**7.1 Need for numerical analysis**

Most of the problems in mechanics start with the equations of motion and analysis of the trajectory of motion. During the process of solving these problems with analytical methods, we are forced to neglect many parameters to avoid complexity. If the external parameters controlling the motion are large in number, the error is also large. As a case study, let us go through the one-dimensional motion.

Consider a freely falling body under gravity. Then,

For simplicity, we can assume that g is a constant. This can be used to calculate the velocity and position of the body at any time.

But the solution based on the above equations are not agreeable with real values due to the following errors.

1. Gravity is not a constant in a wide range. It varies according to

Where h is the height from the surface of the earth and R is the radius of the earth.

1. Force of buoyancy due to the displaced water

Where r is the radius of the body, ρ is the density of the medium, and g is the acceleration due to gravity.

1. Viscous force, F=6πηrv

Where η is the coefficient of viscosity of the medium, r is the radius of the moving body and v is the velocity of the body

1. If C is the drag coefficient, ρ is the density of medium and r is the radius of the moving body.
2. Effect of weather

A solution incorporating all these parameters will be highly complicated. In the numerical analysis, we can solve this problem step by step, including all the parameters, which we like to incorporate. By the fundamentals of differentiation

This is true only if h→0. That means h must be infinitesimally small. This can be made a reality only with a computer using any method like R-K methods, Monte-Carlo methods, Euler methods, etc. In the Euler method, when h becomes very small, the above set of equation become:

Using these three equations we can estimate the acceleration, velocity, and displacement step by step using a computer simulation. Similarly, we can simulate all concepts in Physics: