Fizikadan Uzoqov to`plami boyicha nazariy darslik

FIZIKA

(*qisqacha ma'lumotlar*)

Akademik litsey , kasb-hunar kollejlari, maktab o'quvchilari va oliy o'quv yurtiga kiruvchi abituriyentlar uchun mo'ljallangan.

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Talaba-2017…

1. Moddiy nuqta. Ko'chish.

Fizika — materiyaning tuzilishi va uning xilma-xil o'zgarishlarini o'rgatadi.
Materiya — bu inson ongiga bog'liq bo'lmagan holda mavjud bo'lgan, ko'rinadigan va ko'rinmaydigan butun borliqdir. Materiyaga
- funksiyalar (sin, cos)
- psixologik tushunchalar (rijdon, his-tuyg'u)

kirmaydi.

Fizika 5 ta katta bo'limdan iborat
- Mexanika
- Molekulyar fizika
- Elektr
- Optika
- Atom va yadro fizikasi.

Mexanikaning asosiy masalasi **jismning ixtiyoriy vaqt momentidagi** vaziyatini aniqlashdan iborat.
Mexanika 3 bo'limdan iborat.
- Kinematika
- Dinamika
- Statika

Kinematika — jismning harakatini, shu harakatni yuzaga keltiruvchi sabablarsiz o'rgatadi.

Dinamika — jismning harakat sabablarini o'rgatadi.

Statika — kuch ta'sirida jismning muvozanatda bo'lish shartlarini o'rgatadi.

Mexanik harakat — vaqt o'tishi bilan bir jismning boshqa jismga nisbatan vaziyatining o'zgarishiga aytiladi.

Trayektoriya — jismning harakati davomida qoldirgan izga aytiladi.

Yo'l — trayektoriya uzunligiga aytiladi.

S – yo'l [m]

Ko'chish — jismning boshlang'ich vaziyati bilan oxirgi vaziyatini tutashtiruvchi vektor.

! Yo'l hech qachon 0 ga teng emas $S \neq 0$
Ko'chish nolga teng bo'lishi m-n $\vec{S} = 0$.

Skalyar kattaliklar — faqat son qiymatiga ega bo'lgan kattaliklarga aytiladi.

S – yo'l [m]
t – vaqt [S]
I – tok kuchi [A]
m – massa [kg]
V – hajm [m^3]
P – bosim [Pa]
A – ish [J]
S – yuza

EYK. Zaryad.

Vektor kattaliklar — ham son qiymatiga, ham yo'nalishga ega bo'lgan kattaliklarga aytiladi.

$\vec{S}$ – ko'chish [m]
$\vec{v}$ – tezlik [m/s]
$\vec{a}$ – tezlanish [m/s^2]
$\vec{F}$ – kuch [N]
$\vec{j}$ – tok zichligi [A/m^2]
$\vec{p}$ – impuls [kg · m/s]
$\vec{E}$ – maydon kuchlanganligi
$\vec{q}$ – tok zichligi

Sanoq sistemasi — sanoq jismi va unga bog'langan koordinatalar sistemasi hamda vaqtni o'lchaydigan asbobdan iborat sistemasiga aytiladi.

1.

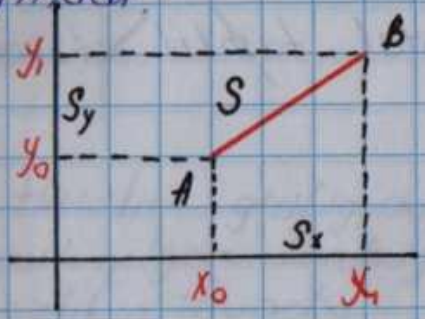
Sanoq sistemasi 2 xil bo'ladi

- Inersial sanoq sistemasi
- Noinersial sanoq sistemasi

Inersial sanoq sistemasi deb, tinch turgan yoki to'g'ri chiziqli tekis harakat qila yotgan sanoq sistemasiga aytiladi.

Shu sanoq sistemada Nyuton qonunlari bajariladi.

Noinersial sanoq sistemasi deb, tezlanish bilan harakatlanayotgan sanoq sistemasiga aytiladi.



$A(x_0 y_0)$ $S_x = x - x_0$

$B(x; y)$ $S_y = y - y_0$

$$\vec{S} = \sqrt{S_x^2 + S_y^2}$$

$x_0; y_0$ – boshlang'ich koordinata

x, y – oxirgi koordinata

Moddiy nuqta — ma'lum sharoitda o'lchamlarini e'tiborga olmasa ham, bo'ladigan jismga aytiladi.

To'g'ri chiziqli tekis harakat. Tezlik.

Harakat 3 turga bo'linadi:

- to'g'ri chiziqli tekis harakat
- to'g'ri chiziqli notekis harakat
- Egri chiziqli harakat.

To'g'ri chiziqli tekis harakat — hech, qanday tezlanishga ega bo'lmagan harakatga aytiladi, ya'ni $a = 0$

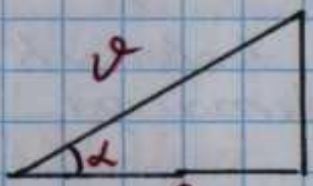
$\vartheta = const.$

Tezlik — vaqt birligi ichida bosib o'tilgan masofaga aytiladi.

$$\vartheta = \frac{S}{t}$$

ϑ — tezlik [m/s]
S — masofa [m]
t — vaqt [s]

$$\vartheta \frac{km}{h} = \frac{\vartheta}{3,6} \frac{m}{s}$$



ϑ_y — tezlikni vertikal tashkil etuvchi

ϑ_x — tezlikni gorizontal tashkil etuvchi

$$\vartheta_y = \vartheta \sin\alpha$$
$$\vartheta_x = \vartheta \cos\alpha$$
$$tg\alpha = \frac{\vartheta_y}{\vartheta_x} = \vartheta$$

$$\vec{S} = \vec{\vartheta} t$$

$$S_x = \vartheta_x t \qquad S_x = x - x_0$$
$$\vartheta_x t = x - x_0$$

$$x = x_0 + \vartheta_x t$$
$$y = y_0 + \vartheta_y t$$

to'g'ri chiziqli tekis harakat tenglamasi

Masalan, $x_1 = 4 + 2t$
$x_2 = t + 7$

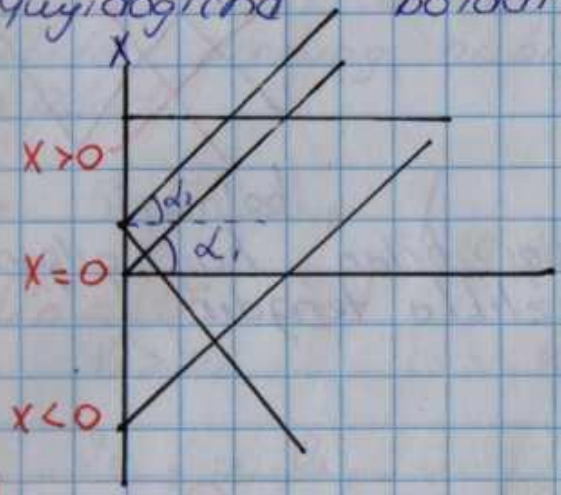
- Uchrashishi uchun $x_1 = x_2$

$4 + 2t = t + 7$
$t = 3$.

- $t \leq 0$ bo'lsa uchrashmaydi.

Harakatni grafik ravishda tasvirlash

- To'g'ri chiziqli tekis harakat grafigi quyidagicha bo'ladi



! Harakat grafigidagi chiziqning vaqt o'qi bilan hosil qilgan burchagi qanchalik katta bo'lsa, tezlik shuncha katta bo'ladi.

Masalan,

$x_0 = -8$

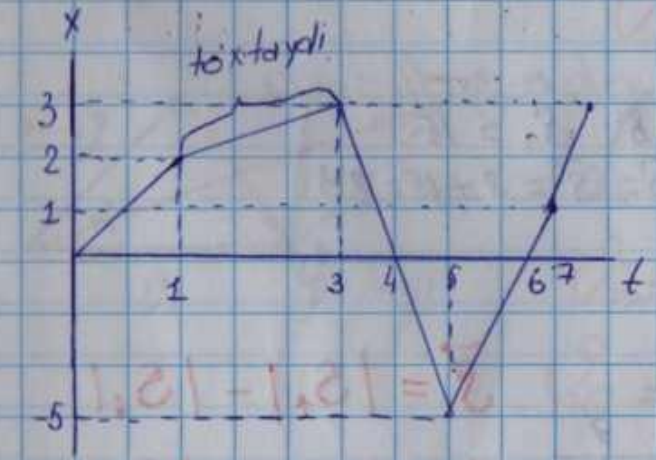
$x = 20$

$t = 4$

$x = x_0 + vt$

$v_x = \frac{x - x_0}{t} = \frac{20+8}{4} = 7.$

$x = -8 + 7t.$



S = yo'l $\vec{S}$ = ko'chish

$t = 1$ $S = 2$ $\vec{S} = 2$

$t = (3-1) = 2$ to'xtaydi

5 sekund harakat qiladi

$7 - 2 = 5$ s.

$t = 3$ $S = 2$ $\vec{S} = 2$

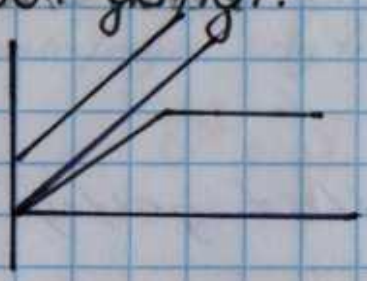
$t = 4$ $S = 4$ $\vec{S} = 0$

$t = 5$ $S = 9$ $\vec{S} = -5$

$t = 6$ $S = 14$ $\vec{S} = 0$

$t = 7$ $S = 15$ $\vec{S} = 3$

• Yol grafigi.



bo'lishi mumkin. $S > 0$

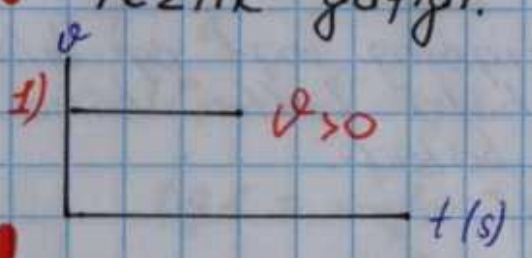
$S < 0$

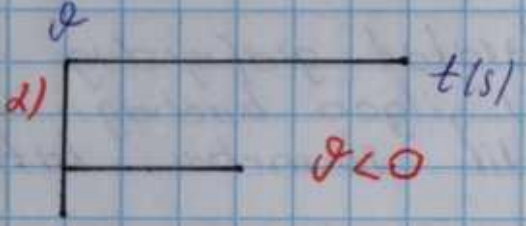
bo'lmaydi

! Yol grafigidagi vaqt o'qi bilan hosil qilgan burchak tangensi tezlikka tengdir.

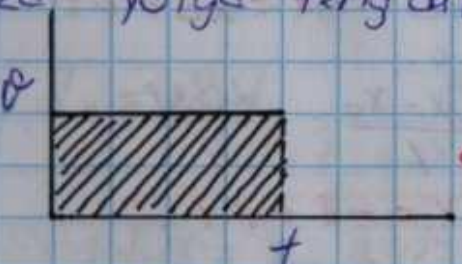
$$tg\alpha = v.$$

• Tezlik grafigi.





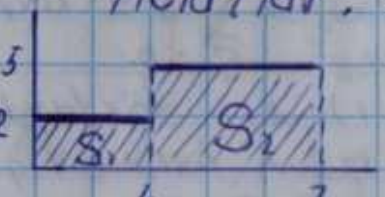
! Tezlik grafigidagi vaqt o'qi bilan hosil qilgan yuza yo'lga tengdir



$$S = v \cdot t = S_{\square}.$$

Holatlar:

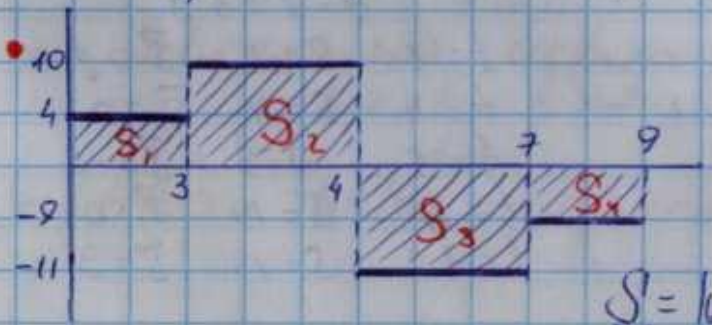
•



$S_1 = 8 \quad S_2 = 15$

$S = \vec{S} = 8 + 15 = 23.$

•



$$\vec{S} = |S_1| - |S_4|$$

$$S = |S_1| + |S_4|$$

$S = |12 + 10| + |-33 - 18| = 73$

$\vec{S} = |22| - |51| = -29$

Harakat nisbiyligi

Hech qanday harakat absolyut emas nisbiydir, Tinchlik ham nisbiydir.

I. Harakati bir-biriga bog'liq bo'lmagan — ikkita jismning nisbiy tezliklari quyidagicha topiladi:

- 

$\alpha = 0°$ (qo'shib ketyapti, bir xil yo'nalish)

$\vartheta_n = |\vartheta_1 - \vartheta_2|$

$V_1 > \vartheta_2$

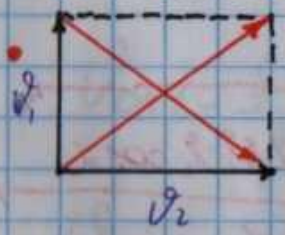
ϑ_n — ularning yerga nisbatan tezligi. Natijaviy tezlik.

- 

(bir-biriga tomon, qarama-qarshi yo'nalish. $\alpha = 180°$)

$$\vartheta_n = \vartheta_1 + \vartheta_2$$

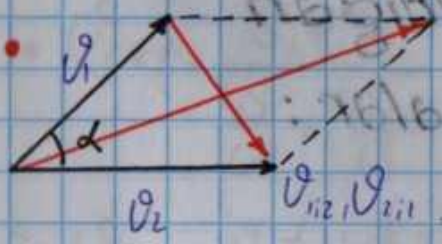
$$\vartheta_{1;2} = \vartheta_{2;1} = \vartheta_1 + \vartheta_2$$

- 

(Bir-biriga tik yo'nalish perpendikulyar $\alpha = 90°$)

$$\vartheta_n = \sqrt{\vartheta_1^2 + \vartheta_2^2}$$

$$\vartheta_{1;2} = \vartheta_{2;1} = \sqrt{\vartheta_1^2 + \vartheta_2^2}.$$

- 

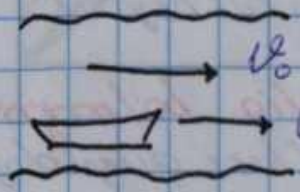
(α - burchak ostida)

$$\vartheta_n = \sqrt{\vartheta_1^2 + \vartheta_2^2 + 2\vartheta_1\vartheta_2\cos\alpha}$$

$$\vartheta_{1;2} = \vartheta_{2;1} = \sqrt{\vartheta_1^2 + \vartheta_2^2 - 2\vartheta_1\vartheta_2\cos\alpha}.$$

II. Harakati bir-biriga bog'liq bo'lgan

ikkita jismning nisbiy tezligi quyidagicha topiladi. (oqim, qayiq, suzuvchi)

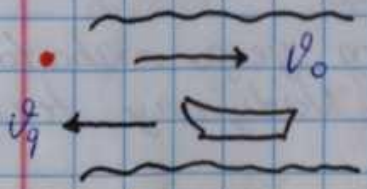


$\vartheta_n = \vartheta_q + \vartheta_o$

qayiqning yerga (qirg'oqqa) nisbatan tezligi.

(Bir xil yo'nalishda; oqim bo'ylab)

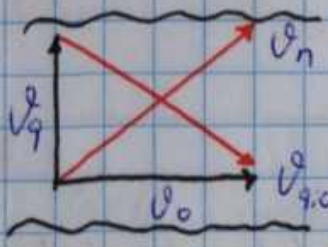
$\vartheta_{q;o} = \vartheta_{o;q} = \vartheta_q - \vartheta_o$ bir-biriga nisbatan tezligi



(qarama-qarshi yo'nalishda)

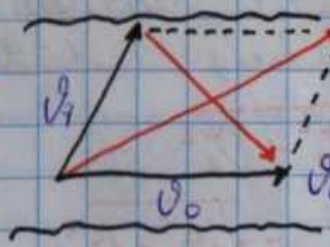
$\vartheta_n = \vartheta_q - \vartheta_o$. [$\vartheta_q > \vartheta_o$ doimo.]

