II. Dynamics of mass point - basic terminology

Dynamics (from greek dynamis - force) is a part of mechanics investigating reasons of any particular case of motion.

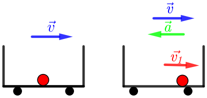
Dynamics is based on Newton's laws of motion or Newtonian classical mechanics. Newton's laws of motion give foundations of the whole classical mechanics and these laws were formulated by Isaac Newton in the year 1687.

Dynamics is related to two basic concepts - mass and force.

Isaac Newton (1642, Woolsthorp - 1727, Londýn)

Newton's first law of motion

Isolated body (mass point) is a body (mass point) that does not interact with any other material object, i.e. it does not act on any external forces (or the resultant of the acting forces is zero).



Newton's first law of motion (Law of inertia):

Every body continues in its state or rest, or uniform motion in a straight line, unless it is compelled to change that state by forces impresses on it.

$\sum_{i=1}^{n} \vec{F}_i = \vec{0}$.

An inertial frame of reference is a system with respect to which an isolated mass point (body) remains at rest or in uniform rectilinear motion. This system is at rest with respect to the surface of the Earth.

Mass m is quantity, which describes resistence (bodies resist changes in their motion).It is scalar physical quantity.

Momentum $\vec{p}$ of mass point is a vector physical quantity that expresses the dynamic rate of motion of a mass point with mass m, moving at a speed of $\vec{v}$. It characterizes the state of motion of a material object in a given reference system.

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

$$[p] = [m \cdot v] = kg \cdot m \cdot s^{-1} = N \cdot s$$

Law of conservation of momentum:

The total momentum of an isolated system is constant in the inertial frame of reference.

$\vec{p} = konst.$

Newton's second law of motion

To change the state of motion of a body in an inertial frame of reference, its mutual interaction (action) with other objects is necessary. The measure of this action is Force.

Force $\vec{F}$ is a vector physical quantity that is a measure of the interaction (action) of material objects (bodies, points) and causes a change of state of motion or deformation.

Newton's second law of motion (Law of force):

The force acting on a mass point is proportional to the product of its mass and the acceleration it gives.

$$\frac{\Delta \vec{p}}{\Delta t} = \vec{F}$$

$$\vec{F} = \frac{\Delta \vec{p}}{\Delta t}$$

$$\vec{F} = \lim_{\Delta t \to 0} \frac{\Delta \vec{p}}{\Delta t} = \frac{d\vec{p}}{dt} = \frac{d(m\vec{v})}{dt}$$

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

$$[F] = [m] \cdot [a] = 1kg \cdot m \cdot s^{-2} = 1N$$

Types of interaction of mass bodies or material points:

1.) gravitational interaction - exists between all material objects

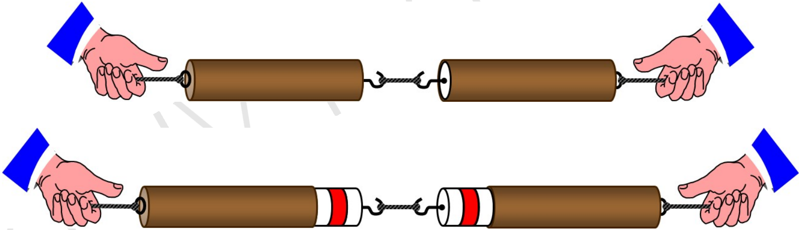
2.) electromagnetic interaction - mutual interaction between electrically charged bodies, electric dipoles, magnetic dipoles, between bodies with electric charge, etc.

3.) weak interaction - participates in the transformation of elementary particles

4.) strong interaction - manifests itself between particles in the nuclei of atoms

Newton's third law of motion

Let us have two mass points A, B, which lie on a common line. The action of material objects is always mutual. If body A acts on body B with a force $\vec{F_1}$ (action), body B also acts on body A with a force $\vec{F_2}$ (reaction). The forces acting on each other have the same magnitude and opposite direction.



Newton's third law of motion (Law of action and reaction):

To every action there is always opposed and equal reaction or the mutual action of two bodies upon each other are always equal and directed to contrary parts.

$$\vec{F}_1 = -\vec{F}_2$$