# DINAMIKA

Dinamikaning asosiy qonuni (Nyutonning ikkinchi qonuni)

$$F \cdot dt = d(m\upsilon)$$

tenglama bilan ifodalanadi.

Agar massa o'zgarmas bo'lsa, u holda

$$F = m\frac{d\upsilon}{dt} = m \cdot a,$$

bundan $a$ - massasi $m$ bo'lgan jismning $F$ kuch ta'sirida olgan tezlanishi.

$s$ masofani o'tishda $F$ kuchning bajargan ishi quyidagi formula bilan ifodalanidi:

$$A = \int_s F_s \cdot ds,$$

bunda $F_s$ - kuchning siljishi yo'nalishidagi proeksiyasi, $ds$ - yo'l qismining kattaligi. Integral butun yo'l $s$ bo'yicha olinadi.

Agar kuchning miqdori hamda uning siljish yo'nalishi bilan hosil qilgan burchagi o'zgarmas bo’lsa, yuqoridagi formula

$$A = F \cdot s \cdot \cos\alpha$$

ko'rinishida bo'ladi, bunda $\alpha$ - kuch $F$ va siljish $s$ orasidagi burchak.

Quvvat

$$N = \frac{dA}{dt}$$

formula bilan ifodalanadi. Quvvat o'zgarmas bo’lsa

$$N = \frac{A}{t}$$

bo'ladi, bunda $A$ - vaqt $t$ ichida bajarilgan ish.

Xuddi shuningdek quvvat quyidagi formuladan aniqlanishi mumkin:

$$N = F \cdot v \cdot \cos\alpha,$$

ya'ni quvvat harakat tezligini kuchning harakat yo'nalishiga bo'lgan proeksiyasining kattaligiga ko'paytmasi bilan aniqlanadi.

υ tezlik bilan harakatlanayotgan *m* massali jismning kinetik energiyasi quyidagiga teng:

$$W_k = \frac{m\upsilon^2}{2}.$$

Potensial energiyaning formulalari ta'sir etuvchi kuchlarning xarakteriga qarab turlicha ifodalanadi.

Izolyatsiyalangan sistemadagi barcha jismlar harakat miqdorining vektor yig'indisi o'zgarmay qoladi, ya'ni:

$$m_1\vec{\upsilon_1} + m_2\vec{\upsilon_2} + \ldots + m_n\vec{\upsilon_n} = const.$$

Massalari $m_1$ va $m_2$ bo'lgan ikki jismning bir to'g'ri chiziq bo'ylab elastikmas markaziy urilishdan keyingi ularning umumiy tezligi quyidagi formuladan topiladi:

$$u = \frac{m_1\upsilon_1 + m_2\upsilon_2}{m_1 + m_2},$$

bunda $\upsilon_1$ - birinchi jismning, $\upsilon_2$ - ikkinchi jismning urilishdan ilgarigi tezligi.

Elastik markaziy urilishdan keyin jismlar turlicha tezliklar bilan harakatlanadi. Birinchi jismning urilishdan keyingi tezligi:

$$u_1 = \frac{(m_1 - m_2)\upsilon_1 + 2m_2\upsilon_2}{m_1 + m_2}$$

va ikkinchi jismning urilishdan keyingi tezligi

$$u_2 = \frac{(m_2 - m_1)\upsilon_2 + 2m_1\upsilon_1}{m_1 + m_2}$$

Egri chiziqli harakatda moddiy nuqtaga ta'sir etuvchi kuchni ikkiga: tangensial va normal tashkil etuvchilarga ajratish mumkin.

Normal tashkil etuvchisi

$$F_n = \frac{m\,\upsilon^2}{R}$$

markazga intilma kuchdan iboratdir. Bu yerda $\upsilon$ - massasi $m$ bo'lgan jismning chiziqli tezligi va $R$ trayektoriyaning berilgan nuqtadagi egrilik radiusidir.

Elastik deformatsiyalovchi kuch deformatsiyasining $x$ kattaligiga proporsionaldir, ya'ni:

$$F = Kx,$$

bundan $k$ - deformatsiya koeffitsienti bo'lib, bir birlikda deformatsiyalovchi kuchga miqdor jihatdan tengdir.

Elastik kuchlarning potensial energiyasi:

$$W_n = \frac{kx^2}{2}.$$

Ikki moddiy nuqta (ya'ni o'lchamlari ularning o'zaro oraliqlariga nisbatan juda kichik bo'lgan jismlar) bir-biriga quyidagi kuch bilan tortiladi:

$$F = \gamma \frac{m_1 m_2}{R^2},$$

bunda $\gamma$ -tortishish doimiyligi yoki gravitatsion doimiyligi bo'lib, $\gamma = 6{,}67 \cdot 10^{-11}$ $m^3/kg.sek^2$ ga tengdir; $m_1$ va $m_2$ o'zaro ta'sir qiluvchi moddiy nuqtalarning massalari: $R$ - ular orasidagi masofa.

Tortishish kuchining potensial energiyasi

$$W_m = -\gamma \frac{m_1 \cdot m_2}{R}$$

"Minus" ishora o'zaro ta'sir qiluvchi ikki jismning potensial energiyasi $R=\infty$ bo'lganda nolga teng bo'lishini ko'rsatadi; bu jismlar yaqinlasha borganda potensial energiyasi ortadi.

Keplerning uchinchi qonuni quyidagi ko'rinishga egadir:

$$\frac{T_1^2}{T_2^2} = \frac{R_1^3}{R_2^3},$$

bunda $T_1$ va $T_2$ - planetalarning aylanish davri, $R_1$ va $R_2$ - planetalar orbitalarining katta o'qlari. Orbita doiradan iborat bo'lgan holda katta o'qlar rolini orbitaning radiusi o'ynaydi.