$\vartheta_{q;o} = \vartheta_{o;q} = \vartheta_q + \vartheta_o$



$\vartheta_n = \sqrt{\vartheta_o^2 + \vartheta_q^2}$

$\vartheta_{o;q} = \vartheta_{q;o} = \sqrt{\vartheta_o^2 + \vartheta_q^2}$



$\vartheta_n = \sqrt{\vartheta_1^2 + \vartheta_2^2 + 2\vartheta_1\vartheta_2\cos\alpha}$

$\vartheta_{o;q} = \vartheta_{q;o} = \sqrt{\vartheta_1^2 + \vartheta_1^2 - 2\vartheta_1\vartheta_2\cos\alpha}$

Eng ko'p uchraydigan old qo'shimchalar:

Katta:
- Tera — $T = 10^{12}$
- Giga — $G = 10^9$
- Mega — $M = 10^6$
- Kilo — $k = 10^3$

Ulush:
- Milli — $m = 10^{-3}$
- Mikro — $\mu = 10^{-6}$ (m/k)
- Nano — $n = 10^{-9}$
- Piko — $p = 10^{-12}$

Sekto — 10^{-2} (kerakli qo'shimchalar)
Angestrun — 10^{-10}

O'rtacha va Oniy tezliklar.

Har qanday harakatda o'rtacha tezlik quyidagicha topiladi

$$v_{o'rt} = \frac{S_{um}}{t_{um}}$$ (butun yo'lning butun vaqtga nisbati)

- $S_{um} = S_1 + S_2 + S_3 + \dots + S_n$
- $t_{um} = t_1 + t_2 + t_3 + \dots + t_n$

$$v_{o'rt} = \frac{S_1 + S_2 + \dots + S_n}{t_1 + t_2 + \dots + t_n}$$

$S_1 = v_1 t_1$ $S_2 = v_2 t_2$ $S_n = v_n t_n$

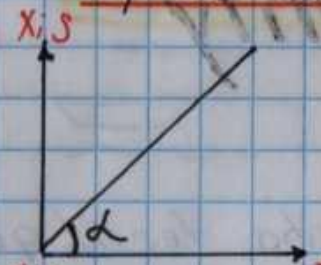
$t_1 = \frac{S_1}{v_1}$ $t_2 = \frac{S_2}{v_2}$ $t_n = \frac{S_n}{v_n}$

- $v_{o'rt} = \frac{2v_1 v_2}{v_1 + v_2}$ agar $S_1 = S_2$ bo'lsa
- $v_{o'rt} = \frac{v_1 + v_2}{2}$ agar $t_1 = t_2$ bo'lsa
- $v_{o'rt} = \frac{S_1 + S_2}{\frac{S_1}{v_1} + \frac{S_2}{v_2}}$ agar t yo'q bo'lsa bo'ladi
- $v_{o'rt} = \frac{v_1 t_1 + v_2 t_2}{t_1 + t_2}$ agar S yo'q bo'lsa bo'ladi

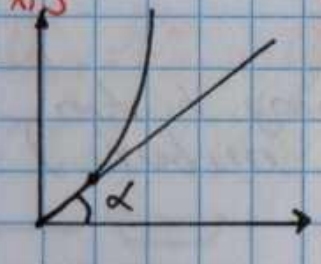
Oniy (lahzaviy) tezlik deb, jismning ixtiyoriy eng kichik vaqt momentidagi tezligiga aytiladi.

yoki trayektoriyaning ma'lum nuqtasi-dagi tezlikka oniy tezlik deyiladi.

Spidometr oniy tezlikni ko'rsatadi



$tg\alpha = \vartheta$



$tg\alpha = \vartheta$.

Asosiy birliklar

	Kattalik nomi	Belgisi	Birligi nomi	Qisqa chd	Izoh
1	Uzunlik	s, l	metr	m	Mexanika
2	Massa	m	kilogramm	kg	Mexanika
3	Vaqt	t	sekund	S	Mexanika
4	Temperatura	T	Kelvin	K	Molek. fizika
5	Modda miqdori	ν	mol	mol	Molek. fizika
6	Tok kuchi	I	amper	A	Elektr
7	Yorug'lik	J	kandela	Kd	optika

Qo'shimcha

8	Yassi burchak	α (β...)	radian	rad	fizika
9	fazoviy burchak	Ω	Steradian	sr	fizika

Tezlanish. Tekis tezlanuvchan harakat.

Vaqt o'tishi bilan tezlikning o'zgarishiga **tezlanish** deyiladi.

$$\vec{a} = \frac{\Delta \vec{\upsilon}}{\Delta t}$$

$\Delta \vec{\upsilon}$ – tezlikning o'zgarishi
a – tezlanish

$$\Delta \upsilon = \upsilon - \upsilon_0$$
$$\Delta t = t - t_0$$

$$a = \frac{\upsilon - \upsilon_0}{t - t_0} \quad \text{yoki} \quad a = \frac{\upsilon - \upsilon_0}{t}$$

- To'g'ri chiziqli tekis harakat.

$\upsilon = \upsilon_0 \qquad a = 0$

- To'g'ri chiziqli tekis tezlanuvchan harakat.

$\upsilon > \upsilon_0 \qquad a > 0 \qquad +\upsilon - +a \qquad \upsilon\uparrow\ a\uparrow$
$\qquad\qquad\qquad\qquad\quad -\upsilon - -a$

- To'g'ri chiziqli tekis sekinlanuvchan harakat.

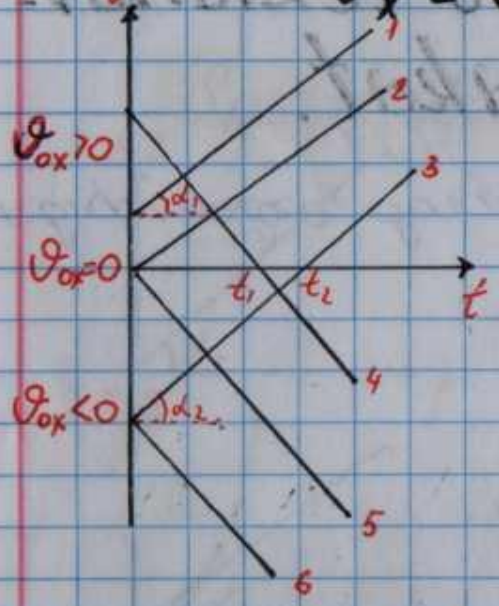
$\upsilon < \upsilon_0 \qquad a < 0 \qquad +\upsilon - -a \qquad \upsilon\uparrow\ a\downarrow$
$\qquad\qquad\qquad\qquad\quad -\upsilon - +a \qquad \upsilon\downarrow\ a\uparrow$

$\upsilon = \upsilon_0 + at$ – oniy tezlik yoki oxirgi tezlik

$\upsilon = \upsilon_0 - at$ – qachon to'xtaydi, qachon tezlik o'zgaradi

$t_t = \frac{\upsilon_0}{|a|}$ – to'xtash vaqti ($\upsilon = 0$).

$$\vartheta_x = \vartheta_{0x} + a_x t.$$



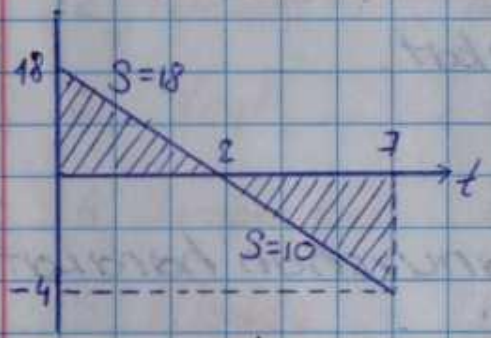
Izoh.

1) $\vartheta_1 = \vartheta_{01} + a_1 t$ tezlanuvchan
2) $\vartheta_2 = a_2 t$ tezlanuvchan ($\vartheta = 0$)
3) $\vartheta_3 = -\vartheta_0 + at$
   t_2 gacha sekinlanuvchan
   t_2 dan keyin tezlanuvchan
4) $\vartheta_4 = \vartheta_0 - at$ sekinlanuvchan
5) $\vartheta_5 = -at$ tezlanuvchan
6) $\vartheta_6 = -\vartheta - at$ tezlanuvchan

Tezlik grafigidagi burchak tangensi tezlanishni beradi.

$$\boxed{tg\alpha = a}$$

Misol:



$\vartheta = -4$
$\vartheta_0 = 18$
$t = 7$

$a = \frac{-4-18}{7} = \frac{-22}{7}$ (tezlanish)

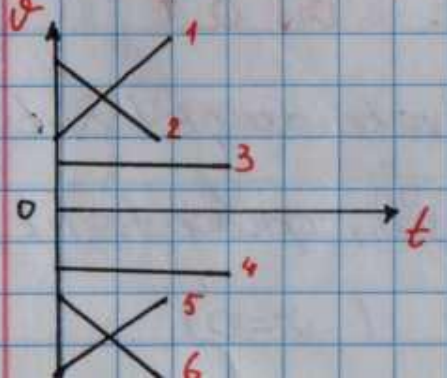
$\vartheta_x = 18 - \frac{22}{7} t.$ (tenglamasi)

$S = S_{1\Delta} + S_{2\Delta} = 18 + 10 = 28$ (yo'l)

$\vec{S} = 18 - 10 = 8$ (ko'chish)

$$\boxed{a_1 < a_2 < a_3}$$

$$\alpha_1 < \alpha_2 < \alpha_3.$$

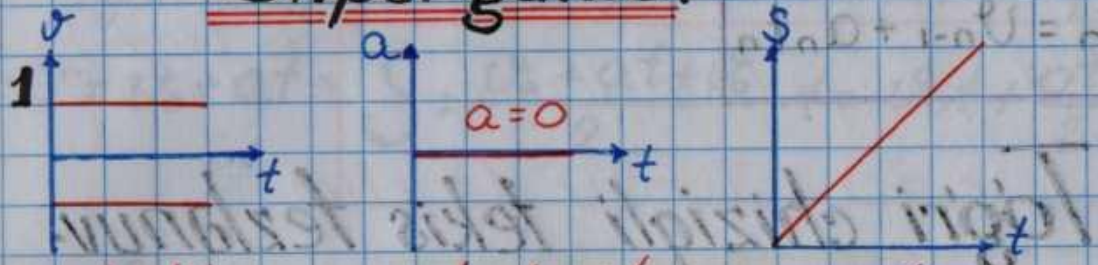


1,6 — tezlanuvchi
2,5 — sekinlanuvchi
3 — t.ch.t tezlanuvchi h.
4 — t.ch.t sekinlanuvchi h.

! Tezlanish grafigidagi vaqt o'tishi bilan chegaralangan yuza tezlikni o'zgarishini beradi.

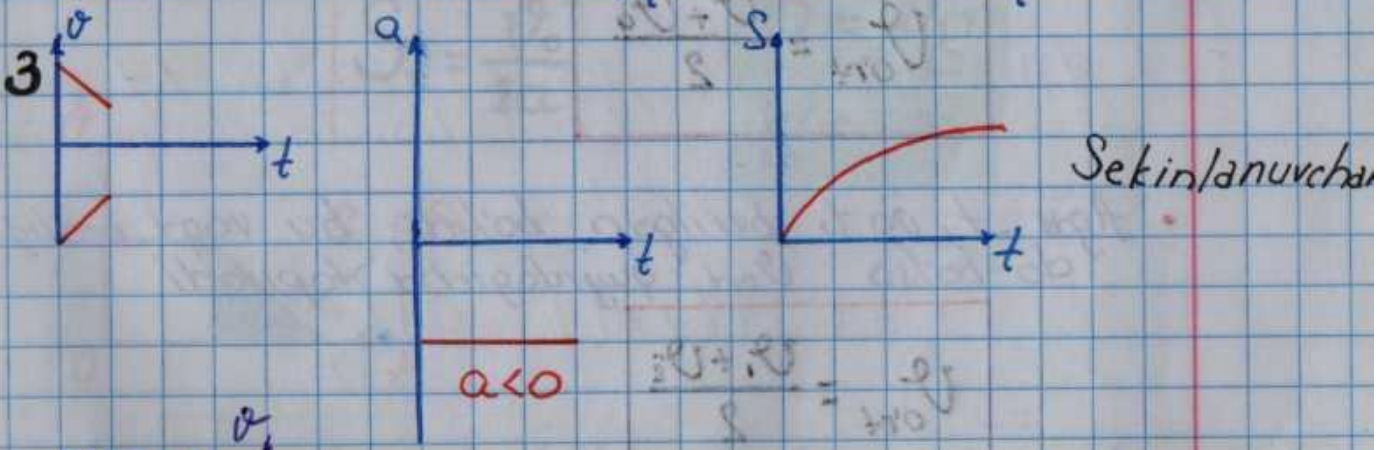
$$\Delta v = S_{(yuza)}$$

Shpargalka.



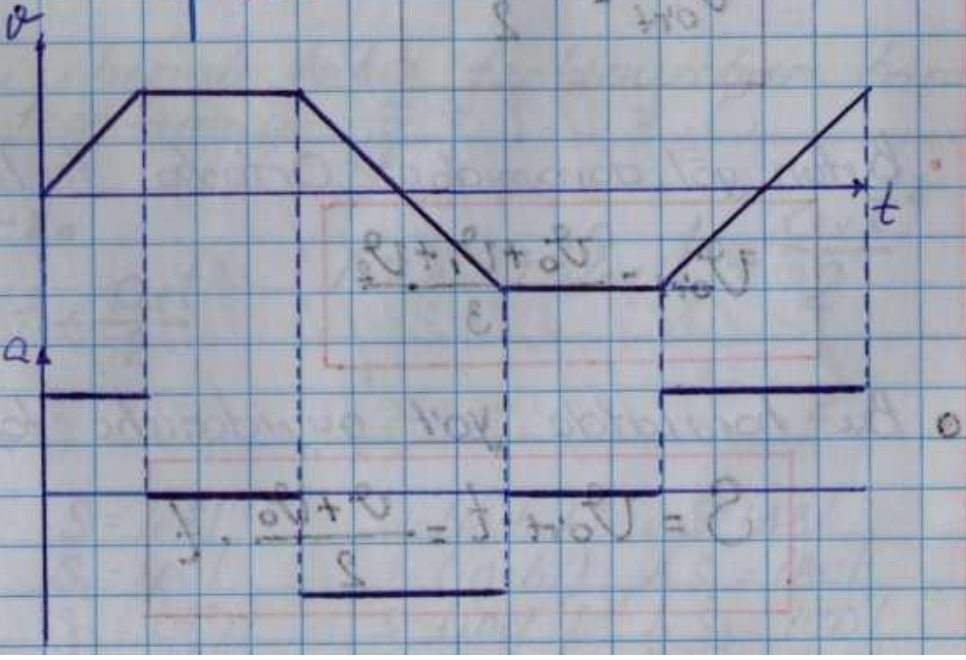
tezlik tezlanish yo'l

Tezlanuvchan



Sekinlanuvchan

Misol:



$$\vartheta_1 = \vartheta_0 + a_1 t_1$$

$$\vartheta_2 = \vartheta_1 + a_2 t_2 = \vartheta_0 + a_1 t_1 + a_2 t_2$$

$$\vartheta_3 = \vartheta_2 + a_3 t_3$$

.....

$$\boxed{\vartheta_n = \vartheta_{n-1} + a_n t_n}$$

To'g'ri chiziqli tekis tezlanuvchan harakatda ko'chish.

