

## MECHANICS - Why?

*Mechanics has been an integral part of human civilization. Ever since lighting fire, making tools for hunting, and start of cultivation, evolutions of mechanics took place intuitively. It grown with human observation and experience. It is starting point of learning of Physics, meaning 'Knowledge of nature'; a word coined from Greek language and involves study of matter, energy and their interaction. In depth study of mechanics is essential for every student, irrespective of discipline. Laws of mechanics find manifestation right from physiology of plants, animals, human, and find manifestation in social behaviour. It extends into advanced physics from atomic to cosmic scale. Efforts shall be made to correlate mechanics with the other branches of physics, wherever necessary, to establish the relevance.*

As one proceeds with application of concepts of physics, it may be considered as an extensive subject. But, with the grooming of ability to integrate these concepts it becomes so intuitive that one can feel a set of laws, with different permutations and combinations, coming into play in any physical observation or problem. This is precisely the reason to integrate complete mechanics into one chapter. Nevertheless, elaboration of individual principles of mechanics shall be done assuming a boundary, for simplicity and clarity, which to exclude phenomenon extraneous to it. However, as the journey into mechanics proceeds, integration of concepts studied earlier is done and it is intrinsic to the philosophy of this manual. Proficiency in physics depends upon one's ability to visualize given problems with the known laws of physics, and to correctly translate them into a mathematical statement or a set of such statements.

This chapter would start with understanding of units, measurement, dimensions and analysis of errors, followed by kinematics, dynamics, work and energy, circular and rotational motion, gravitation, fluid behaviour, mechanical properties of matter, and Simple Harmonic Motion (SHM). The SHM forms a foundation to the study of energy and its propagation.

Readers are advised not to limit joy of exploring the subject to the study of this manual only. The joy should find extension into visualizing these laws in their surrounding right from home to everything phenomenon that they observe. This will help them in analyzing different types of problems. Thus they would gain proficiency, accuracy and speed, essential,

both for mentoring students and their success in competition.

Accordingly, illustration of each topic is made along with typical problems from selected and world class books viz. Concepts of Physics, Part-I by H.C. Verma; S.L. Loney's books – a) Elements of Statics & Dynamics, Part I & II, b) c) An Elementary Treatise on Statics, An Elementary Treatise of Dynamics of Particles and Rigid Bodies; Physics Part I, by Robert Resnick and David Helliday, University Physics by Sears and Zeemansky and Problems in Physics by I.E. Irodov. and other sources including text books of NCERT and various state boards of higher secondary education.

**History of Mechanics:** A brief historical account is considered to be essential so that students and mentors of science are able to appreciate contemporary knowledge of mathematics and science is a gift to us out of tireless and gruesome quest of human race and researchers. It is believed that this would incite a sense of Personal Social Responsibility (PSR) among students to continue with the quest for making living on this planet sustainable.

In Indian mythology, during the **Vedic era**, competence in astronomy viz-a-viz astrology, Fire arms, Air/Space aviation etc. is available in scriptures. However, in recorded history of science, **Socrates, Plato and Aristotle**, Greek philosophers during 4<sup>th</sup> to 5<sup>th</sup> Century BC, are considered to be first set of scientific philosophers.

**Nicolaus Copernicus**, an astronomer from Poland, in early sixteenth century, was first to propound the concept of a heliocentric solar system, in which the

sun, rather than the earth, is the centre of the solar system. Later, **Galileo**, an Italian astronomer, physicist, engineer, philosopher, developed telescope to make observations to establish validity of the proposition that earth revolves around the Sun and not the vice-versa. His contributions have earned him titles of "father of observational astronomy", "father of modern physics", and the "father of science". **Tycho Brahe** had recorded some observation on planetary motion which was shared with **Johannes Kepler** a German mathematician and astronomer, in very early years of Seventeenth century. Kepler analyzed Brahe's data to propound three Laws of Planetary Motion which formed basis of Laws of Gravitation discovered by **Sir Isaac Newton**. The latter was an English Physicist and Mathematician and in his book "Mathematical Principles of Natural Philosophy", first published in 1687, he laid foundation of classical mechanics through Laws of Motion. Later, Albert Einstein through his thought experiments evolved Theory of Relativity in 1905. This theory revolutionized understanding matter and energy and their convertibility without any experimental verification. There have been numerous contributions by various scientists to mature the understanding of mechanics but, the quest is still on for a unified theory to address laws of nature.

The journey of mechanics, which grows into Physics in particular and Science in general, can be

rationalized into - a) observation of facts, b) measurement of variables, c) visualization of interdependencies of variables, d) mathematical formulation of problem and e) verification results through its reproducibility. ***In case results of any analysis do not conform to the observations, there are only Two possibilities; either known laws have not been applied correctly, or the problem is in a domain beyond boundaries of known laws. It is a cross road to think beyond the existing knowledge.***

Dimensional analysis in physics constitutes verification and correlation of independent variables governing a physical phenomenon. It is different from the dimensions referred to in Coordinate Geometry. Accordingly, dimensional analysis together with units, measurement and error estimations was elaborated in prologue "Physics : Not a Subject to Learn".

**Conclusions:** This Mentor's Manual being developed by is a free web resource and is available on [our website](#), which is aimed at enhancing the learning of mathematics and science. Your suggestions for value addition at every stage and chapter in this endeavour are gratefully welcomed through [Contact Us](#), are welcomed in tune with the sense of Personal Social Responsibility (PSR) of elite readers.