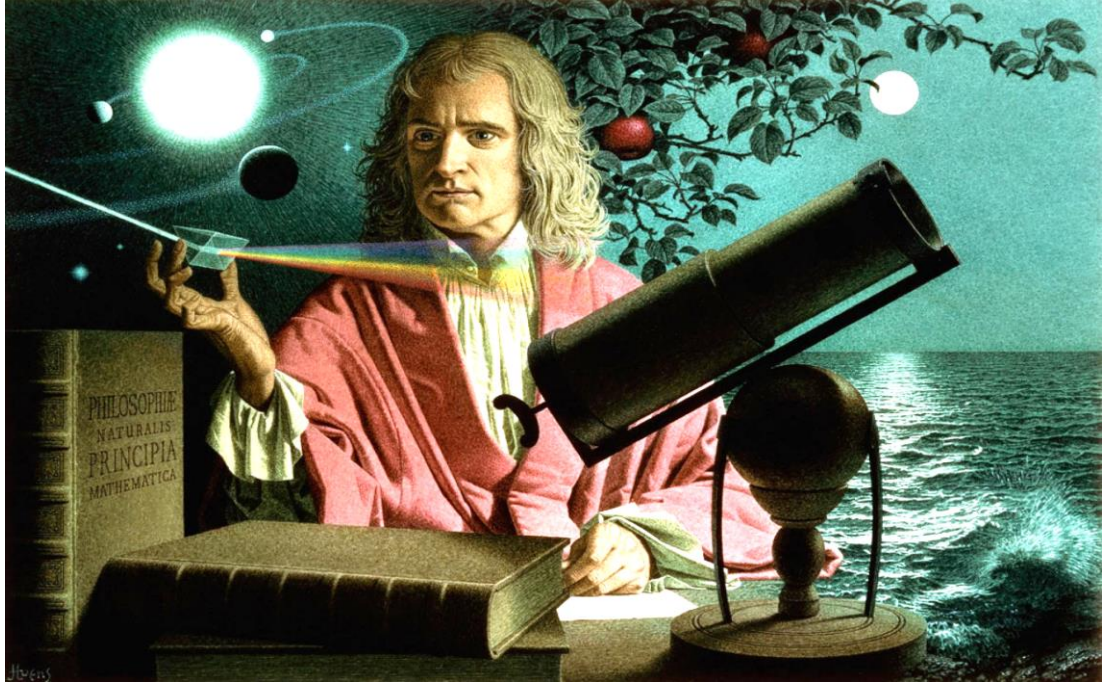
Buyuk mutafakkir Aristotelning yozishicha, “Agar jismga itaruvchi kuch ta’sir etmay qolsa, harakatlanuvchi jism to‘xtab qoladi.”

Yerga nisbatan bo‘lgan tinch holatni jismning tabiiy holati deb tushuntirilgan.

Agar jismga boshqa hech qanday jism ta’sir etmasa, jism Yerga nisbatan o‘zining tinch holatini yoki to‘g‘ri chiziqli tekis harakatini saqlaydi.

Galiley tomonidan o‘rnatilgan bu qonun mexanikaning asosiy qonunlarini tarkib toptirishda birinchi qadam bo‘ldi.

Dinamika grekcha “dynamis” so‘zidan olingan bo‘lib “kuch” degan ma’noni bildiradi.

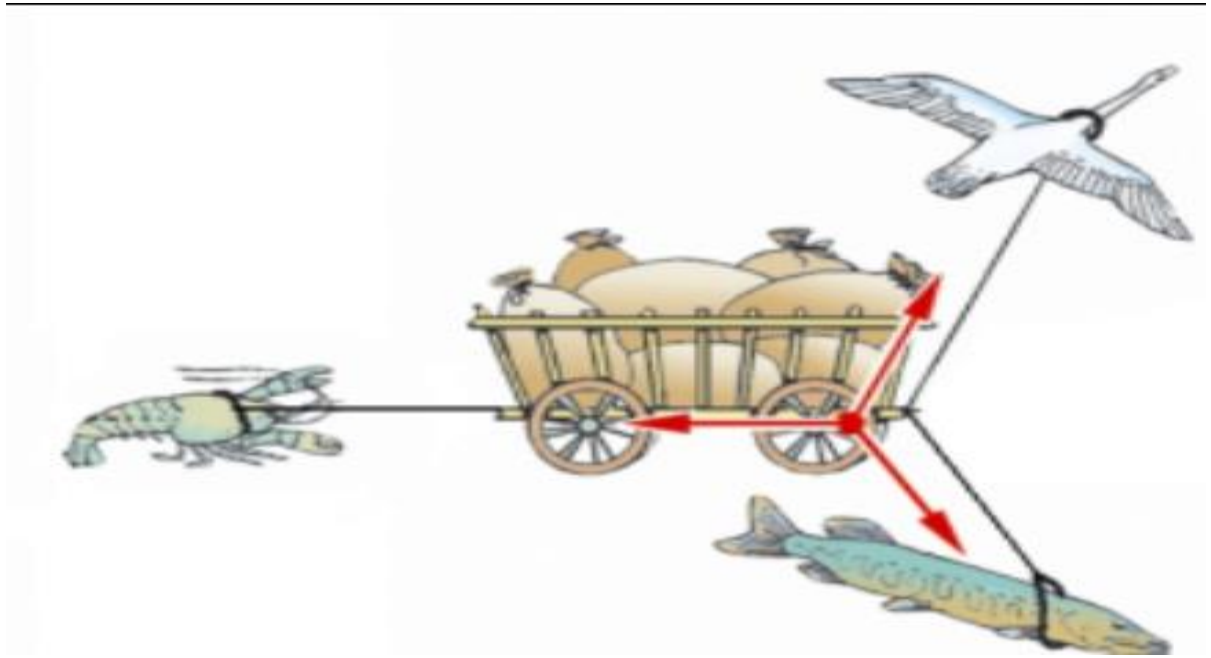



Jism tezligining o‘zgarishi (ya’ni tezlanish) har doim boshqa bir jismning ta’siri tufayli vujudga keladi.

Jismlarning bir-biri bilan o‘zaro ta’sirlashish jarayoniga – o‘zaro ta’sir deyiladi. Fizikada o‘zaro ta’sirlar doimo juft bo‘ladi.