- Bu harakatda **o'rtacha tezlik** quyidagicha topiladi:

$$\boxed{\vartheta_{o'rt} = \frac{\vartheta + \vartheta_0}{2}}$$

- Agar t_1 va t_2 berilgan bo'lsa, bu vaqt oralig'ida bo'lsa $\vartheta_{o'rt}$ quyidagicha topiladi:

$$\boxed{\vartheta_{o'rt} = \frac{\vartheta_1 + \vartheta_2}{2}}$$

- Butun yo'l davomidagi O'rtacha tezlik

$$\boxed{\vartheta_{o'rt} = \frac{\vartheta_0 + \vartheta_1 + \vartheta_2}{3}}$$

- Bu harakatda **yo'l** quyidagicha topiladi:

$$\boxed{S = \vartheta_{o'rt} \cdot t = \frac{\vartheta + \vartheta_0}{2} \cdot t}$$

• Agar vaqt yo'q bo'lsa yo'l quyidagicha topiladi.

$$t = \frac{v - v_0}{a} \Rightarrow \boxed{S = \frac{v + v_0}{2} \cdot \frac{v - v_0}{a} = \frac{v^2 - v_0^2}{2a}}$$

• Agar vaqt bo'lsa yo'l quyidagicha topiladi.

$$v = v_0 + at \Rightarrow \boxed{S = \frac{v_0 + at + v_0}{2} \cdot t = v_0 t + \frac{at^2}{2}}$$

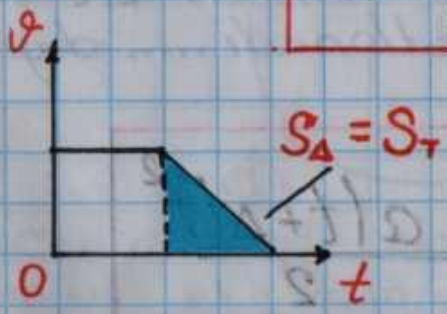
• Bu harakatda tormoz yo'li quyidagicha topiladi.

$$\boxed{S_T = \frac{v_0 t}{2}} \Rightarrow t_T = \frac{v}{a}$$

$$\boxed{S_T = \frac{v_0^2}{2a}}$$

$$a = \mu g$$

$$g = 10$$

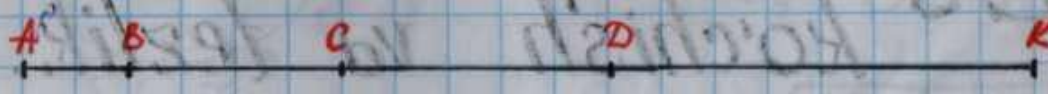


• Tog'ri chiziqli tekis tezlanuvchan harakat tenglamasi.

$$S_x = x - x_0$$

$$S_x = v_{ox} t + \frac{a_x t^2}{2}$$

$$\boxed{X = X_0 + v_{ox} \cdot t + \frac{a_x t^2}{2}}$$



$t_1 = 1$	$S_1 = \lvert AB \rvert$	1-(inchi)	$\Delta S_1 = \lvert AB \rvert$
$t_2 = 2$	$S_2 = \lvert AC \rvert$	2-(inchi)	$\Delta S_2 = \lvert BC \rvert$
$t_3 = 3$	$S_3 = \lvert AD \rvert$	3-(inchi)	$\Delta S_3 = \lvert CD \rvert$
$t_n = n$	$S_n = \lvert AK \rvert$	n-(inchi)	$\Delta S_n = \lvert DK \rvert$

$$S_n = v_0 t_n + \frac{a t_n^2}{2}$$

$$\Delta S_n = v_0 + \frac{a}{2}(2t_n - 1) \quad \text{(inchi)}$$

• Agar $v_0 = 0$ bölsa 2-formulada (inchi) toqlar jadvali dan foydalanib topish mumkin

$v_0 = 0$ Toqlar (inchi)

Vaqt	1	2	3	4	5	n
toq sonlar	1	3	5	7	9	2n-1
Yo'l	S_1	$3S_1$	$5S_1$	$7S_1$	$9S_1$	$S_1(2n-1)$

• Masalalarda 2 ta jism bir-biridan Δt vaqt intervali bilan harakatlanadi..... deyilsa, quyidagicha topiladi:

$$S_1 = v_0(t+\Delta t) + \frac{a(t+\Delta t)^2}{2}$$

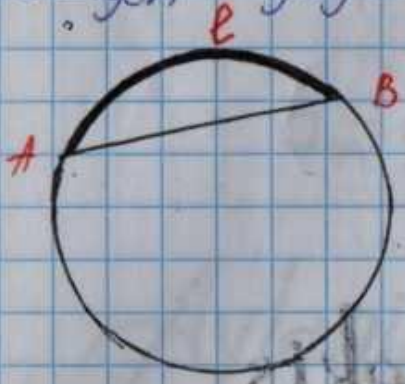
$$S_2 = v_0 t + \frac{a t^2}{2}$$

Egri chiziqli harakatda ko'chish va tezlik.

Jismning harakat trayektoriyasi aylanadan yoki aylana yoyidan iborat bölsa bunday harakatga aylana harakat deyiladi.

Aylanma harakatda chiziqli tezlik va burchak tezlik tushunchalari bor.

Chiziqli tezlik deb vaqt birligi ichida bosib o'tilgan yoy uzunligiga aytiladi.

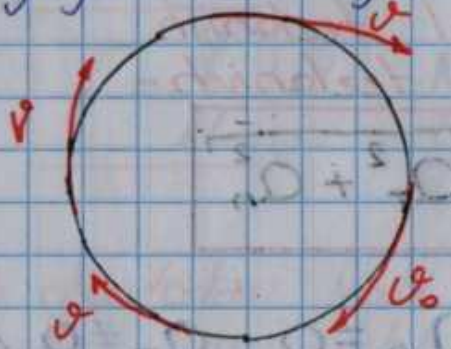


$$v = \frac{l}{t}$$

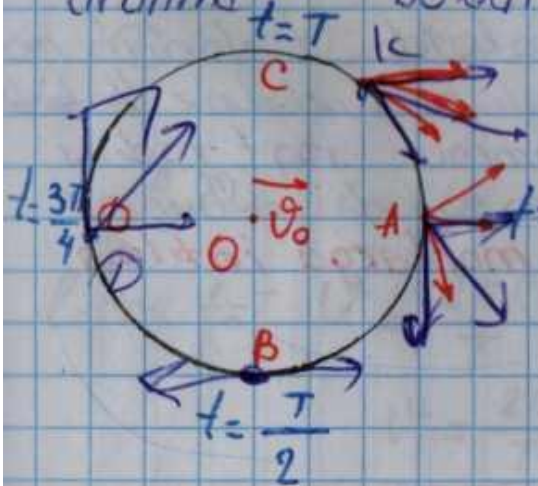
Birligi $[\frac{m}{s}]$.

$l = \overset{\smile}{AB}$

- Aylana bo'ylab tekis harakatda chiziqli tezlik moduli (qiymati) o'zgarmas bo'lib, yo'nalishi uzluksiz o'zgarib turadi va harakat vaqti trayektoriyaga o'tkazilgan urinma bo'ylab yo'nalgan.



- Egri chiziqli notekis harakatda chiziqli tezlik moduli va yo'nalishi uzluksiz o'zgarib turadi faqatgina oniy tezlik moduli o'zgarmaydi, yo'nalishi urinma bo'ladi.



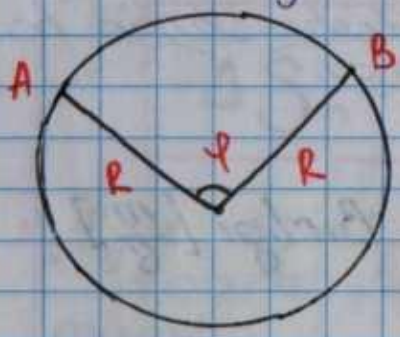
$$v_C = 2v_0$$

$$v_A = \sqrt{2} \cdot v_0 = v_D$$

$$v_B = 0$$

$$v_K = \sqrt{v_1^2 + v_2^2 + 2v^2 \cos\alpha}$$

• **Burchak tezlik** deb vaqt birligi ichida radius vektorining burulish burchagiga aytiladi. $[\omega]$



$$\omega = \frac{\varphi}{t}$$

$$\vartheta = \omega R$$

Aylana bo'ylab tekis harakatdagi tezlanishi.

Tezlanish 2 xil bo'ladi:

• a_T — tangensial tezlanish

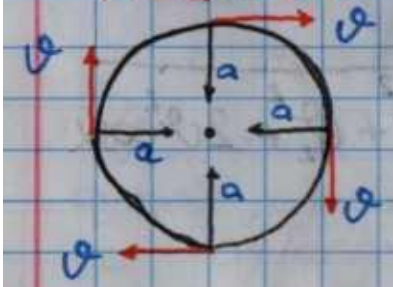
• a_n — normal tezlanish

$$a_{to'la} = \sqrt{a_T^2 + a_n^2}$$

1) ⟶ gor $\quad a_n = 0 \quad a_T \neq 0 \quad a_T = \frac{\vartheta - \vartheta_0}{t}$

2)  $\quad a_T = 0 \quad a_n \neq 0$

• Aylana bo'ylab tekis harakatda tezlanish moduli o'zgarmas bo'lib yo'nalishi uzluksiz ~~bo'ladi~~ o'zgarib turadigan va hamma vaqt radius bo'ylab markazga tomon yo'nalgan. Shuning uchun bu tezlanishga **markazga intilma tezlanish** deyiladi.



$\vec{\vartheta} \perp \vec{a}$

$\alpha = 90° = \frac{\pi}{2}$

a hamma nuqtada bir xil bo'ladi $= \frac{\vartheta^2}{R}$

$$a_n = \frac{\vartheta^2}{R}$$

markazga intilma tezlanish formulasi

$$a_n = \omega^2 \cdot R$$

$$a_n = \omega \cdot \vartheta$$

Burchak tezlik bilan ifodalangan formula

$a_n \Rightarrow a_{M.I.}$

Aylanish davri va chastotasi.

Aylanish davri yoki **davr** deb bir marta to'liq aylanish uchun ketgan vaqtga aytiladi.

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

N — aylanishlar soni
t — vaqt
T — davr.

Aylanish chastotasi yoki **chastotasi** deb vaqt birligi ichidagi aylanishlar soniga aytiladi.

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

ν — chastota $\left[\frac{dvl}{s}\right]\left[\frac{T}{s}\right][Hz]$

Davr $T = \frac{1}{\nu}$ chastota $\nu = \frac{1}{T}$

- Aylana bo'ylab harakatda chiziqli funksiya.

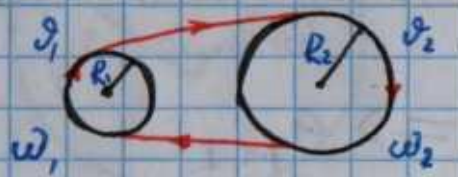
$l = 2\pi R$ $t = T$ $\vartheta = \frac{2\pi R}{T}$ $\vartheta = 2\pi R \cdot \nu$

$$\vartheta = \frac{2\pi R}{T} \cdot \cos\varphi$$

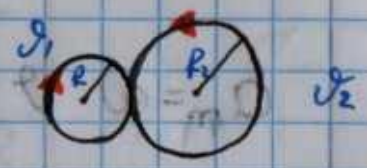
$\omega = \frac{2\pi}{T}$ $\omega = 2\pi\nu$

$$a = \frac{\vartheta^2}{R} = \frac{4\pi^2 R}{T^2} \qquad a = 4\pi^2 R \nu^2$$

- Endi ikkita yoki bir nechta o'qqa mahkamlangan aylanuvchi sistemalarning harakatini qaraymiz.



Zanjizli



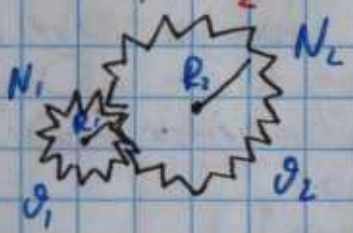
fritsion

$\vartheta_1 = \vartheta_2 \quad \omega_1 \neq \omega_2 \quad \vartheta = \omega R$

$\omega_1 R_1 = \omega_2 R_2 \quad \omega = \frac{\vartheta}{R} \quad \omega \sim \frac{1}{R}$

$R_1 < R_2$

$\omega_1 > \omega_2$



Tishli.

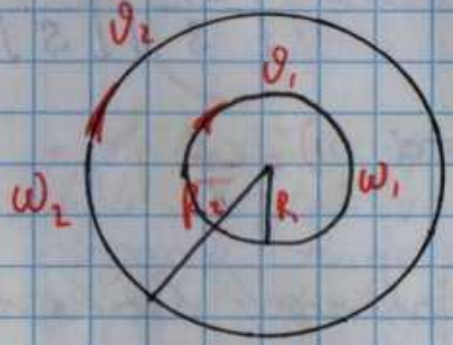
$\omega_1 N_1 = \omega_2 N_2$

$\vartheta_1 N_1 = \vartheta_2 N_2$

$R_1 < R_2$

$a_1 > a_2$

- Bitta o'qqa yoki umumiy o'qqa mahkamlangan aylanuvchi sistema



$\omega_1 = \omega_2 \quad \vartheta_1 \neq \vartheta_2$

$\vartheta = \omega R$

$R_1 < R_2 \quad \vartheta \sim R$

$\vartheta_1 < \vartheta_2 \quad a = \omega^2 R \quad a \sim R$

$R_1 < R_2 \quad a_1 < a_2$

Dinamika asoslari.

Nyutonning birinchi va ikkinchi qonunlari.

Galeleyning nisbiylik prinspi 2ta postulot (aksioma) ga asoslanadi:

1. Enersial sanoq sistemasi tinch yoki boro-latda ekanligini sistemaning ichida hech qon-day mexanik tajribalar biban aniqlab bolmay-di.

2. Barcha inersial sanoq sistemalarida harakat qonunlari bir xil.

Massa deb, jismning inertligini harakter-lovchi kattalikka aytiladi.

m – massa. [kg]

! Massasi katta jism inertroq hisoblanadi.

[Inertlik – jismning tinch holatini saqlashi]

! Inert massa va gravitatsion massa tengdir.

Platina va iridiy qotishmasidan tayyorlangan.

1960-yil. Serr shahrida saqlanadi Massa etaloni.

Hajm deb, jismning uchta o'lchamining ko'paytmasiga aytiladi.

$$V = a \cdot b \cdot h$$

$$V = S \cdot h$$

V – hajm $[m^3]$ birligi.

$1\ mm^3 = 10^{-9}\ m^3$
$1\ sm^3 = 10^{-6}\ m^3$
$1\ dm^3 = 10^{-3}\ m^3$
$1\ l = 10^{-3}\ m^3$
$1\ km^3 = 10^{6}\ m^3$

Zichlik deb, hajm birligidagi massaga aytiladi.

$$\rho = \frac{m}{V}$$

$$[\frac{kg}{m^3}] \qquad \rho\ \frac{g}{sm^3} = \rho \cdot 10^3\ \frac{kg}{m^3}.$$

Suyuqlik zichligi **aeriometr** bilan o'lchanadi.

Kuch – jismlarning o'zaro ta'sirini miqdor jihatidan hamda yo'nalish jihatidan harakterlovchi fizik kattalik.

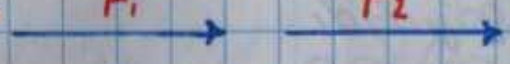
F – kuch $[N]$

- Kuch ta'sirida jism shaklini o'zgartiradi yoki tezlanish oladi. Ikkalasi bo'lishi ham mumkin

Kuch dinamometr bilan o'lchanadi.

Teng ta'sir etuvchi kuch yoki **Natijaviy kuch** deb jismga qo'yilgan kuchlarning geometrik yig'indisiga aytiladi.

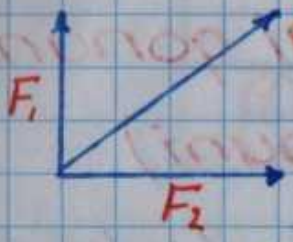
2 ta kuchning teng ta'sir etuvchisi quyidagi topiladi:

- 

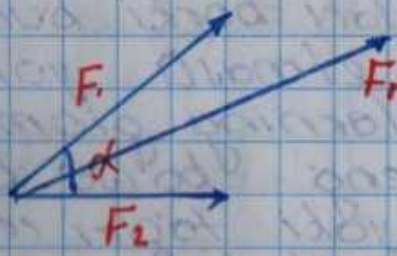
$$F_n = F_1 + F_2$$

- 

$$F_n = |F_1 - F_2|$$

- 

$$F_n = \sqrt{F_1 + F_2}$$

- 

$$F_n = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\alpha}$$

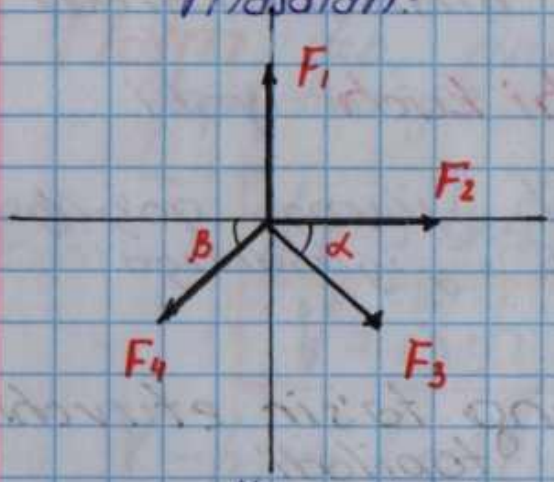
Bir necha (2dan ko'p) teng ta'sir etuvchisi quyidagicha topiladi.

$$F_n = \sqrt{F_x^2 + F_y^2}$$

$$F_x = F_{1x} + F_{2x} + F_{3x} + \dots F_{nx}$$

$$F_y = F_{1y} + F_{2y} + F_{3y} + \dots F_{ny}$$

Masalan:



$F_{1x} = 0$
$F_{2x} = F_2$
$F_{3x} = F_3 \cos\alpha$
$F_{4x} = -F_x \cos\beta$

$F_{1y} = F_1$
$F_{2y} = 0$
$F_{3y} = -F_3 \sin\alpha$
$F_{4y} = -F \sin\beta.$

Keyin F_x lar va F_y lar qo'shilib formulaga qo'yiladi.

! Jism tinch turganda teng ta'sir etuvchi kuch nolga tengdir.

