Lecturer: Mohanad Muayad Alyas

Analytical Mechanics

2023-2024

Lec.8: Rectilinear motion uniform acceleration

Rectilinear motion of a particle

2.1 Newton's Laws of Motion

I. Every body continues in its state of rest or of motion in a striaght line, unless it is compelled by a force to change that state.

II. change of motion is proportional to the applied force and takes place in the direction of the force.

III. To every action there is always an equal and opposite reaction, or, the mutual actions of two bodies are always equal and oppositely directed

---

2.4 - Linear momentum :-

$$\vec{p} = m\vec{v}$$

$$\vec{F} = m\vec{a} = m\frac{d\vec{v}}{dt} = \frac{d}{dt}(m\vec{v})$$

$$\vec{F} = \frac{d\vec{p}}{dt}$$

The third Law, the Law of action and reaction, canbe expressed interms of linear momentum. Thus for two mutually interacting bodies A & B

$$\frac{d\vec{P}_A}{dt} = -\frac{d\vec{P}_B}{dt}$$

or $$\frac{d}{dt}(\vec{P}_A + \vec{P}_B) = 0$$

By integration

$$\vec{P}_A + \vec{P}_B = \text{constant}$$

Thus the third Law implies that the linear momentum of two interacting bodies always remains constant.

This a special case (two bodies) for a more general rule that the total linear momentum of any isolated system remains constant in time

⟶ the law conservation of linear momentum.

2.6 Rectilinear Motion - uniform acceleration:

a moving particle remains on a single straight line let it the x - axis, The general eq. of motion is

$$F(x, \dot{x}, t) = m\ddot{x}$$

The simplest situation in which force is constant

$$\vec{F} = m\frac{d\vec{v}}{dt} \longrightarrow \frac{d\vec{v}}{dt} = \frac{F}{m} = \text{constant} = a$$

by direct integration

$$v = at + v_0 \quad \text{------} \quad (1)$$

$$x = \frac{1}{2}at^2 + v_0 + x_0 \quad \text{---} \quad (2)$$

Where v_0 : initial velocity

x_0 : initial position

by eliminating t between eq. (1) and eq. (2), we obtain

$$2a(x - x_0) = v^2 - v_0^2$$

Example a body falling freely with acceleration $\vec{g}$.