# Dinamikaning birinchi qonuni:

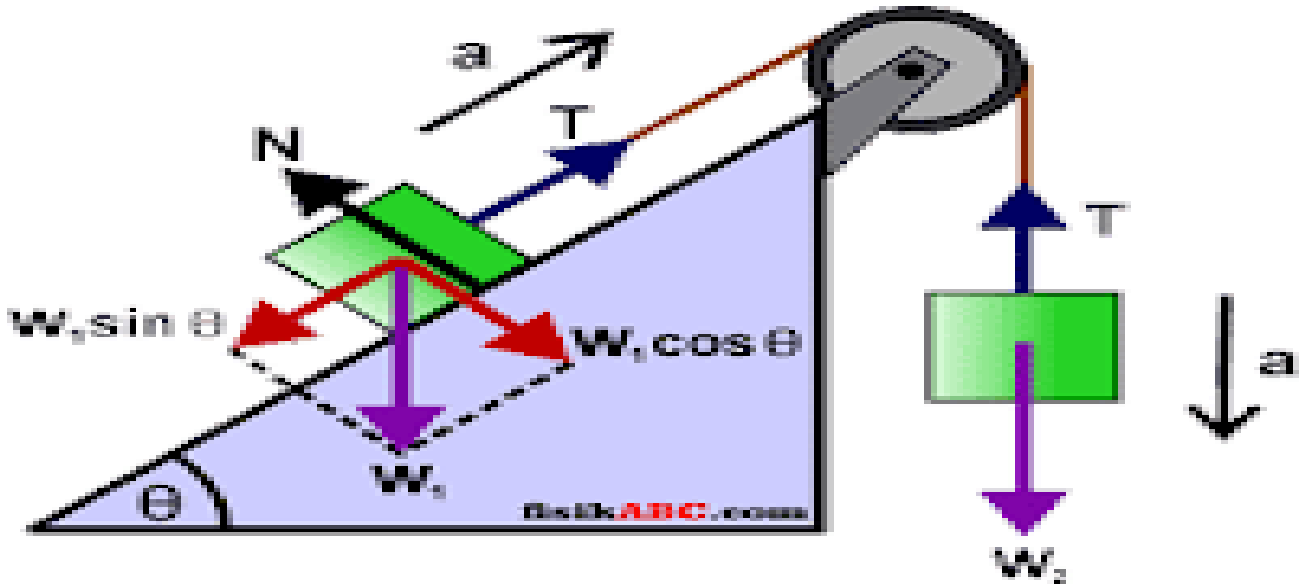
Inersial sistema deb ataluvchi shunday sanoq sistemalar mavjudki, undagi jism boshqa jismlardan yetarli darajada uzoq joylashgan bo‘lsa, tinch holatda yoki to‘g‘ri chiziqli tekis harakatda bo‘ladi.



Nyutonning ta’biricha, mexanikada, jismlarning bir-biriga ta’siri natijasida tezlanish olishiga sabab bo‘ladigan miqdoriy o‘lchamga ***kuch*** deyiladi.

1) jismlarda tezlanish, kuch ta’siri tufayli bo‘ladi;

2) tezlanish beruvchi kuch boshqa jismlarning ta’siri tufayli yuzaga keladi.

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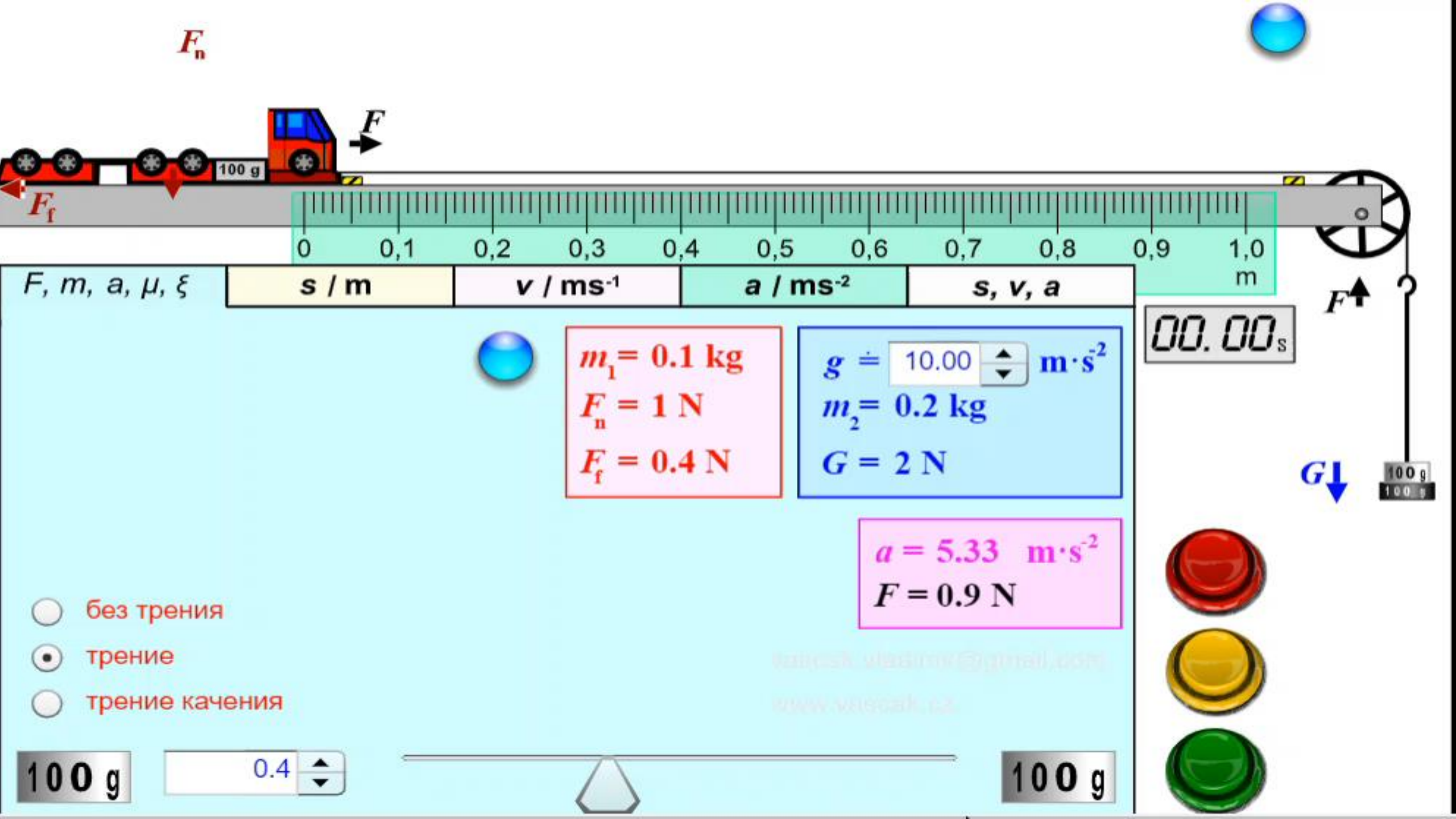
Tajribalar shuni ko‘rsatadiki, jismning olgan tezlanishi unga qo‘yilgan kuchdan tashqari jismning xossalariga ham bog‘liq. Mexanikada bu xossa ***jism massasi*** bilan ta’riflanadi.