Nyutonning birinchi qonuni (Energiya qonuni)

Shunday sanoq sistemalari borki bunda jismga kuch ta'sir etmasa yoki ta'sir etayotgan kuchlarning geometrik yig'indisi 0 ga teng bo'lsa bu jism tinch turadi yoki to'g'ri chiziqli tekis harakat qiladi.

$$\vec{F} = 0 \quad \sum \vec{F} = 0 \quad \vartheta = const$$

$$\sum_{i=1}^{n} \vec{F}_i = \vec{F}_1 + \vec{F}_2 + \dots + \vec{F}_n.$$

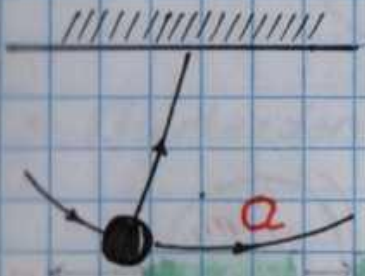
Nyutonning ikkinchi qonuni (O'zaro ta'sir qonuni)

Jismning oladigan tezlanishi kuchga to'g'ri proporsional, massaga teskari proporsional! Yoinda fizhi

kuch yo'nalishida bo'ladi:

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

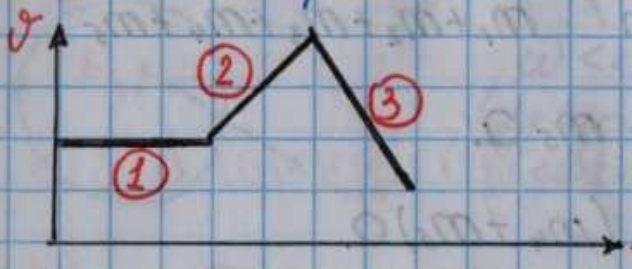
a ↑ F ↑



Aylanma harakatda **a** markazga intiladi

F ↑

- Tezlik grafigi berilgan bo'lsa quyidagilarni aniqlash mumkin



① $F_{to'rtishish} = F_{ishqalanish}$ $F=0$ $a=0$
to'g'ri chiziqli tekis h.

② $F_T > F_{ish}$ $F=const$ $a>0$
to'g'ri. ch. t. tezlanuvchan h.

③ $F_T < F_{ish}$ $F=const$ $a<0$
t. ch. t. sekinlanuvchan h.

- Jismlar o'zaro ta'sirlashsa kuchlar tenglashadi,

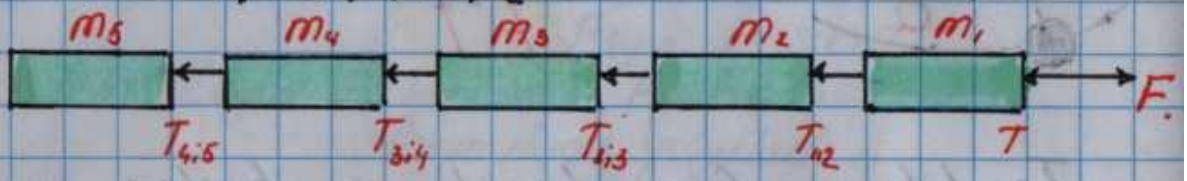
$$F_1 = F_2$$
$$m_1 a_1 = m_2 a_2$$
$$\frac{m_1 \vartheta_1}{t_1} = \frac{m_2 \vartheta_2}{t}$$

$$\boxed{m_1 \vartheta_1 = m_2 \vartheta_2}$$

$$a = \frac{F}{m_1 + m_2}$$

$$F_1 = m_1 a \qquad F_2 = m_2 a$$

$$F = F_1 + F_2$$



$$a = \frac{F}{\Sigma m} = \frac{F}{m_1 + m_2 + m_3 + m_4 + m_5}$$

$$T_{4;5} = m_5 a$$

$$T_{3;4} = (m_4 + m_5) a$$

$$T_{2;3} = (m_3 + m_4 + m_5) a$$

$$T_{1;2} = (m_2 + m_3 + m_4 + m_5) a$$

$$T = (m_1 + m_2 + m_3 + m_4 + m_5) a$$

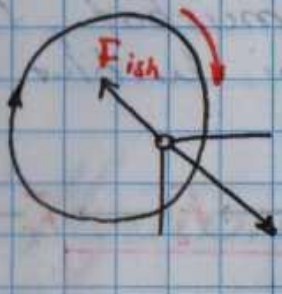
Agar jism aylana bo'ylab tekis aylansa markazga intilma kuch yuzaga keladi. Agar aylana bo'ylab tezlanish bilan harakat lansa markazdan qochma kuch yuzaga keladi

$$F_{m.i} = m \cdot a = \frac{m\vartheta^2}{R} = m\omega^2 R = m\omega\vartheta$$

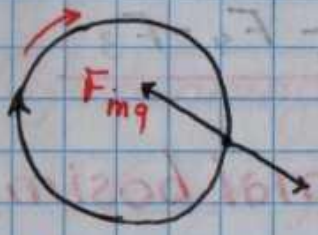
$$F_{m.q} = ma = \frac{m\vartheta^2}{R} = m\omega^2 R = m\omega\vartheta$$

- Markazga intilma kuch.

- Markazdan qochma kuch

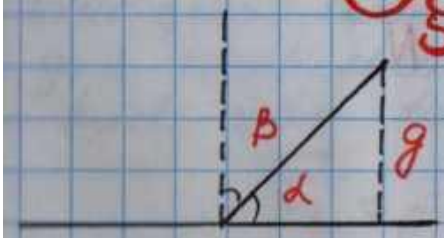


$\omega > 0$
(tezlanuvchan)
(tezlanish yo'nalishi bilan bir xil bo'ladi)



$\omega < 0$
(sekinlanuvchan).
(qarama-qarshi yo'nalishda bo'ladi).

Og'ish burchagi.



α — gorizontga og'ish burchagi.
β — vertikalga og'ish burchagi.

$$tg\alpha = \frac{g}{a}$$

$$tg\beta = \frac{a}{g}$$

$$a = \frac{\vartheta^2}{R}$$

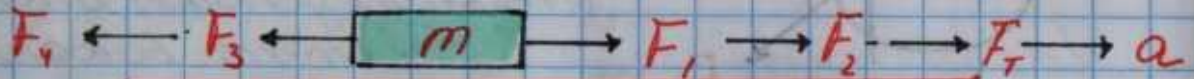
$$g = 10$$

Oltin qoidalar:

1-qoida. Agar jism tinch turgan bo'lsa jismga bir xil yo'nalishda ta'sir qiluvchi kuchlarning yig'indisi qarama-qarshi yo'nalishda ta'sir qiluvchi kuchlarning yig'indisiga tenglashtiriladi.
(Tekis ke lo yotgan bo'lsa)

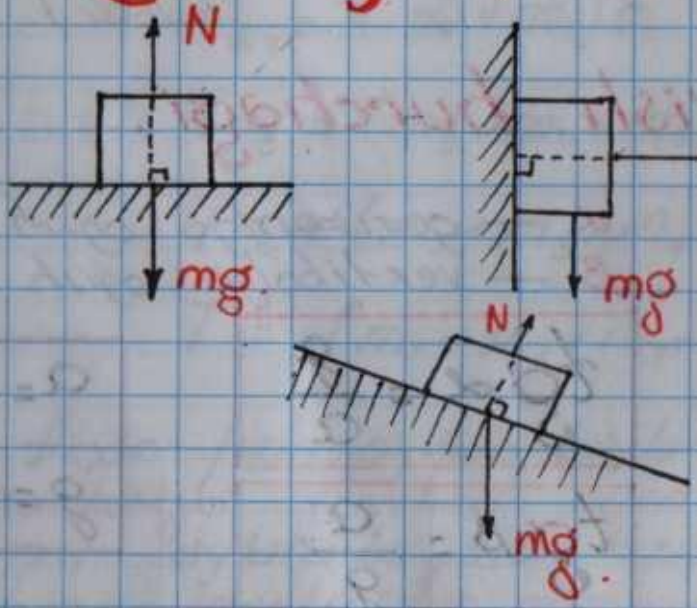
$$F_1 + F_3 + F_T = F_2 + F_4$$

2-qoida Agar jism (a) tezlanish bilan harakatlanayotgan bo'lsa (a) ga nisbatan tenglama tuzamiz. (a)ning yönalishidagi kuchlarni musbat, (a) ga qarama-qarshi yönalishdagi kuchlar manfiy bo'ladi.



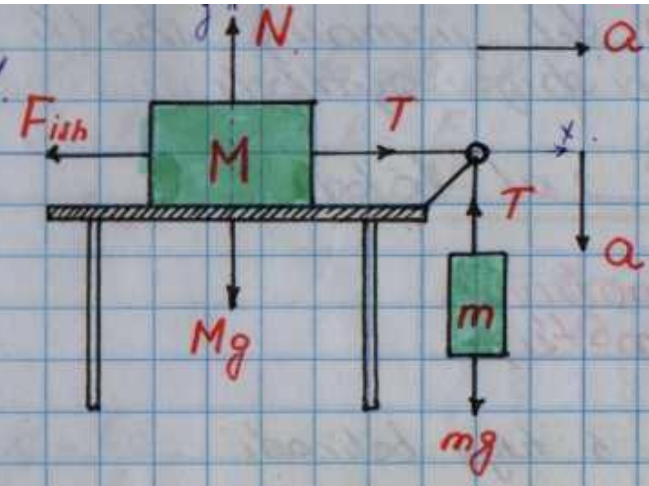
$$ma = F_1 + F_2 + F_T - F_4 - F_3$$

Reaksiya (normal bosim) kuchi.



mg – og'irlik kuchi.
N – reaksiya (normal bosim) kuchi.

Misol.



y: M uchun $N = Mg$

x: M uchun $Ma = T -$

y: m chun $ma = mg$

$$a = \frac{mg - F_{ish}}{M + m}$$

$F_{ish} = 0$ bolsa

$F_{ish} = \mu$

$$a = \frac{mg}{M + m}$$

$F_{ish} = M$

bolodi.

Nyutonning Uchinchi qonuni.

Nyutonning uchinchi qonuni (ta'sir yoki aks ta'sir qonuni)

Bir jism ikkinchi jismga qandaydir kuch bilan ta'sir qilsa, ikkinchi jism ham birinchi jismga xuddi shunday lekin qarama-qarshi kuch bilan ta'sir qiladi.

$$\vec{F_1} = -\vec{F_2}$$

- Ikki xil kuch tortishib tursa ($v = 0$, tinch) dinamometr kichkina kuchni ko'rsatadi.

  Agar kuchlar birxil bolsa bittasini ko'rsatadi.

- Sudrab ketsa, harakatda bolsa ayirmani ko'rsatadi. Kuchlar birxil bolsa 0 ni ko'rsatadi.

Elastiklik kuchi.

Jism diformatsiyalanganda yuzaga kelgan kuchga **elastiklik kuchi** deyiladi.

Diformatsiya deb jismning shakli yoki hajmining o'zgarishiga aytiladi.

Diformatsiya 2 xil bo'ladi

- Elastik diformatsiya
- Plastik diformatsiya.

Diformatsiya 5 turga bo'linadi

- Cho'zilish diformatsiyasi
- Siqilish diformatsiyasi
- Siljish diformatsiyasi
- Egilish diformatsiyasi
- Buralish diformatsiyasi

Elastiklik kuchi Guk qonuni bilan topiladi:

$$F_{el} = k \cdot \Delta l.$$

$$(F_{el})_x = -k \cdot \Delta l \quad (x \text{ o'qdagi proeksiyasi})$$

- (-) ishorasi elastiklik kuchi ta'sir etayotgan kuchga qarama-qarshi yo'nalishdaligi bildiradi.

k – bikirlik $\left[\frac{N}{m}\right]$.
Δl – absolyut uzayish $[m]$.

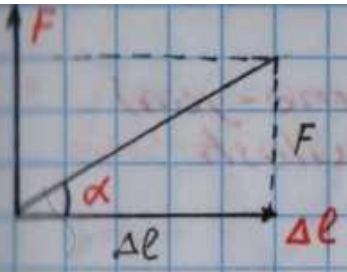
$$k = \frac{ES}{l_0}$$

E – yung moduli (elastiklik moduli) $[Pa]$.
S – yuza (ko'ndalang kesim yuzasi).

$$F_{el} = \frac{ES}{l_0} \cdot \Delta l$$

$$\Delta l = l - l_0$$

$$F_{el} = \frac{ES}{l_0} \cdot (l - l_0)$$



$$F = k \cdot \Delta l$$

$$k = \frac{F}{\Delta l} \qquad tg\alpha = \frac{F}{\Delta l}$$

$$\boxed{k = tg\alpha}$$

$$K = \frac{ES}{l_0}$$

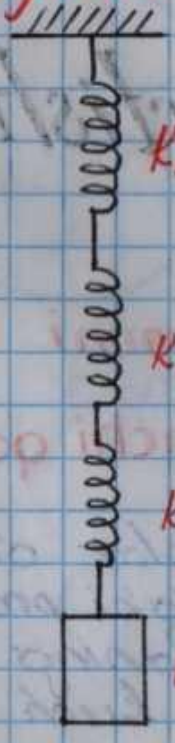
$$\boxed{K \sim S} \qquad \boxed{K \sim \frac{1}{l_0}}$$

• Agar purjinaning bikirligi k ga teng bolso purjina yarmining bikirligi 2 barobar kattaboladi

$$\boxed{\varepsilon = \frac{\Delta l}{l_0} \cdot 100\%}$$

ε – nisbiy uzayish (ebsolon).

Prujinalarni ketma-ket ulash.



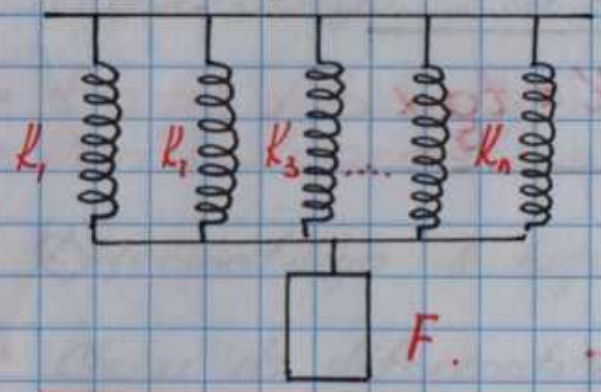
$$\boxed{\frac{1}{K_{k.k}} = \frac{1}{K_1} + \frac{1}{K_2} + \frac{1}{K_3} + \dots + \frac{1}{K_n}}$$

• Agar k lar teng bolsa unda quyidagicha boladi.

$$K_1 = K_2 = K_3 = \dots = K_n = K_0$$

$$\boxed{K_{k.k} = \frac{K_0}{n}}$$

Prujinalarni parallel (yonma-yon) ulash



$$K_{par} = K_1 + K_2 + K_3 + ... + K_n$$

- Agar k lar teng bo'lsa unda quyidagicha bo'ladi.

$$K_1 = K_2 = K_3 = ... = K_n = K_0$$

$$K_{par} = n \cdot k_0$$

- Parallel va Ketma-ket ulashda bog'lanish.

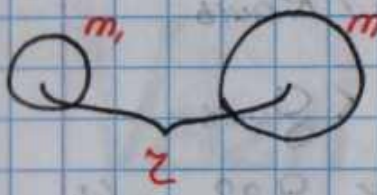
$$K_{par} = n^2 \cdot K_{k.k}$$

Butun olam tortishish kuchi.

Butun olam tortishish qonuni (Nyutonning tortinchi qonuni)

Massalari m_1 va m_2 bo'lgan jismlar o'zaro massalarining ko'paytmasiga to'g'ri proporsional ular orasidagi masofaning kvadratiga teskari proporsional kuch bilan tortishadi.

• Jismlar orasidagi tortishish kuchiga gravitatsiya kuchi deyiladi.



$$F_1 = F_2 = F_{gr} = G \cdot \frac{m_1 \cdot m_2}{r^2}$$

G, γ — gravitatsiya doimiysi. [Kavendish]

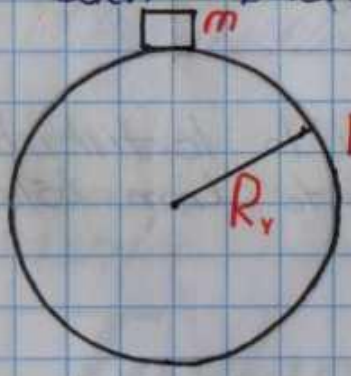
$$G = \gamma = 6{,}67 \cdot 10^{-11} \frac{N \cdot m^2}{kg^2}$$

Og'irlik kuchi.

Og'irlik kuchi — jismning yerga tortadigan kuchidir.

$$F = m \cdot g \qquad P = m \cdot g$$

• Yer sirtida turgan jismni yer quyidagi kuch bilan tortib turadi.



$M_y = 6{,}\cdot 10^{24}$ kg (yer massasi)
$R_y = 64 \cdot 10^5$ m (yer radiusi)

$$F_y = \gamma \cdot \frac{M_y \cdot m}{R_y^2}$$

$F = mg$ $\quad F = \gamma \cdot \frac{M_y \cdot m}{R_y^2}$

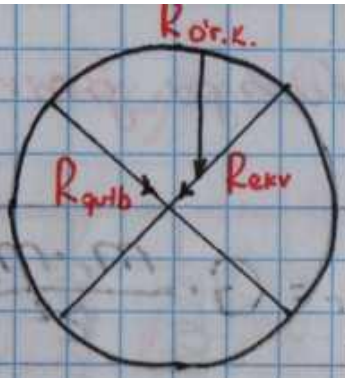
$$mg = \gamma \cdot \frac{M_y \cdot m}{R_y^2}$$

$g_y = 9{,}8$ m/s² yer uchun

$g_{oy} = 1{,}6$ m/s² oy uchun

$g_q = 270$ m/s² quyosh uchun.

