MOTION UNDER UNIFORM ACCELERATION

Galileo's plank experiment:

also known as Galileo's inclined plane experiment, was a significant experiment conducted by the Italian scientist Galileo Galilei in the late 16^{th} century. This experiment was pivotal in shaping our understanding of the principles of motion and laid the groundwork for Isaac Newton's laws of motion.

There are some fundamental experiments of Galileo in physical science given below:

Experiment of a free-falling body (Pisa tower experiment):

Galileo observed that a heavy object and a light object will fall to the ground simultaneously from a particular height.

All bodies of any mass will fall down simultaneously at the same time from a particular height. That is the acceleration of all free-falling bodies are same. We know that acceleration is the ratio of force and mass.

The force exerted on a bigger body is greater than the smaller ones in the same force field. This implies acceleration remains constant in the case of all free-falling bodies.

The experiment of inertia:

The property for which a body restrains the force applied to it is called inertia. This is observed by Galileo.

He noticed that moving a heavy body is very hard than moving a light body.

No force is exerted on a moving body of constant velocity. We know that force is the product of mass and acceleration. i.e and the acceleration is the time rate of change to velocity.

If velocity remains constant, then acceleration will be zero. i.e, the force exerted on a body moving with constant speed is zero.

The experiment of simple harmonic motion:

The time period of simple oscillation of a pendulum is constantly in motion.

The time period of a simple pendulum in simple harmonic motion is constant in time and it depends only on the mass of the pendulum and the string's length.

This concept helped newton in the formation of his famous law of motion.

The motion of a body on an inclined plane:

When the force is exerted on a body, then it changes its velocity.

If a body rolls down on an inclined plane, then its velocity will increase due to the effect of the earth's gravitational force exerted on the body.

This implies that when the force is exerted on a body its velocity will be increase or decrease.

Average Acceleration

Time rate of change of velocity is called acceleration.

If Δv is change in velocity in time Δt, then average acceleration in time interval Δt is

$$< a >= \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}.$$

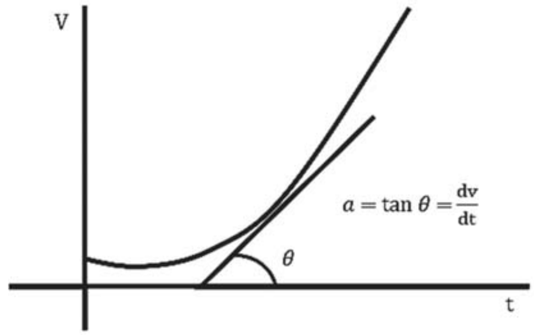
Instantaneous Acceleration

The acceleration at any instant is called instantaneous acceleration. Mathematically

$$a = \underset{\Delta t \to 0}{\text{Limit}} \langle a \rangle = \underset{\Delta t \to 0}{\text{Limit}} \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$$

Graphical Form of Instantaneous Acceleration

Instantaneous acceleration can be defined as the gradient of the tangent to the velocity-time graph at any given moment, t.



Motion Under Uniform Velocity

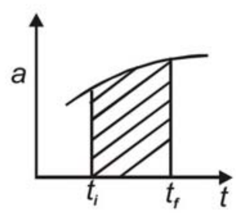
Uniform motion refers to a motion pattern where an object moves in a straight line at a consistent speed. This implies that the object's velocity remains steady as it covers the same distances within identical time intervals. In cases of uniform rectilinear motion, the object experiences zero acceleration, indicating that its velocity remains unchanged over time. Consequently, the average speed of the object matches its actual speed. Examples of uniform motion include a car maintaining a constant velocity and a person running steadily along a straight path without varying their speed.

Uniform Acceleration

If a particle's velocity changes by the same amount in equal time intervals, its acceleration is called uniform. This means neither its direction nor its magnitude alters over time.

Acceleration Time – Graph

The area under the acceleration-time graph between t_i and t_f gives the change in velocity ($v_f - v_i$) between the two instants.



Shaded area = $v_f - v_i$ = change in velocity

Displacement in N^th Second

$$S_{n^{th}} = u + \frac{1}{2}a(2n - 1)$$