$$\frac{F}{a} = const.$$

***Massa*** – jismning inertlik xossasini belgilaydi, ya’ni uning kuch ta’sirida qanchalik tezlanish olish qobiliyatini xarakterlaydi.

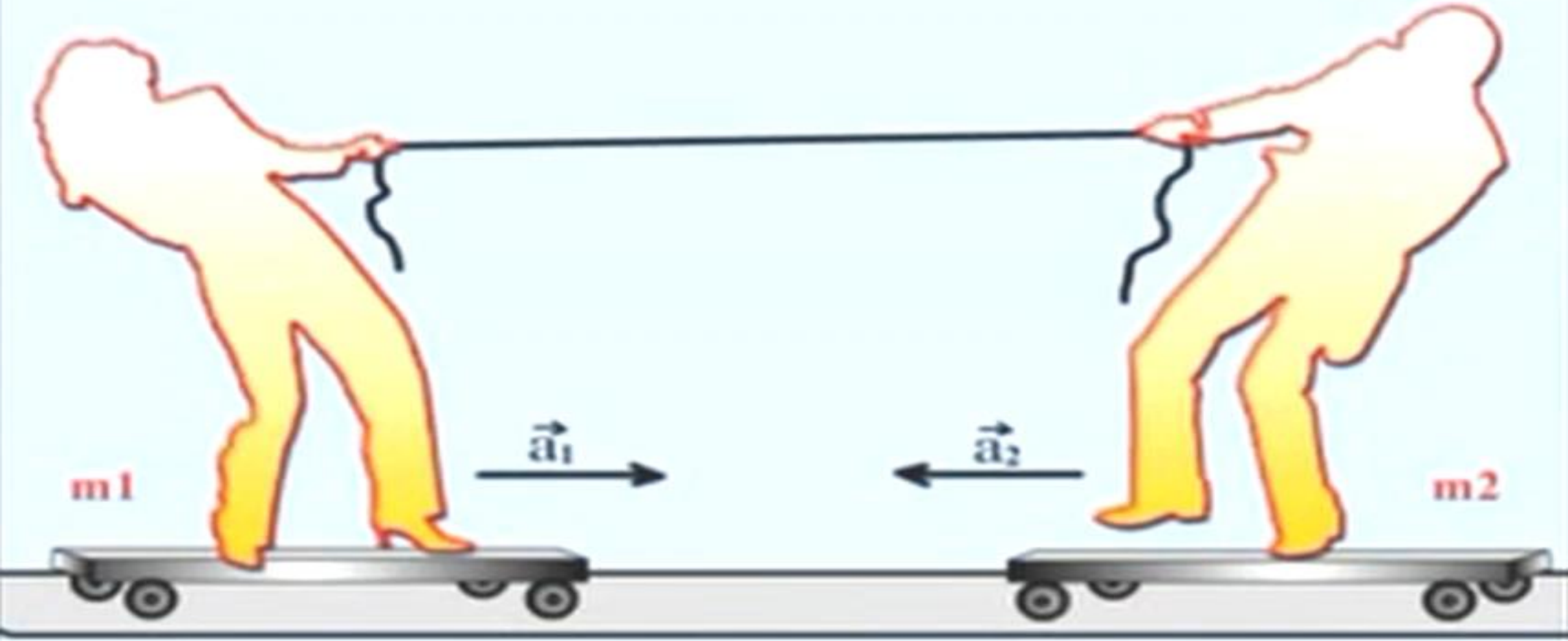

$F_n$
$F$
100 g
$F_f$
0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1,0
m
F, m, a, μ, ξ
s / m
v / ms⁻¹
a / ms⁻²
s, v, a
00.00 s
$m_1$ = 0.1 kg
$F_n$ = 1 N
$F_f$ = 0.4 N
g ≐ 10.00 m·s⁻²
$m_2$ = 0.2 kg
G = 2 N
a = 5.33 m·s⁻²
F = 0.9 N
F
G
100 g
100 g
100 g
100 g
0.4
без трения
трение
трение качения

Jismning olgan tezlanishi qo‘yilgan kuchga to‘g‘ri, jismning massasiga teskari proporsional bo‘ladi:

$$\vec{a} = \frac{\vec{F}}{m}$$

$$\vec{F} = m\vec{a} \qquad m = \frac{\vec{F}}{\vec{a}}$$

Bu ifoda dinamikaning ikkinchi qonuni deyiladi.