Yer



$R_{ekv} = 6378\ km$
$R_{qutb} = 6356\ km.$

$$g \sim \frac{1}{R^2}$$

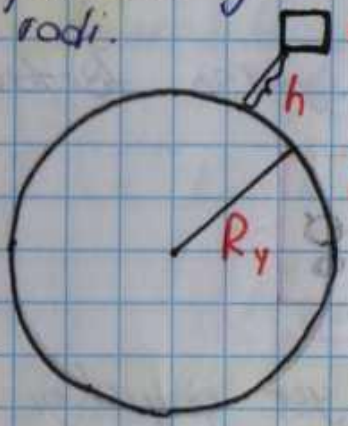
$R_{ekv} > R_{o'r.k} > R_{qutb}$

$g_{ekv} < g_{o'r.k} < g_{qutb}$

$9,78 < 9,8 < 9,82\ m/s^2$

$P_{ekv} < P_{o'r.k} < P_{qutb}$

- Agar jism yer sirtidan h balandlikda turgan jismni yer quyidagi kuch bilan tortib turadi.



$$F_h = \gamma \cdot \frac{M_y \cdot m}{(R_y + h)^2}$$

$$g_h = \gamma \cdot \frac{M_y}{(R_y + h)^2}$$

- Yer sirtidan qanday balandlikda tortishish kuchi yer sirtidagidan n marta kam bo'ladi.

$$\frac{F_h}{F_y} = \frac{1}{n}$$

$$F_h \cdot n = F_y$$

$$\gamma \cdot \frac{M_y \cdot m}{R_y^2} = n \cdot \gamma \cdot \frac{M_y \cdot m}{(R_y + h)^2}$$

$$(R_y + h)^2 = n \cdot R_y^2$$

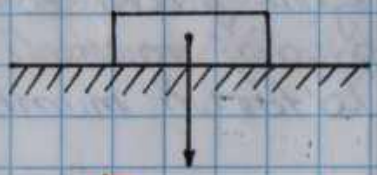
$$\sqrt{n} \cdot R_y = R_y + h$$

$$h = R_y \cdot (\sqrt{n} - 1)$$

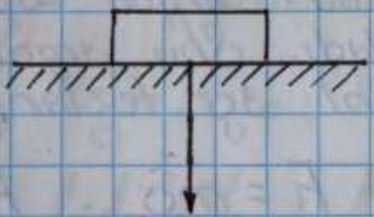
Vazn. Vaznsizlik.

Og'irlik kuchi ta'sirida jismning tayanchga yoki osmaga bo'lgan ta'sir kuchiga **vazn (og'irlik)** deyiladi.

- Og'irlik kuchi jismga tushadi. Og'irlik tayanchga yoki osmaga tushadi.



$F_{og} = mg$



$P = mg$

- Agar jism faqat og'irlik kuchi ta'sirida harakatlansa u **vaznsiz** bo'ladi. $(F=0)$
- Yer o'z o'qi atrofida 17-18 marta tezroq aylansa ekvatordagi nuqtalar vaznsiz harakatda bo'ladi.

Tezlanish bilan harakatlanayotgan jismning vazni.

- Agar jism pastga yoki yuqoriga tekis $(a=0)$ harakat qilsa uning og'irligi o'zgarmaydi va quyidagiga teng

$$F_o = mg$$

Bunda $a = 0$
$\vartheta = const$
tekis harakat

• Agar jism yuqoriga tezlanish bilan harakat qilsa umumiy og'irligi ortadi.

$$F_1 = m(g+a)$$

Botiq sirtda

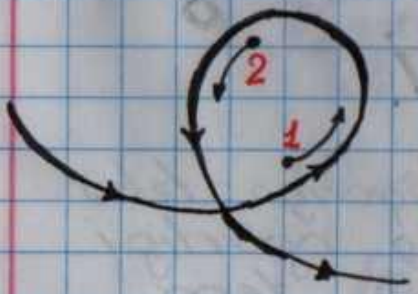
$$a = \frac{\vartheta^2}{R} \qquad F_1 = m\left(g + \frac{\vartheta^2}{R}\right)$$

Masala: Arqon ko'pi bilan 10 kg lik yukni ko'tara oladi. Shu arqon bilan qayday massali jismni 3g tezlanish bilan ko'tarish mumkin.

$$F = m_1 g \qquad F = m_2(g+a)$$
$$m_1 g = m_2(g+3g)$$
$$m_1 g = m_2 4g$$
$$m_2 = \frac{m_1}{4} = \frac{10}{4} = 2{,}5\,kg$$

• Jismning yuqoriga harakatdagi (tezlanish bilan) og'irligining, tinch holatdagi og'irligiga nisbatiga **yuklama** deyiladi.

$$\frac{F_1}{F_o} = n$$



O'lik sirtmoq, o'lim sirtmoqi

$$n_1 = \frac{m(g+a)}{mg} = \frac{g+a}{g}$$

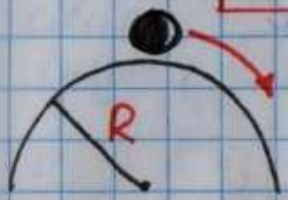
! Pastan tepaga

$$n_2 = \frac{a-g}{g} \quad (a > g)$$

! yuqori nuqta, tepadan pastga

• Agar jism pastdan tezlanish bilan harakat qilsa uning og'irligi kamayadi.

$$F_t = m(g-a)$$



qavariq sirtda (ko'prik)

$$a = \frac{v^2}{R} \qquad F_t = m\left(g - \frac{v^2}{R}\right)$$

• Jismning og'irligi yo'qoladigan harakatga **vaznsizlik** deyiladi. ($F=0$)

Jismning og'irlik kuchi ta'siridagi vertikal harakati.

• Agar jism yuqoriga tik (vertikal) otilsa, uning harakati to'g'ri chiziqli tekis sekinlanuvchan harakat qiladi.

$$h_t = v_0 t - \frac{gt^2}{2}$$

$$h_t = \frac{v^2 - v_0^2}{-2g}$$

$$h_{max} = \frac{v_0^2}{2g}$$

$$t_1 = \frac{v_0}{g}$$ Ko'tarilish vaqti.

$$v_1 = v - gt$$ Ko'tarilish tezligi.

- Agar jism pastga otilsa, harakat to'g'ri chiziqli tekis tezlanuvchan bo'ladi.

$$h_1 = v_0 t + \frac{gt^2}{2}$$

$$h_1 = \frac{v^2 - v_0^2}{2g}$$

$$v_1 = v_0 + gt$$ Tushish tezligi

$$t_1 = \sqrt{\frac{2h_{max}}{g}}$$ Tushish vaqti

- Hamma vaqt ko'tarilish va tushish vaqti teng bo'ladi.

$$t_1 = t_1$$

$$t = t_1 + t_1 = 2t_1 = 2t_1$$

$$t_1 = \frac{t}{2}$$

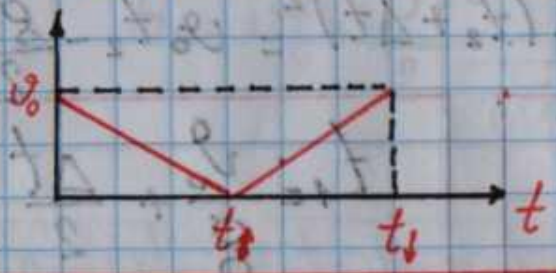
$$h_{max} = \frac{gt_1^2}{2}$$

$$h_{max} = \frac{gt^2}{8}$$ - Umumiy (ko'tarilish va tushish uchun)

$v_2 = gt_2 - v_0$

$v_1 = v_0 - gt_1$

• Jism qanday tezlik bilan yuqoriga otilsa, xuddi shunday tezlik bilan qaytib tushadi.



$$\Delta h_t = v_0 + \frac{g}{2}(2t-1)$$

Inchi:: $v_0 = 0$, erkin tushish, bosh.tezliksiz

$$\Delta h_t = \frac{g}{2}(2t-1) = 5(2t-1)$$

$$\Delta h_t = v_0 - \frac{g}{2}(2t-1)$$

Masala. Jism 180 m balandlikdan erkin tushyapti, oxirgi sekundda necha metr yo'l bosadi.

$h = v_0 t + \frac{gt^2}{2}$ $\quad h = 5 \cdot (12-1) = 55$ m.

$v_0 = 0$

$h = \frac{gt^2}{2}$

$180 = \frac{10 \cdot t^2}{2}$

$t = 6$.

• Agar ikkita jism biror vaqt intervali bilan yuqoriga tik otilsa ularning uchrashish vaqtlari quyidagicha topiladi:

$$h_1 = v_0 t_1 - \frac{g t_1^2}{2}$$

$$h_2 = v_0 t_2 - \frac{g t_2^2}{2}$$

$$h_1 = h_2 \qquad t_1 = t_2 + \Delta t$$

$$v_0(t_2+\Delta t) - \frac{g}{2}(t_2+\Delta t)^2 = v_0 t_2 - \frac{g t_2^2}{2}$$

$$\boxed{t_2 = \frac{v_0}{g} - \frac{\Delta t}{2}} \qquad \boxed{t_1 = \frac{v_0}{g} + \frac{\Delta t}{2}}$$

Masala: 2 sekund vaqt intervali 2 tomchi uzuldi. ikkinchisi uzulganidan qancha vaqt o'tgach ular orasidagi masofa 45 m bo'ladi.

$$h_1 = h_2 + 45$$

$$h_1 = \frac{g t_1^2}{2} \qquad h_2 = \frac{g t_2^2}{2} \qquad t_1 = t_2 + \Delta t$$

$$\Delta t = 2$$

$$\Delta h = h_1 - h_2 \qquad \Delta h = 45.$$

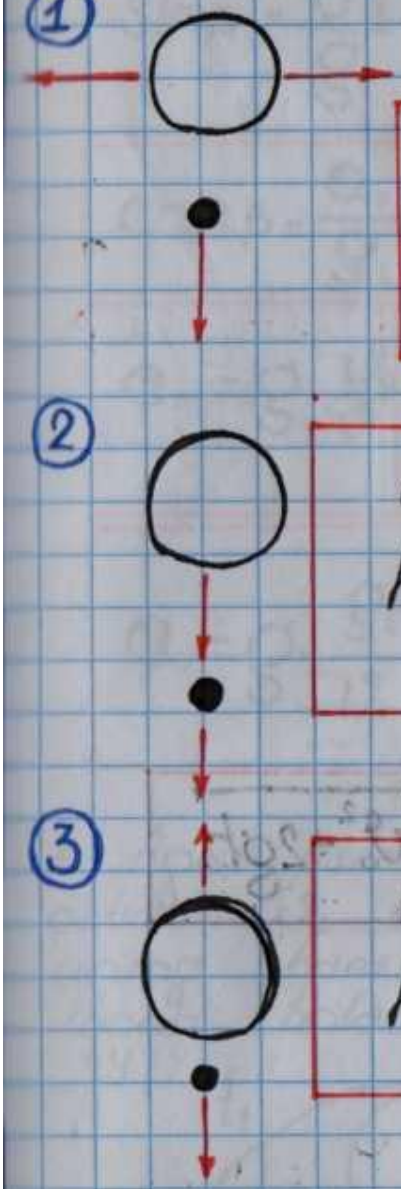
$$\Delta h = \frac{g}{2}(t_2+\Delta t)^2 - \frac{g t_2^2}{2}$$

$$45 = 5(t_2+2)^2 - 5t^2$$

$$9 = (t_2+2)^2 - t_2^2$$

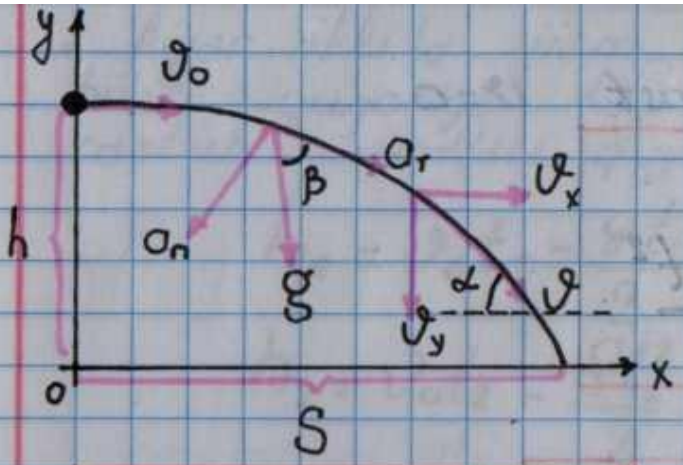
$$t_2 = 1{,}25$$

$$t_1 = \Delta t + t_2 = 2 + 1{,}25 = 3{,}25.$$



Jismning og'irlik kuchi ta'sirida harakati: boshlang'ich tezlik gorizontga qiya yo'nalgan

• Agar jism biror h balandlikdan v_0 boshlang'ich tezlik bilan gorizontal otilsa bu jismning harakat trayektoriyasi parabolodan iborat bo'ladi.



$$\vartheta_x = \vartheta_0 = const$$

$$\vartheta_y = gt = \sqrt{2gh}$$

$$\vartheta = \sqrt{\vartheta_x^2 + \vartheta_y^2} = \sqrt{\vartheta_0^2 + (gt)^2} = \sqrt{\vartheta_0^2 + 2gh}$$

$$t = \sqrt{\frac{2h}{g}}$$

$$h = \frac{gt^2}{2} \qquad h = \frac{\vartheta_y^2}{2g}$$

$$S = \vartheta_x t = \vartheta_0 \sqrt{\frac{2h}{g}}$$

$$\sin\alpha = \frac{\vartheta_y}{\vartheta} = \frac{gt}{\vartheta}$$

$$\cos\alpha = \frac{\vartheta_0}{\vartheta}$$

$$tg\alpha = \frac{\vartheta_y}{\vartheta_x} = \frac{gt}{\vartheta_0}$$

$$g = \sqrt{a_\tau^2 + a_n^2}$$

$$\sin\beta = \frac{a_n}{g} \qquad a_n = g\sin\beta$$

$$\cos\beta = \frac{a_\tau}{g} \qquad a_\tau = g\cos\beta$$

$$a_n = g\cdot\frac{v_0}{v} = \frac{gv_0}{\sqrt{v_0^2+(gt)^2}}$$

$$a_\tau = g\cdot\frac{gt}{v} = \frac{g^2t}{v} = \frac{g^2t}{\sqrt{v_0^2+(gt)^2}}$$

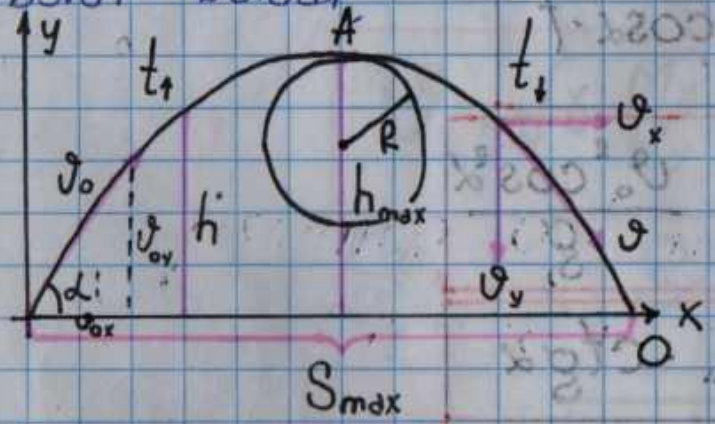
$\alpha + \beta = 90°$

$\beta = 90 - \alpha$

$a_n = g\sin(90-\alpha) = g\cos\alpha$

$a_\tau = g\cos(90-\alpha) = g\sin\alpha$

• Agar jism gorizontga nisbatan α burchak ostida v_0 boshlang'ich tezlik bilan otilsa, uning harakat trayektoriyasi paraboladan iborat boladi.



$$v_{ox} = v_0\cos\alpha$$

$$v_{oy} = v_0\sin\alpha$$

$$v_x = v_{min} = v_{ox} = v_0\cos\alpha$$

$$v_y = v_{oy} - gt = v_0\sin\alpha - gt$$

$$v = \sqrt{v_x^2 + v_y^2}$$

$$t_1 = \frac{v_0 \sin\alpha}{g} \qquad t_1 = \sqrt{\frac{2h_m}{g}}$$

$$t_1 = t_1 \qquad t_{um} = 2t_1 = 2t_1$$

$$h_{max} = \frac{v_0^2 \sin^2\alpha}{2g} \qquad h_m = \frac{gt_1^2}{2} \qquad h_m = \frac{gt_{um}^2}{8}$$

$$h = v_0 t \sin\alpha - \frac{gt^2}{2}$$

$$S_{max} = v_x \cdot t_{um} = v_0 \cos\alpha \cdot \frac{2v_0 \sin\alpha}{g}$$

$$S_{max} = \frac{v_0^2 \sin 2\alpha}{g}$$

$$S = v_x \cdot t = v_x \cos\alpha \cdot t$$

$$R_A = \frac{2h_{max}}{tg^2\alpha} = \frac{v_0^2 \cos^2\alpha}{g}$$

$$S_{max} = 4h_{max} \cdot ctg\alpha$$

- 45° burchak ostida otilgan jism eng uzoq joyga borib tushadi
- Bu harakatda jismning to'liq mexanik energiyasi havoning qarshiligi hisobga olinmasa trayektoriyaning barcha nuqtalarida bir xil bo'ladi.
  Agar havoning qarshiligi hisobga olinsa otilish nuqtasida eng katta, tushish nuqtasida eng kichik bo'ladi.

