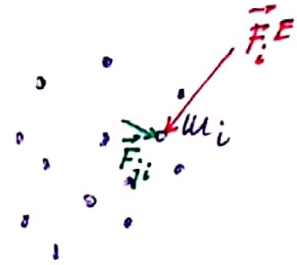
MOMENTUM OF SYSTEM OF PARTICLES

Total momentum of the system:

$$\vec{p} = \sum_{(i)} m_i \vec{v}_i$$



Equation of motion of one particle:
(i-th particle)

$$\frac{d(m_i \vec{v}_i)}{dt} = \vec{F}_i^E + \sum_{(j)} \vec{F}_{ji} \qquad (1)$$

By summation of all equations $i = 1 \dots n$ we get:

$$\frac{d}{dt} \sum_{(i)} m_i \vec{v}_i = \sum_{(i)} \vec{F}_i^E + \underbrace{\sum_{(i)} \left(\sum_{(j)} \vec{F}_{ji} \right)}_{\vec{\emptyset}}$$

$$\sum_{(i)} \left(\frac{d(m_i \vec{v}_i)}{dt} \right) = \frac{d}{dt} \left(\sum_{(i)} m_i \vec{v}_i \right)$$

$$\boxed{\frac{d\vec{p}}{dt} = \vec{F}^E}$$

Change of momentum of system of particles in time is equal to resulting external force.

Internal forces don't influence total momentum of the system.

LAW OF CHANGE OF MOMENTUM OF SYSTEM OF PARTICLES in integral form:

$$\boxed{\vec{p}_2 - \vec{p}_1 = \int_{t_1}^{t_2} \vec{F}^E \, dt}$$

example of component equation:

$$\sum_{(i)} m_i v_{ix2} - \sum_{(i)} m_i v_{ix1} = \int_{t_1}^{t_2} \vec{F}^E \, dt$$

LAW OF CONSERVATION OF MOMENTUM OF THE SYSTEM

$$\vec{p}_2 - \vec{p}_1 = \vec{\emptyset}$$

$$\int_{t_1}^{t_2} \vec{F}^E \, dt = \vec{\emptyset}$$

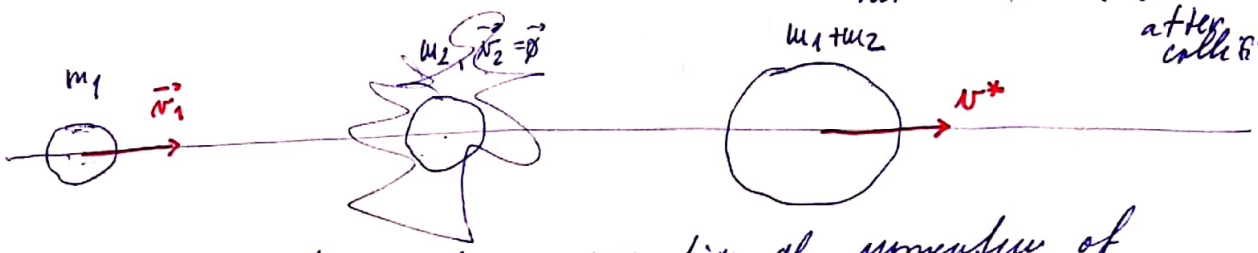
impulse of external forces

$$\sum_{(i)} m_i v_{ix2} = \sum_{(i)} m_i v_{ix1} = \text{const.}$$

example: Ideally plastic collision

Given: m_1, m_2 } before collision
v_1, v_2 }

Task: $v^* = ?$ (velocity after collision)



We use law of conservation of momentum of system of particles:

$$m_1 v_1 + \underbrace{m_2 v_2}_{\emptyset} = (m_1 + m_2) v^* \qquad (v_2 = \emptyset)$$

$$v^* = \frac{m_1}{m_1 + m_2} \cdot v_1$$

velocity of the system after collision