$\vec{a}_1$
$\vec{a}_2$
m1
m2

Dinamikaning uchinchi qonuni quyidagicha ta’riflanadi:

Ta’sir har doim aks ta’sirni vujudga keltiradi. Ular son qiymati jihatidan bir-biriga teng bo‘lib, bir to‘g‘ri chiziq bo‘ylab qarama-qarshi yo‘nalgan:

$$\overrightarrow{F_{1,2}} = -\overrightarrow{F_{2,1}}$$

$$\frac{a_2}{a_1} = \frac{m_1}{m_2}$$

$$\vec{\vartheta} = const \quad a = 0$$

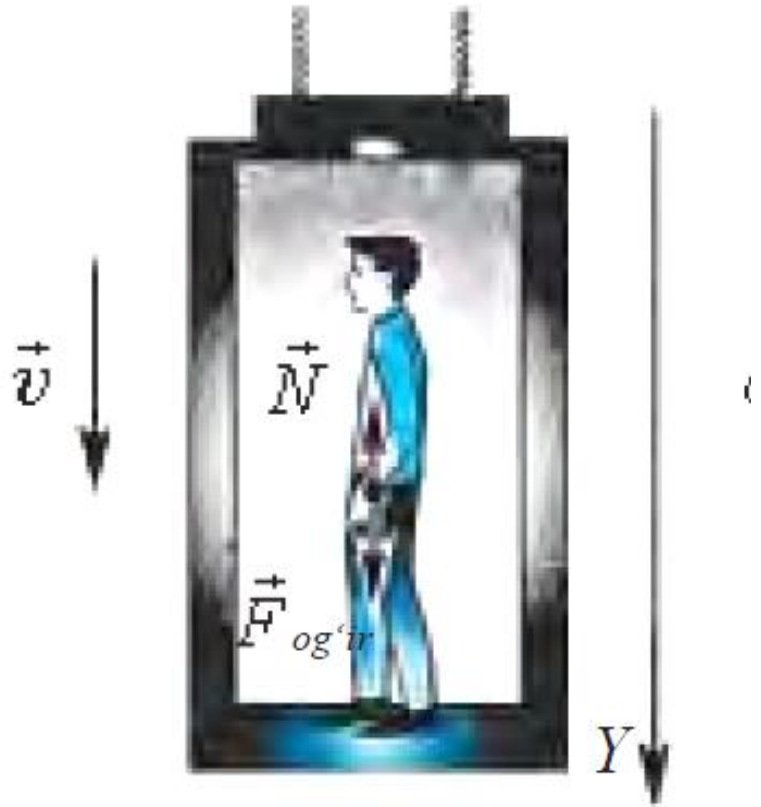
$$\overrightarrow{F_{og'}} + \vec{N} = 0$$

$$F_{og'} - N = 0$$

$$F_{og'} = N = mg$$

$|\vec{P}| = |\vec{N}|$ dan

$\vec{P} = m\vec{g}$ yoki $P = mg$



$$\vec{N} + \overrightarrow{F_{og'}} = m\vec{a}$$

$$\vec{N} = -\vec{P}$$

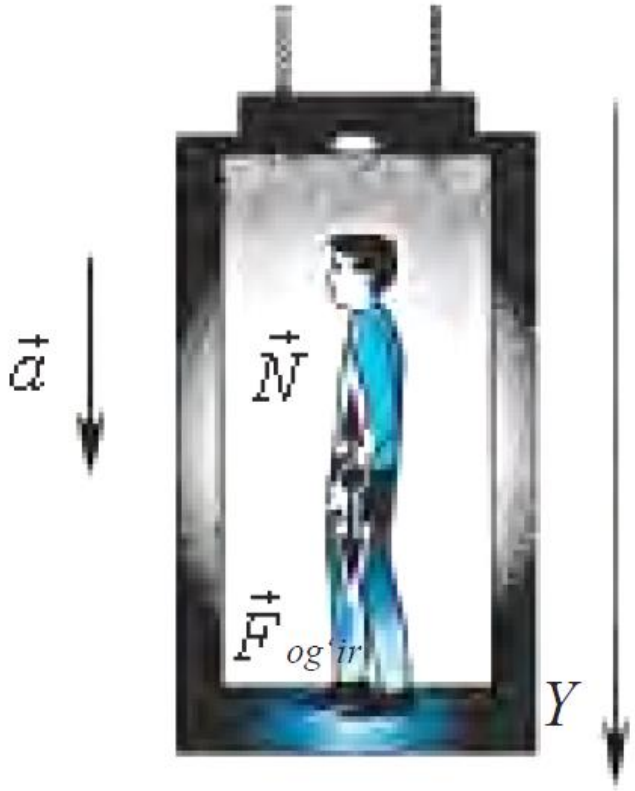
$$-\vec{P} + \overrightarrow{F_{og'}} = m\vec{a}$$