Yerning sun'iy yo'ldoshlari. Birinchi kosmik tezlik.

Yerning tortishish kuchini yenga oladigan tezlikka **birinchi kosmik tezlik** deyiladi.

$$F = \gamma \cdot \frac{M_y m}{R_y^2} = F = ma$$

$$ma = \gamma \cdot \frac{M_y \cdot m}{R_y^2}$$

$$a = \gamma \cdot \frac{M_y}{R_y^2} \qquad a = \frac{\vartheta^2}{R_y}$$

$$\frac{\vartheta^2}{R_y} = \gamma \cdot \frac{M_y}{R_y^2}$$

$$\boxed{\vartheta_I = \sqrt{\gamma \cdot \frac{M_y}{R_y}}}$$

$$g_y = \gamma \cdot \frac{M_y}{R_y^2} \qquad g_y R_y = \gamma \cdot \frac{M_y}{R_y}$$

$$\boxed{\vartheta_I = \sqrt{g_y R_y}} \qquad \vartheta_I = 7900\ ^m/_s \approx 8\ ^{km}/_s$$

$$\boxed{\vartheta_{II} = \sqrt{2} \cdot \vartheta_I}$$ Ikkinchi kosmik tezlik

$\vartheta_{II} = 11{,}2\ ^{km}/_s$ Ikkinchi

$\vartheta_{III} = 16{,}6\ ^{km}/_s$ Uchinchi } Kosmik tezliklar.

• Biror h balandlikdan uchirilgan raketa birinchi kosmik tezligi quyidagicha topiladi.

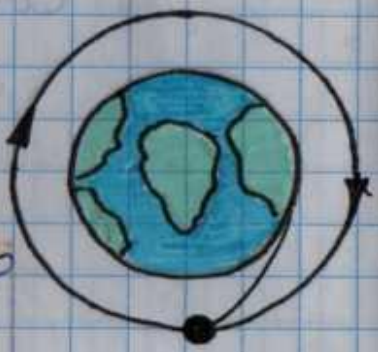
$$\vartheta_{1h} = \sqrt{\gamma \cdot \frac{M_y}{R_y + h}} = \sqrt{g_y \cdot (R_y + h)}$$

Holatlar:

• $\vartheta < \vartheta_1$

Jismning tezligi birinchi kosmik tezlikdan < bo'lsa, jism ellips yoyi bo'ylab, harakatlanib yerga qaytib tushadi.

• $\vartheta = \vartheta_1$



Jismning tezligi birinchi kosmik tezlikka teng bo'lsa, jism yerga nisbatan aylana bo'ylab harakat qilib, yerning suniy yo'ldoshiga aylandi.

• $\vartheta_1 < \vartheta < \vartheta_{II}$

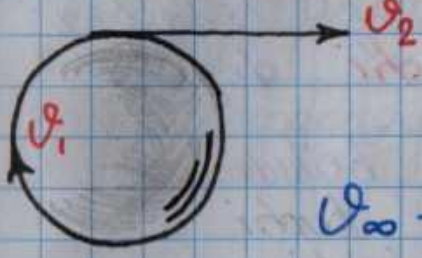
Jismning tezligi birinchi kosmik tezlikdan katta va ikkinchi kosmik tezlikdan kichik bo'lsa, ellips bo'ylab harakat qiladi, suniy yo'ldoshga aylandi.

• $\vartheta = \vartheta_{II}$

Jismning tezligi ikkinchi kosmik tezlikka teng bo'lsa, yerga nisbatan parabola bo'ylab harakatlanib quyoshning suniy yeldoshiga aylandi.

• $\vartheta = \vartheta_{III}$

Jismning tezligi 3-kosmik tezlikka teng bo'lsa, yerga nisbatan giperbola bo'ylab harakatlanib, galaktikaning sun'iy yo'ldoshiga aylanadi.



Raketa va Planeta tezliklari bir xil yonalishda.

ϑ_∞ - ? $\quad \frac{m\vartheta_\infty^2}{2} = \frac{m\vartheta_2^2}{2} - \frac{m\vartheta_1^2}{2}$

$$\vartheta_\infty^2 = \vartheta_2^2 - \vartheta_1^2$$

Kepler qonuni.

Kepler qonuni — Planetaning aylanish davri kvadratlarining nisbati, katta yarim o'qlari kublarining nisbatiga to'g'ri proporsional.

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

T — davr
R — radius.

• M=const, bo'lsa

$$\vartheta_1 \sim \frac{1}{\sqrt{R}}$$

• p=const, bo'lsa

$$\vartheta_1 \sim R$$

$$T^2 \sim R^3$$

$$\begin{cases} T \sim \sqrt[2]{R^3} \\ R \sim \sqrt[3]{R^2} \end{cases}$$

Isboti:

$$\vartheta_1 = \sqrt{\gamma \frac{M}{R}}$$

$$\vartheta = \frac{2\pi R}{T}$$

$$\gamma \cdot \frac{M}{R} = \frac{4\pi^2 R^2}{T^2}$$

$$T^2 = \frac{4\pi^2 R^3}{\gamma \cdot M}$$

$$T^2 \sim R^3.$$

Ishqalanish kuchi. Tinchlikdagi ishqalanish.

Sirtlarning notekisligi va molekulalarning tortishishi natijasida yuzaga keladigan kuchga **ishqalanish kuchi** deyiladi.

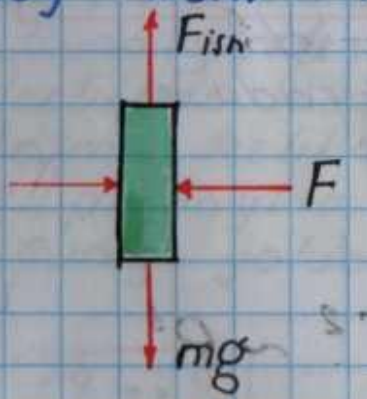
Ishqalanish kuchi 3 xil bo'ladi:

- Tinchlikdagi ishqalanish kuchi
- Sirpanish ishqalanish kuchi
- Dumalanish ishqalanish kuchi

Tinchlikdagi ishqalanish kuchi ta'sir etayotgan kuchning sirtdagi proeksiyasiga teng

- Tinch turgan jismga **tik (perpendikular)** ravishda kuch ta'sir etsa **ishqalanish kuchi** **nolga (0)** teng bo'ladi

- Jism gorizontal sirtda tinch turganda normal bosim kuchi ortsa ham, kamaysa ham ishqalanish kuchi o'zgarmaydi.

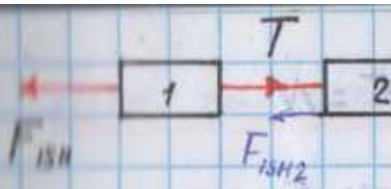


iskanjada ushlab turibdi (bunda F ta'sir etayotgan kuchning aloqasi bo'lmaydi)

$$F_{ish} = mg$$

- Agar jism aylana harakat qilsa ishqalanish kuchi quyidagiga teng

$$F_{ish} = ma = m\omega^2 R \qquad F_{ish} \sim \omega^2$$



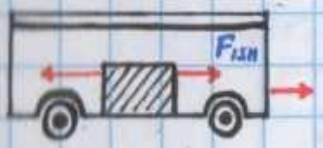
$$F_{ISH} = T + F$$

agar $F_{ISH2} > F$ bo'lsa
$T = 0$.

Sirpanish ishqalanish kuchi.

Jism sirpanganda yuzaga keladigan kuchga sirpanish ishqalanish kuchi

- Bu kuch doimo jismning harakatiga qarama-qarshi yo'nalgan bo'ladi.



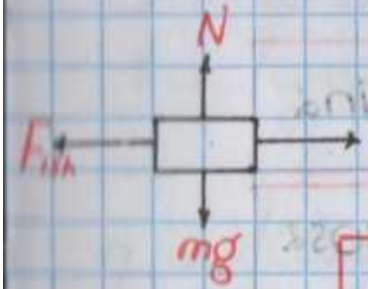
- Vagon strelka yo'nalishida harakatlanmoqda. Vagon ichida yuk turibdi. Bu yukning ishqalanish kuchi ham strelka yo'nalishida bo'ladi. Chunki vagon oldinga yursa ichidagi yuk ortga harakatlanadi ishqalanish kuchi esa unga qarama-qarshi yo'nalishda bo'ladi. Shunda strelka yo'nalishida bo'ladi.

$$F_{ISH} = \mu \cdot N$$

N – normal bosim kuchi (reaksiya kuchi)
μ – ishqalanish koeffitsiyenti ($\mu < 1$ bo'ladi)

- Ishqalanish kuchi yuzaga bog'liq emas.

$$F_{ISH} \not\sim S$$



$\vartheta = const$ $\quad a = 0$

$F_{ISH} = F_T$ $\quad N = mg$

$$F_{ISH} = \mu \cdot mg \qquad F_T = F_{ISH} = \mu \cdot mg$$

$F_{ISH} = \mu mg$ $\quad F = N$

$F_{ish} = \mu N = \mu \cdot F$

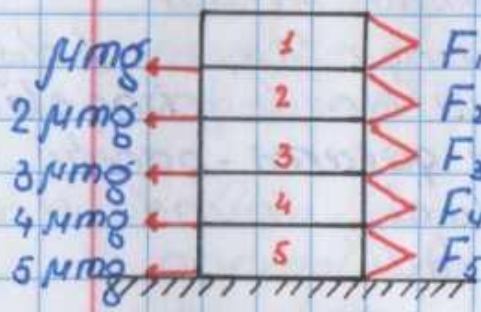
$\mu F = mg$

$F = Kx$ (prujina)

$$\mu Kx = mg$$

- Tormoz kuchining ogirlik kuchiga nisbat ishqalanish koeffitsiyentiga teng

$$\frac{F_{TOR}}{F_{og'}} = \mu$$



$F_1 = \mu mg$

$F_2 = 3\mu mg$

$F_3 = 5\mu mg$

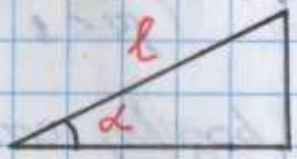
$F_4 = 7\mu mg$

$F_5 = 9\mu mg$

- Gishtlar orasidan sug'urib olishda (qolganlarni qimirlatmaydigan) kerak kuch.

Qiya tekislik

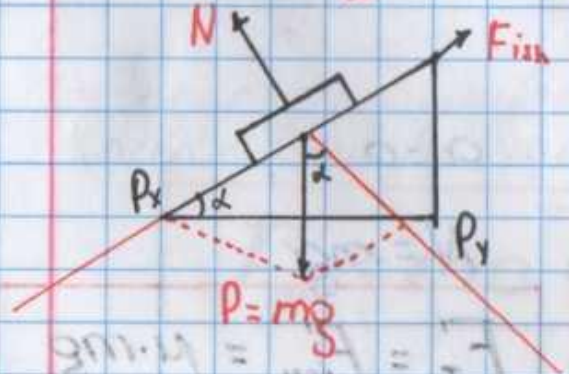
- Qiya tekislikda qiyalig' deganda $\sin\alpha$ tushuniladi



a

$$\sin\alpha = \frac{h}{\ell}$$

α – qiyalik burchagi



$$P_x = mg\sin\alpha$$

$$P_y = mg\cos\alpha$$

Tinch holatda: $F_{ish} = P_x$

$N = P_y$

$$F_{ish} = P_x = mg \cdot \sin\alpha$$

Harakatda: $F = \mu N$

$N = P_y = mg\cos\alpha$

$$F_{ish} = \mu mg\cos\alpha$$

$F_{ish_1} = F_{ish_2}$ (tenglashtirilsa)

$mg\sin\alpha = \mu mg\cos\alpha$

$$\mu = \frac{\sin\alpha}{\cos\alpha} = tg\alpha$$

- Agar $\mu = tg\alpha$ bo'lsa, jism qiya tekislikda tinch bo'lsa, tinch turadi; harakatlanayotgan bo'lsa to'g'ri chiziqli tekis harakat qiladi.
$a = 0 \quad \vartheta = const$

- Agar $\mu > tg\alpha$ bo'lsa, tinch turgan bo'lsa tinch turadi, harakatlanayotgan bo'lsa to'g'ri chiziqli tekis sekinlanuvchan harakat qiladi.
$a < 0$

- Agar $\mu < tg\alpha$ bo'lsa, tinch to'g'ri chiziqli tekis tezlanuvchan harakat qiladi.
$a > 0$

Qiya tekislikning foydali ish koeffitsiyenti.

$$\eta = \frac{\sin\alpha}{\sin\alpha + \mu\cos\alpha}$$

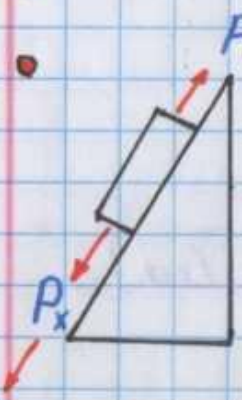
$$\eta = \frac{\sin\alpha}{\sin\alpha + \mu\cos\alpha} = \frac{tg\alpha}{tg\alpha + \mu} = \frac{1}{1 + \mu ctg\alpha}$$

Holatlar:

$$F + F_{ish} = P_x$$

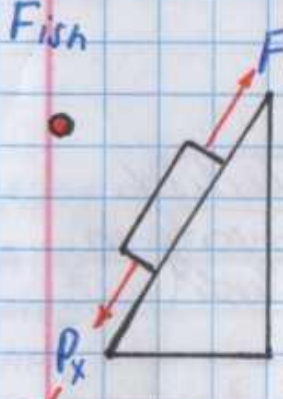
tinch turganda.

F – ushlab turgan kuch



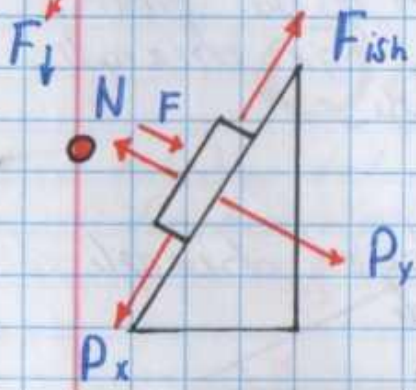
$$F_2 = P_x + F_{ish}$$

yuqoriga tortilsa



$$F_{\downarrow} \pm P_x = F_{ish}.$$

Pastga tortilsa.



$$N = F + P_y$$

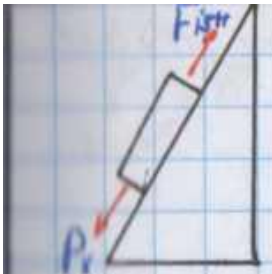
tik bosib turilsa

$$F_{ish} = P_x$$

$$\mu \cdot N = P_x$$

$$\mu \cdot (F + P_y) = P_x$$

$$F = \frac{P_x}{\mu} - P_y = \frac{mg\sin\alpha}{\mu} - mg\cos\alpha$$



$$ma_{\downarrow} = P_x - F_{ISH}$$

$$a_{\downarrow} = g(\sin\alpha - \mu\cos\alpha)$$

Pastga va yuqoriga tezlanish b-n tortilsa

$$a_{\uparrow} = g(\sin\alpha + \mu\cos\alpha)$$

$$ma = F - (P_x + F_{ISH})$$

tezlanish bilan biror kuch b-n yuqoriga tortilsa.

$$ma = P_x + F - F_{ISH}$$

tezlanish bilan biror kuch b-n pastga tortilsa.

Ishqalanish kuchi ta'siridagi harakat

- Jismga ishqalanish kuchi ta'sir qilsa u to'g'ri chiziqli tekis sekinlanuvchan harakat qiladi.

