of light is a constant, irrespective of the velocity of the observer. The discovery that speed of light is a constant was a revolutionary idea which has its roots from Maxwell's equations for Electro Magnetism and the idea that there is nothing in space as luminiferous Ether. The special theory of relativity when combined with the field of Quantum Mechanics gives rise to the field of special relative Mechanics and the development of Quantum Electro dynamics. Einstein though himself was against the theory of Quantum physics was the root cause for the development of it. The general theory of relativity was published by Einstein a decade after the publication of special theory of relativity. The traditional approach towards space and time was discarded and the new perspective of combining space and time and treating them as single entity space-time was introduced. Space-time is termed as the fourth dimension. He explains that gravity is curvature of space-time and gravity is a geometrical property.

CONCLUSION

Classical Physics alone cannot explain the reality. So modern physics was developed to know the macroscopic and microscopic reality. Classical physics was followed before the before 20th century. While

modern Physics came after 20th century. In classic physics the key areas are Newtonian Mechanics, Classical Electromagnetism, optics and thermodynamics. This cannot be applied to particles travelling in speed of light. Modern physics can dwell deep into the microscopic world. The main areas are Quantum Mechanics, Special relativity and General relativity - Classical physics holds the determinism theory, if initial states are given the whole history & the system can be predicted. Modern physics holds the non-determinism or Probability theory which states that only probability of the system can be predicted. classical physics assume space and Time to be Absolute, but Modern physics assume space and Time as one entity space-time and can be affected by mass and Energy. So many subjects in Physics like Nuclear Physics, atomic physics, astrophysics and relativity can only be studied using Quantum Mechanics & Relativity. Modern Physics is seen as the development of Classical physics.

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