$$\vec{P} = \overrightarrow{F_{og'}} - m\vec{a}$$

$$\vec{P} = m\vec{g} - m\vec{a}$$

$$\boldsymbol{\vec{P} = m(\vec{g} - \vec{a})}$$

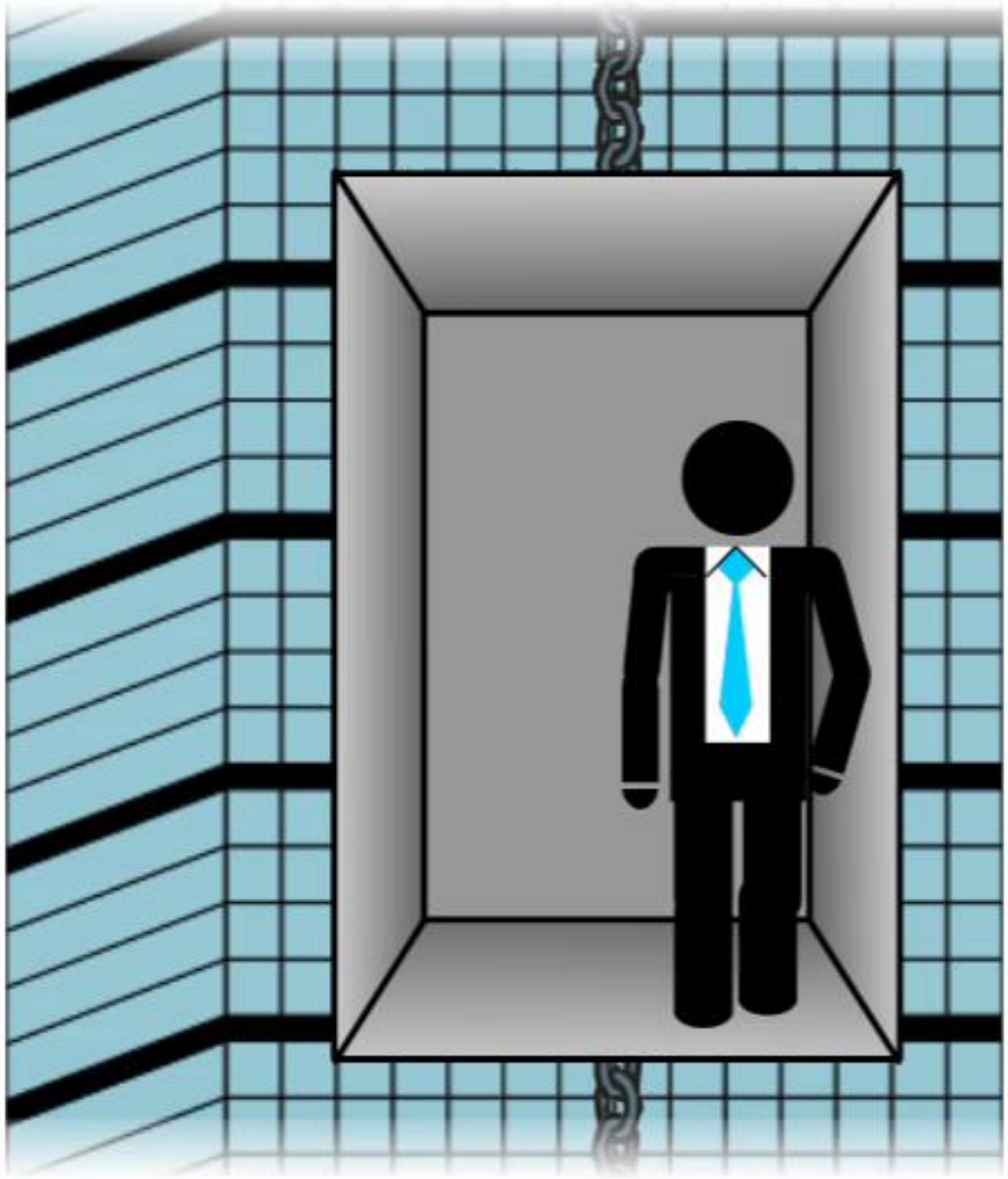
$P = 0$ holat vaznsizlik deb ataladi.