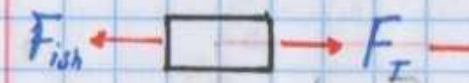
$$F_{ISH} = ma = \frac{m\vartheta_0^2}{2S_T}$$

$$S_T = \frac{\vartheta_0^2}{2a} = \frac{\vartheta_0^2}{2\mu g}$$ tormoz yo'li

$$t_T = \frac{\vartheta_0}{a} = \frac{\vartheta_0}{\mu g}$$ tormoz vaqti

• Tortishish kuchi = og'irlik kuchiga nisbati qarshilik koeffitsiyentiga teng

$$\frac{F_T}{F_{og'}} = K$$

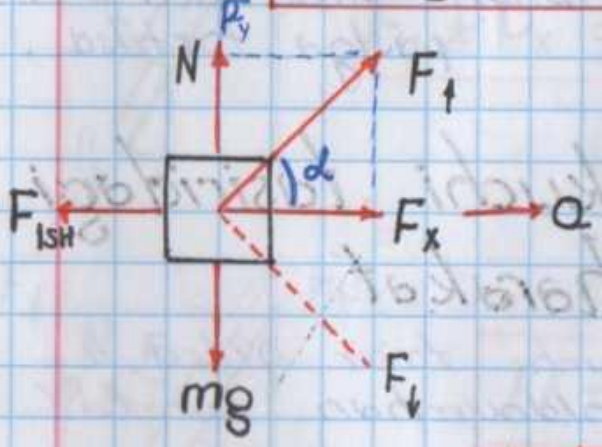


$$ma = F_T - F_{ish}$$

$$ma = F_T - \mu mg \quad (:mg)$$

$$\frac{a}{g} = \frac{F_T}{mg} - \mu$$

$$a = g(K - \mu)$$



$a = 0$
$\vartheta = const$

$F_x = F\cos\alpha$

$N + F_y = mg$

$N = mg - F_y = mg - F\sin\alpha$

$$F_\uparrow = \mu(mg - F\sin\alpha)$$

tezlanishsiz

$$F_\downarrow = \mu(mg + F\sin\alpha)$$

Tezlanish bilan: Tepaga

$$ma = F\cos\alpha - \mu(mg - F\sin\alpha)$$

Pastga

$$ma = F\cos\alpha - \mu(mg + F\sin\alpha)$$

Bir necha kuch ta'siridagi harakat

- Agar jism yuqoriga yoki pastga tekis harakat qilsa $a=0$, havoning qarshilik kuchi esa

$$F_{qar} = mg$$

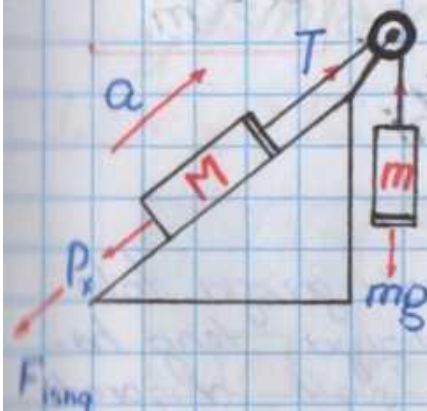
ga teng. Tezligi esa $\vartheta = \frac{h}{t}$ formula bilan aniqlanadi.

- Jism tepaga tezlanish bilan otilsa, qarshilik kuchi:

$$F_1 = m(a-g)$$

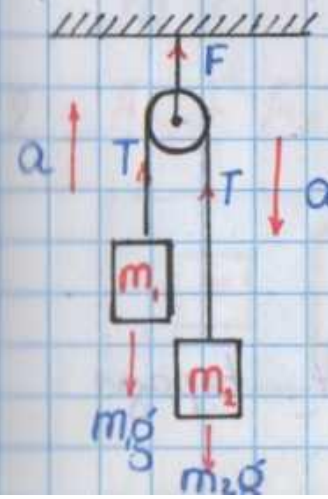
- Jism pastga tezlanish bilan otilsa, qarshilik kuchi:

$$F_1 = m(g-a)$$



$$\begin{cases} ma = mg - T \\ Ma = T - P_x - F_{ish} \end{cases}$$

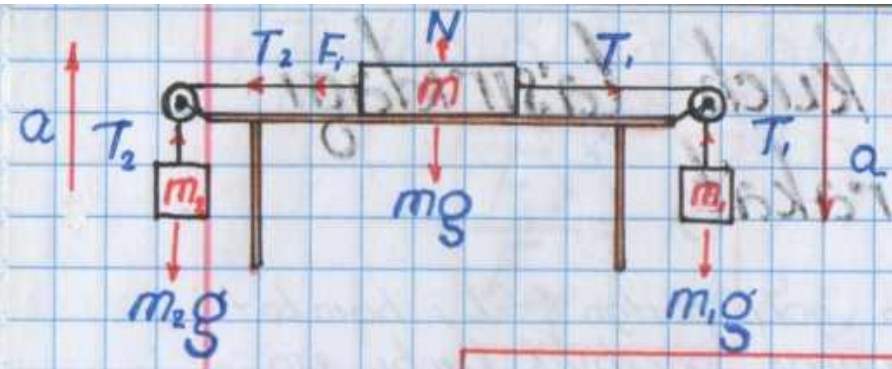
$$a = \frac{mg - P_x - F_{ish}}{m+M}$$



$$\begin{cases} m_1a = T - m_1g \\ m_2a = m_2g - T \end{cases}$$

$$a = \frac{m_2 - m_1}{m_2 + m_1} \cdot g \qquad T = \frac{2m_1m_2}{m_1+m} \cdot g$$

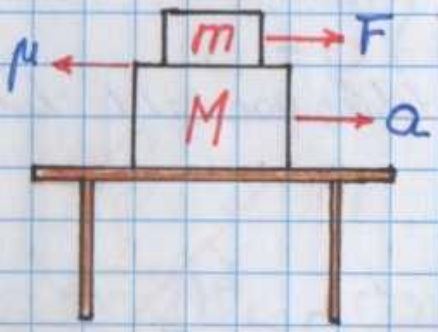
$$F = 2T \qquad \text{doimo} \quad a < g$$



$$\begin{cases} m_1a = m_1g - T \\ m_2a = T_2 - m_2g \\ ma = T_1 - T_2 - F_{ish} \end{cases}$$

$$a = \frac{m_1g - m_2g - F_{ish}}{m_1 + m_2 + m}$$

Masala: Mutlaq silliq stol ustida M massali jism turibdi. Shu jism ustida m massali taxtacha yotibdi. Ular orasidagi ishqalanish koeffitsiyenti μ ga teng. Agar taxtachaga F kuch ta'sir etsa M massali jism qanday tezlanish oladi.



$F_{ishq} = \mu mg$

agar $F_{ish} \geq F$ $\quad a = \frac{F}{M+m}$

agar $F_{ish} \leq F$ $\quad a = \frac{F_{ish}}{M}$

Arximed kuchi

Arximed kuchi — suyuqlik yoki gazga to'la botirilgan jism oziningo og'irligiga teng hajmli suyuqlik yoki gazni siqib chiqaradi.

$$F_A = \rho_s \cdot g \cdot V_b$$

ρ_s — suyuqlik zichligi.
V_b — botirilgan jism hajmi.

- Arximed kuchi hamma vaqt tepaga

$F_s = mg - F_A$ jismning suyuqlikdagi og'irligi

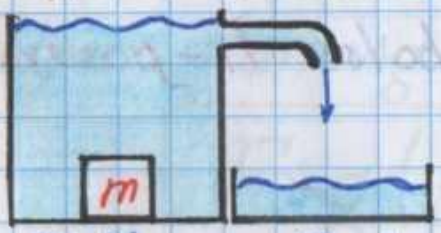
$m = \rho V$ massa

- $\rho_{suv} = 1000\ Kg/m^3$ $\rho_{vodorod} = 0,09\ Kg/m^3$
- $\rho_{muz} = 900\ Kg/m^3$ $\rho_{havo} = 1,3\ Kg/m^3$
- $\rho_{kerosin} = 800\ Kg/m^3$ $\rho_{granit} = 2700\ Kg/m^3$
- $\rho_{simob} = 136000\ Kg/m^3$. $\rho_{temir} = 7800\ Kg/m^3$
- $\rho_{qo'rg'oshin} = 11300\ kg/m^3$
- $\rho_{alyuminiy} = 2700\ Kg/m^3$

$F_{K.K} = F_A - mg$ Ko'tarilish kuchi.

Jismlarning Suzish Shartlari.

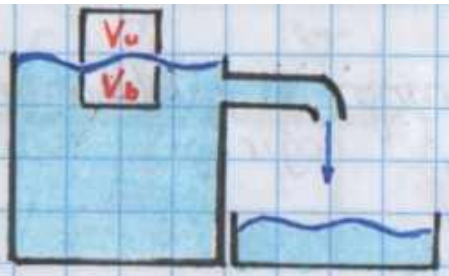
1. $F_{og'} > F_A$, $\rho > \rho_s$ jism to'la cho'kadi.



$V_s = V$
$m > m_s$

2. $F_{og'} = F_A$ $\rho = \rho_s$ jism to'la botib suzadi.

$m_s = m$
$V_s = V$

3. 

$F_{og} < F_A$ $\rho < \rho_s$

jismning ma'lum qismi botib suzadi

$V_s > V$ $m_s = m$

Masala: hajmi $0{,}3 \cdot 10^{-3}$ massasi 2 kg bo'lgan jism suvga tashlansa necha kg suv to'kiladi.

$V = 0{,}3 \cdot 10^{-3}$
$m = 2$ kg

$\rho = \frac{m}{V} = \frac{2}{0{,}3 \cdot 10^{-3}} > \rho_s$

$\rho > \rho_s$. demak V olinadi.

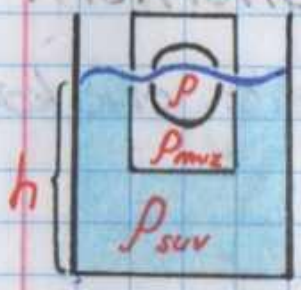
J: m = 0,3 kg suv to'kiladi

agar $\rho > \rho_s$ (V) olinadi

agar $\rho < \rho_s$ (m) olinadi

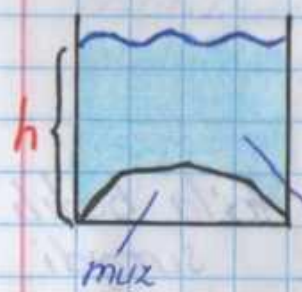
$$\frac{V_{bot}}{V} = \frac{\rho}{\rho_s}$$

$$\frac{V_{usti}}{V} = \frac{\rho_s - \rho}{\rho_s}$$



$\rho \leq \rho_{suv}$ bo'lsa h-o'zgarmaydi.

$\rho > \rho_{suv}$ bo'lsa h-pasayadi.

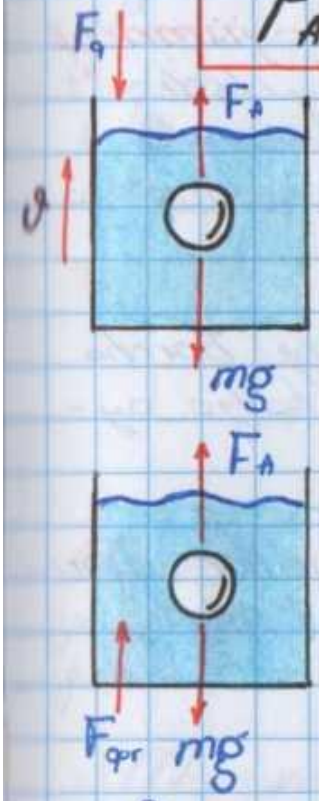


agar muz erisa suv sathi pasayadi

h-pasayadi.

Havoda Suzish.

$$F_A = \rho_h \cdot g \cdot V$$



$a = 0$
$\vartheta = const$

agar, $\vartheta = 0$ bo'lsa

$F_A = mg$

$F_A = mg + F_{qar}$

$ma = mg - F_A - F_{qar}$.

- Bizga ma'lumki barcha jismlar issiqlikdan kengayadi, sovuqdan torayadi
- Suv $+4°C$ da eng kichik hajmga, eng katta zichlikka ega bo'ladi. $4°C$ dan boshlab suvni isitsak ham, sovutsak ham kengayadi.
- Havo sharining ko'tarish kuchi:

$$F = g \cdot (\rho_h - \rho_g) V.$$

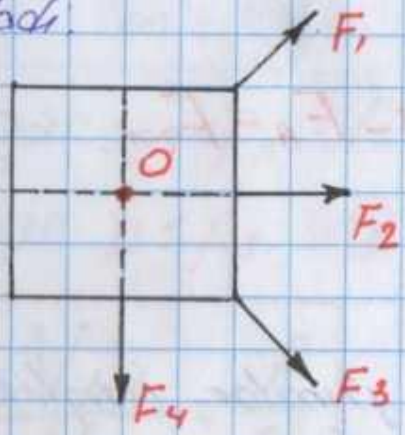
V – sharning hajmi
ρ_h – shar atrofidagi havoning zichligi
ρ_g – undagi gazning zichligi.

- Areometr – yordamida suyuqlik zichligi o'lchanadi.

Jismning og'irlik markazi

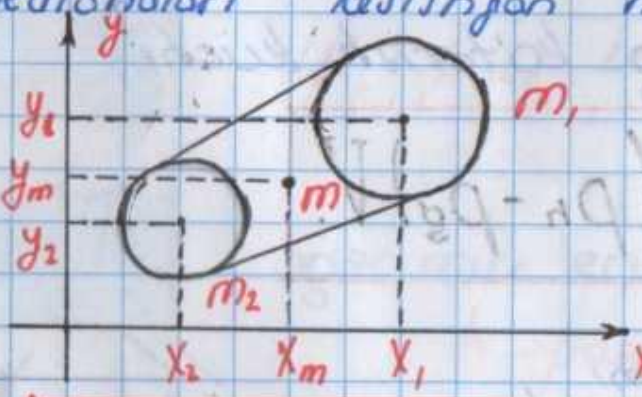
Jismning massasi yig'ilgan nuqtaga **jismning massa** yoki **og'irlik markazi** deyiladi. Jismni ilgarilama harakatga keltiruvchi kuchlarning ta'sir chizig'i kesishgan nuqtaga **massa markazi** deyiladi.

Ilgarilama harakat deb, jismning barcha nuqtalari bir xil tezlik bilan harakatga aytiladi.



F_2 va F_4 kuchlar ilgarilama harakat qiladi.

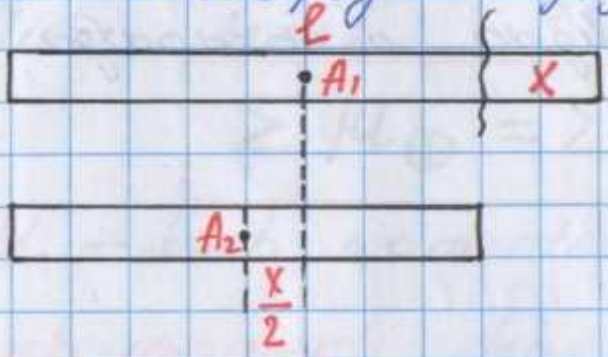
- Aning geometrik shaklga ega bo'lgan jismlarning markazi ularning geometrik markazida bo'ladi. Masalan, Kubning massa markazi diagonallar kesishgan nuqtada, uchburchakniki esa medianalari kesishgan nuqtada bo'ladi.



$$X_m = \frac{X_1 m_1 + X_2 m_2 + \ldots + X_n m_n}{m_1 + m_2 + \ldots + m_n}$$

$$y_m = \frac{y_1 m_1 + y_2 m_2 + \ldots + y_n m_n}{m_1 + m_2 + \ldots + m_n}$$

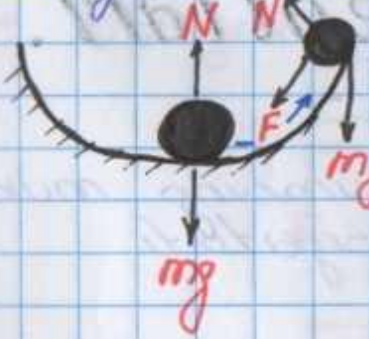
- Har qanday bir jinsli jismning massa markazi uning o'rtasida bo'ladi.
- ℓ uzunlikdagi sterjenning bir uchidan x qismi kesib olindi. Bunda massa markazi $x/2$ masofaga siljiydi.



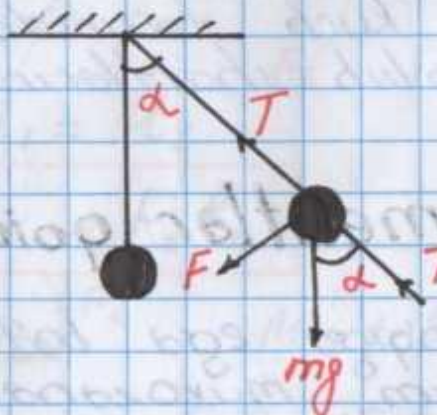
Muvozanat deb, jismning tinch turgan yoki to'g'ri chiziqli tekis harakatlanayotgan holatiga aytiladi.