# Liftdagi insonning og‘irligi yerdagi og‘irligiga teng holat (tekis harakat)

$$\vec{g} - \vec{a} = \vec{g}$$

$$\vec{a} = 0$$



$\gg g$

$> g$

$g$

$< g$

$0$

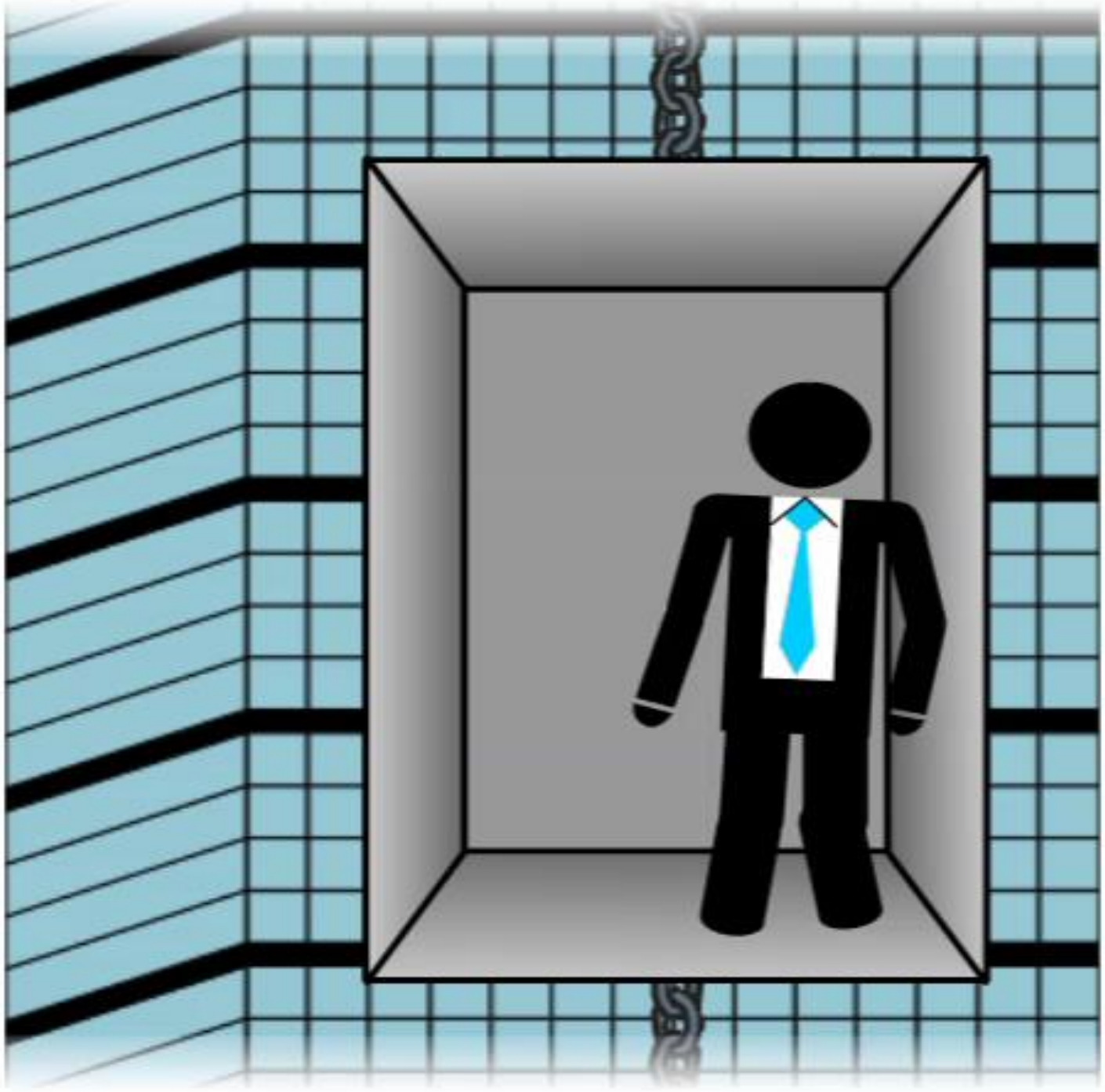
$< 0$

Liftdagi insonning og‘irligi manfiy ya’ni qarama-qarshiga o‘zgargan holat:

$$\vec{g} - \vec{a} < 0$$

Liftdagi insonning og‘irligi 0 ga teng bo‘lgan holat uchun:

$$\vec{g} - \vec{a} = 0$$



$\gg g$

$> g$

$g$

$< g$

$0$

$< 0$

Liftdagi insonning og‘irligi noldan katta, lekin kamayotgan holat uchun:

$$0 < \vec{g} - \vec{a} < \vec{g}$$

$$\vec{P} = m(\vec{g} - \vec{a})$$

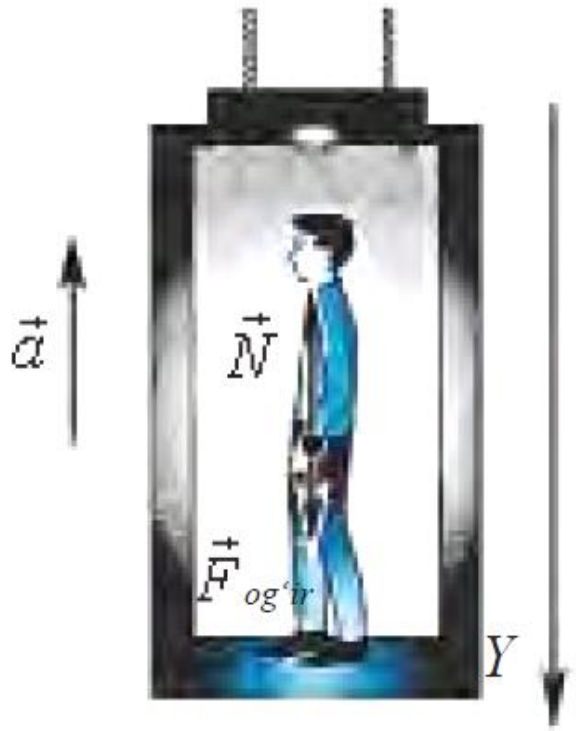
Lift tezlanishining yo‘nalishi og‘irlik kuchiga qarama qarshi bo‘lganidan:

$$\vec{P} = m(\vec{g} - (-\vec{a})) = m(\vec{g} + \vec{a})$$

Bu jarayonda inson oladigan yuklanish:

$$n = \frac{\vec{P}}{\overrightarrow{F_{og‘}}} = \frac{m(\vec{g}+\vec{a})}{m\vec{g}} \Rightarrow$$

$$n = \frac{\vec{g}+\vec{a}}{\vec{g}} = 1 + \frac{\vec{a}}{\vec{g}}$$



Liftdagi insonning og‘irligi  Yerdagidan biroz katta bo‘lgan holat uchun:

$$\vec{g} + \vec{a} > \vec{g}$$

Liftdagi insonning og‘irligi Yerdagidan ancha katta bo‘lgan holat uchun:

$$\vec{g} + \vec{a} \gg \vec{g}$$

$\gg g$

$> g$

$g$

$< g$

$0$

$< 0$

Zinadan tezlanish bilan tushilganda, og‘irligimiz $m\vec{a}$ ga kamayadi, tezlanish bilan ko‘tarila boshlasak, aksincha $m\vec{a}$ ga ortadi.

Agar doimiy tezlikda tushsak yoki ko‘tarilsak og‘irligimiz o‘zgarmaydi.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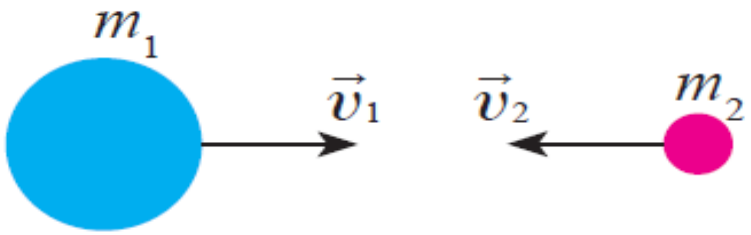
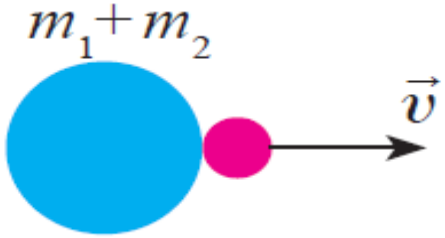
# Absolyut noelastik to‘qnashish.

Absolyut noelastik to‘qnashish deb, ikkita deformatsiyalanadigan sharlarning to‘qnashib, birga yoki bir xil tezlik bilan harakatlanishiga aytiladi. Bunda kinetik energiyaning ma’lum qismi issiqlikka aylanadi.

$$m_1\vec{\vartheta}_1 + m_2\vec{\vartheta}_2 = (m_1 + m_2)\vec{\vartheta}$$

$$\vec{\vartheta} = \frac{m_1\vec{\vartheta}_1 + m_2\vec{\vartheta}_2}{m_1 + m_2}$$

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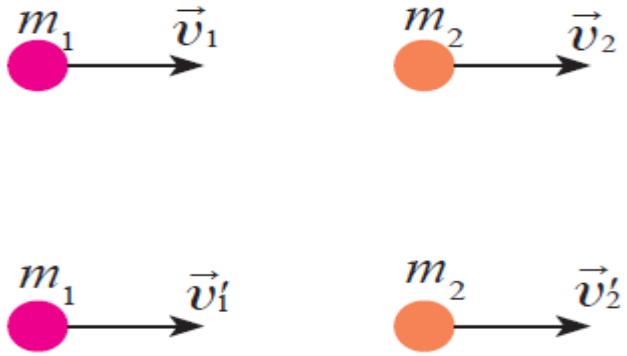
# Absolyut elastik to‘qnashish

Absolyut elastik to‘qnashish deb, ikkita deformatsiyalanmaydigan sharlarning to‘qnashishiga aytiladi. Bunda sharlarning to‘qnashishdan oldingi kinetik energiyalari, to‘qnashishdan keyin ham to‘laligicha kinetik energiyaga aylanadi.




$$m_1\vec{\vartheta}_1 + m_2\vec{\vartheta}_2 = m_1\vec{\vartheta}_1' + m_2\vartheta_2'$$

$$\frac{m_1\vartheta_1^2}{2} + \frac{m_2\vartheta_2^2}{2} = \frac{m_1\vartheta_1'^2}{2} + \frac{m_2\vartheta_2'^2}{2}$$

$$\vartheta_1' = \frac{2m_2\vartheta_2 + (m_1 - m_2)\vartheta_1}{m_1 + m_2}$$

$$\vartheta_2' = \frac{2m_1\vartheta_1 + (m_2 - m_1)\vartheta_2}{m_1 + m_2}$$

5

2

?

# 1-masala

0,3 m/s tezlik bilan harakatlanayotgan 20 t massali vagon 0,2 m/s tezlik bilan harakatlanayotgan 30 t massali vagonni quvib yetadi. Agar to‘qnashish noelastik bo‘lsa, ular o‘zaro urilgandan keyin vagonlarning tezligi qanday bo‘ladi?

**Berilgan:**

$m_1 = 20\ t$

$\vartheta_1 = 0{,}3\ m/s$

$m_2 = 30\ t$

$\vartheta_2 = 0{,}2\ m/s$

**Topish kerak:** $\vartheta - ?$

**Formula:**

$$m_1\vec{\vartheta}_1 + m_2\vec{\vartheta}_2 = (m_1 + m_2)\vec{\vartheta}$$

$$\vartheta = \frac{m_1\vartheta_1 + m_2\vartheta_2}{m_1 + m_2}$$

**Yechish:**

$$\vartheta = \frac{20\ t \cdot 0{,}3\frac{m}{s} + 30\ t \cdot 0{,}2\frac{m}{s}}{20\ t + 30\ t} = 0{,}24\ m/s$$

**Javob:** $\vartheta = 0{,}24\ m/s$

# 2-masala

6 m/s tezlikka ega 2 kg massali shar massasi 1 kg bo‘lgan harakatsiz turgan shar bilan to‘qnashadi. Urilish markaziy va absolyut elastik deb hisoblab, ikkinchi sharning to‘qnashuvdan keyingi tezligini toping.

## Berilgan:

$m_1 = 2\ kg$

$\vartheta_1 = 6\ m/s$

$\vartheta_2 = 0$

$m_2 = 1\ kg$

## Topish kerak:

$\vartheta_2' - ?$

## Formula:

$$\vartheta_2' = \frac{2m_1\vartheta_1 + (m_2 - m_1)\vartheta_2}{m_1 + m_2}$$

**Yechish:** $\vartheta_2' = \frac{2 \cdot 2\ kg \cdot 6\frac{m}{s} + (1\ kg - 2\ kg) \cdot 0}{2\ kg + 1\ kg} = 8\ m/s$

**Javob:** $\vartheta_2' = 8\ m/s$

**2.1.** Tekis harakatlanib tushayotgan aerostat xuddi shunday tezlikda yuqoriga ko'tarila boshlashi uchun, aerostatdan qancha og'irlikdagi ballastni (yukni) tashlab yuborish kerak? Aerostatning ballast bilan birga og'irligi 1600 *kG*, yuqoriga ko'rsatuvchi kuchi 1200 *kG*. Yuqoriga ko'tarilishda va tushishida havoning qarshilik kuchi birday hisoblansin.

**2.2.** Ipga og'irligi $P=1$ *kG* bo'lgan yuk osilgan. Agar yuk osilgan ip 1) $a=5$ *m/sek*$^2$ tezlanish bilan yuqoriga ko'tarilayotgan, 2) Xuddi shunday $a=5$ *m/sek*$^2$ tezlanish bilan pastga tushayotgan hollarda ipning taranglik kuchi topilsin.

**2.3.** Biror diametrli po'lat sim 4400 N gacha yukka chidash bera oladi. Bu simga 3900 N yuk osib, u uzilib ketmasligi uchun yukni qanday maksimal tezlanish bilan yuqoriga ko'tarish kerak?

**2.4.** Yo'lovchilar bilan birga liftning og'irligi 800 *kG*. Lift osilgan trosning tarangligi: 1) 1200 *kG* va 2) 600 *kG* bo'lsa, lift qanday tezlanish bilan va qanday yo'nalishda harakatlanadi?

**2.5.** Ipga tosh osilgan. Bu toshni $a_1=2$ *m/sek*$^2$ tezlanish bilan yuqoriga ko'tarilganda, ipning uzilib ketishi mumkin bo'lgan taranglik kuchidan ikki marta kichik $T$ taranglik kuchi hosil bo'lgan. Ip uzilib ketishi uchun bu toshni qanday $a_2$ tezlanish bilan yuqoriga ko'tarish kerak?