Muvozanat 3 xil bo'ladi:
- *Turg'un muvozanat*
- *Turg'unmas muvozanat*
- *Befarq muvozanat*

Turg'un muvozanat deb jismning muvozanat vaziyatidan chiqqanimizda uni muvozanat vaziyatiga qaytaruvchi kuch paydo bo'ladigan muvozanatga aytiladi.



$$(mg)^2 = N^2 + F^2$$

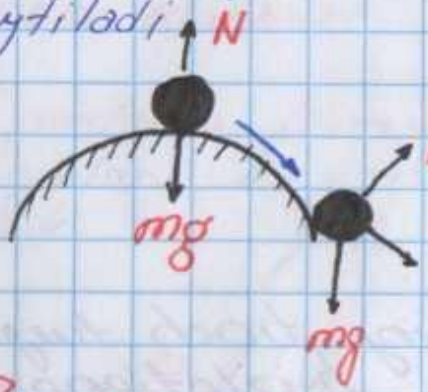


$$(mg)^2 = F^2 + T^2$$

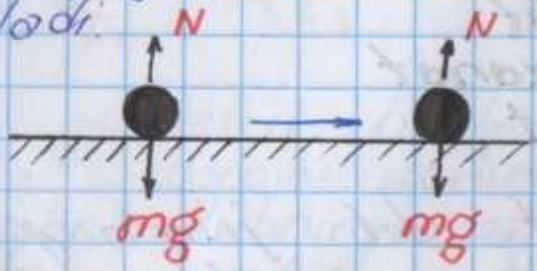
$$F = mg\sin\alpha$$
$$F = mg\cos\alpha$$

• Jismning massa markazi qandaydir parda bo'lsa u shunchalik turgun (mustahkam) boladi.

Turg'unmas muvozanat deb jismning muvozanat vaziyatidan chiqarganimizda uni muvozanat vaziyatidan uzoqlashtiruvchi kuch paydo bo'ladigan muvozanatga aytiladi.



Befarq muvozanat deb, jismni muvozanatdan chiqarganimizda hech qanday kuch paydo bo'lmaydigan muvozanatga aytiladi.



Statika elementlari.

Statika kuch ta'sirida jismning muvozanatda bo'lish shartlarini o'rganadi.

Momentlar qoidasi

• Aylanish o'qiga ega bo'lmagan (aylanmaydigan) jism muvozanatda bo'lishi uchun teng ta'sir etuvchi kuch 0 (nol) ga teng bo'lishi kerak.

• Aylanish o'qiga ega bo'lgan (aylanadigan) jism muvozanatda bo'lishi uchun soat mili bo'yicha aylanuvchi musbat kuch momentlarining yig'indisi, soat miliga qarama-qarshi aylantiruvchi manfiy kuch momentlarining yig'indisiga teng bo'lishi kerak.

$$\Sigma M_{\oplus} = \Sigma M_{\ominus}$$

M — kuch momenti [N.m].

Kuch momenti deb kuchning kuch yelkasiga ko'paytmasiga aytiladi.

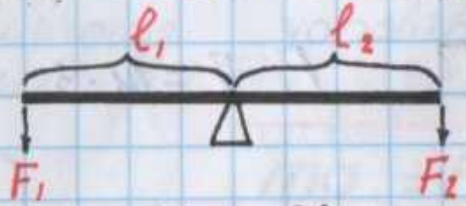
$$M = F \cdot \ell$$

ℓ — kuch yelkasi [m]

Kuch yelkasi deb kuchning ta'sir chizig'idan aylanish o'qigacha bo'lgan eng qisqa masofaga aytiladi

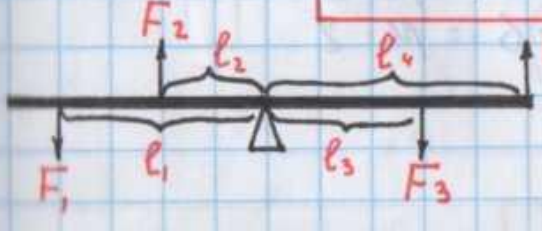
Richag deb, qo'zg'almas aylanish o'qiga ega bo'lgan qattiq jismga aytiladi.

• Richagni arximed kashf etgan



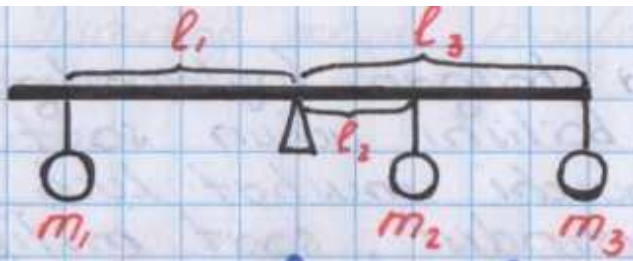
$$M_1 = M_2$$

$$F_1\ell_1 = F_2\ell_2$$

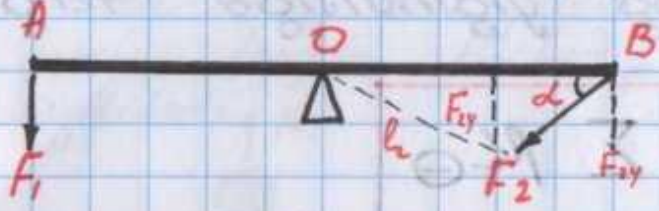


$$M_2 + M_3 = M_1 + M_4$$

$$F_2\ell_2 + F_3\ell_3 = F_1\ell_1 + F_4\ell_4$$

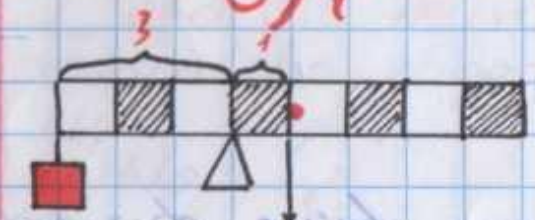


$$m_1 l_1 = m_2 l_2 + m_3 l_3$$

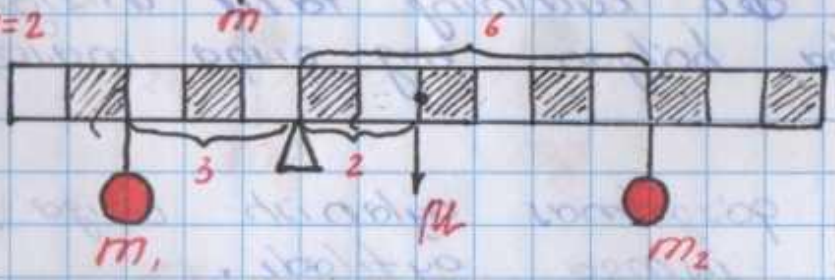


$$F_1 |OA| = F_{2y} |OB| \qquad F_{2y} = F_2 \sin\alpha$$
$$F_1 |OA| = F_2 \sin\alpha \, |OB|.$$
$$l_2 = |OB| \sin\alpha$$

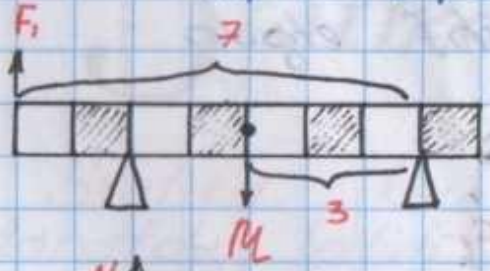
Misollar:



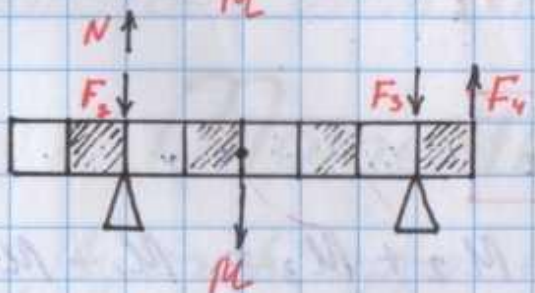
$$m \cdot 3 = M \cdot 1$$
$$M = 2 \cdot 3 = 6.$$



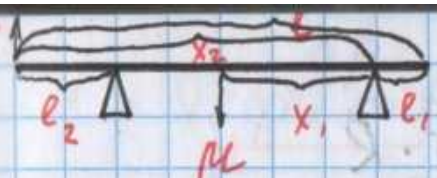
$$m_1 \cdot 3 = 2 \cdot M + m_2 \cdot 6$$



$$F_1 \cdot 7 = M \cdot 3$$



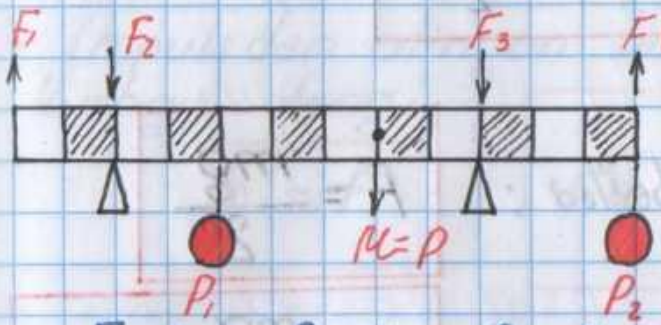
$$F_2 \cdot 5 = M \cdot 3$$
$$F_3 \cdot 5 = M \cdot 2$$
$$F_4 \cdot 6 = M \cdot 2$$



$F_1 x_2 = M \cdot x_1$

$x_1 = \frac{l}{2} - l_1$

$x_2 = \frac{l}{2} - l_1$



$F_1 \cdot 9 + P_2 \cdot 3 = P_1 \cdot 5 + P \cdot 2$

$F_2 \cdot 7 = P \cdot 2 + P_1 \cdot 5 + P_2 \cdot 3$

$F_3 \cdot 7 = P_1 \cdot$

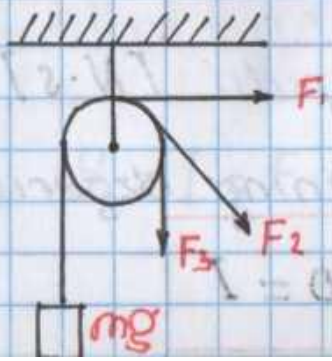
Ishni osonlashtirish uchun foydalaniladigan qurulmaga blok deyiladi.

Blok 2 xil bo'ladi:

- Ko'char blok
- Ko'chmas blok

Ko'chmas blok kuchdan yutuq bermaydi. Faqat kuchning yo'nalishini o'zgartiradi

$mg = F$



$F_1 = F_2 = F_3 = mg$

Ko'char blok

$F \cdot 2R = mg \cdot R$

$$F = \frac{mg}{2}$$

Agar blok ko'p bo'lsa: $$F = \frac{mg}{2^n}$$

Foydali ish koeffitsiyenti $$\eta = \frac{mg}{2F} \cdot 100\%$$

Kuch va Impuls.

Jism impulsi deb, jism massasining tezlikka ko'paytmasiga aytiladi

$$p = m \cdot v$$

p – jism impulsi $[Kg \cdot m/s]$

- Impulsning yo'nalishi tezlikni yo'nalishi bilan bir xil bo'ladi.

Kuch impulsi deb, kuchning shu kuch ta'sir etayotgan vaqtga ko'paytmasiga aytiladi

$$I = F \cdot \Delta t$$

I – Kuch impulsi $[N \cdot s]$

- Jism impulsining o'zgarishi kuch impulsiga teng

$$\Delta p = I$$

$\Delta p = p - p_0$

$p = m\vartheta \quad p_0 = m\vartheta_0$

$$\Delta p = I = m(\vartheta - \vartheta_0)$$

- Impuls dan olingan birinchi darajali kasila Kuchga teng.

$$p' = F \qquad \vec{F} = \frac{\Delta \vec{p}}{\Delta t}$$

- Agar jism impulsining koordinata o'qlariga proeksiyalari berilsa,

$p_x = K_x$

$p_y = K_y$

$$p = \sqrt{K_x + K_y}$$

Holatlar.

① 

$$p_n = p_1 + p_2$$

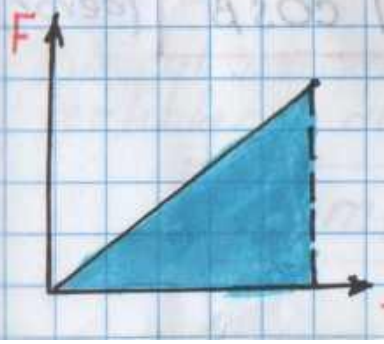
p_n – jismlar sistemasining impulsi.

$$p_{1,2} = p_{2,1} = |p_1 - p_2| = |m_1\vartheta_1 - m_2\vartheta_2|$$

Bir-biriga nisbati

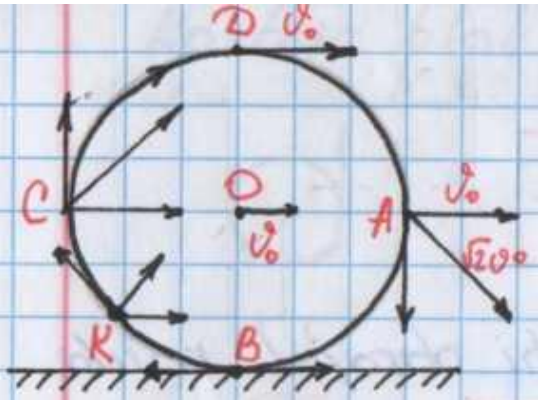
② 

$$p_n = p_1 - p_2 \qquad p_{1,2} = p_{2,1} = p_1 + p_2$$



$$S = I = F \cdot t$$

Bu yuza impulsni beradi.



A(·) $t = \frac{T}{4}$ $\Delta p = \sqrt{2}m\vartheta$

B(·) $t = \frac{T}{2}$ $\Delta p = 2m\vartheta$

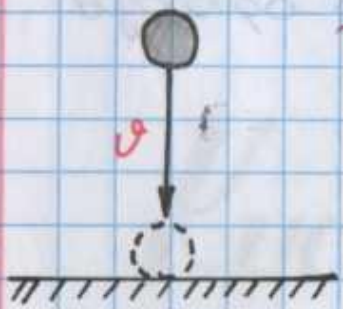
C(·) $t = \frac{3T}{4}$ $\Delta p = \sqrt{2}m\vartheta$

D(·) $t = T$ $\Delta p 0$

K(·) Ixtiyoriy nuqta

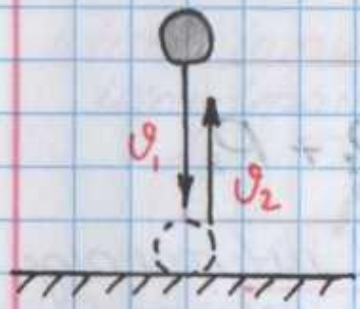
$$\Delta p = m\cdot\sqrt{2\vartheta_0^2 + 2\vartheta_0^2\cos\alpha}$$

Holatlar.



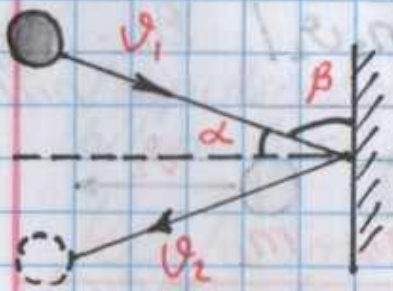
Agar jism yerga tushsa-yu, qayta ko'tarilmasa

$$\Delta p = m\vartheta \qquad \vartheta = \sqrt{2gh}$$



Agar jism yerga tushib, qayta ko'tarilsa

$$\Delta p = m(\vartheta_1 + \vartheta_2)$$



Agar jism burchak ostida yerga (devor) urilib, qayta ko'tarilsa

$$\Delta p = m(\vartheta_1 + \vartheta_2)\cos\alpha \quad \text{(jism)}$$

$$\Delta p = m(\vartheta_1 + \vartheta_2)\cos\beta \quad \text{(devor)}$$

Impulsning saqlanish qonuni Reaktiv harakat.

Impulsning saqlanish qonuni quyidagicha

Yopiq sistemada jism impulslarning yig'indisi o'zgarmas dir.

$$\Sigma P = const$$

$$\Sigma p_{ov} = \Sigma p_{KEY} \quad (p_1 = p_2)$$

To'qnashuv 2 xil bo'ladi va ular quyidagilar.

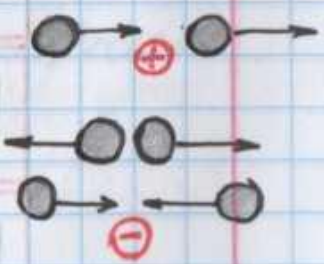
1. Mutlaq elastik to'qnashuv
2. Mutlaq noelastik to'qnashuv.

Agar ikki jism to'qnashganda, ular to'qnashib bir xil yo'nalishda emas turli tomonga harakatlansa bu to'qnashuv elastik, buni aksi bo'lib ular bir yo'nalish olsa noelastik to'qnashuv deyiladi.

• Elastik to'qnashuv uchun impulsning saqlanish qonuni:

$$p_1 \pm p_2 = p_1' \pm p_2'$$

$$m_1 v_1 \pm m_2 v_2 = m_1' v_1 \pm m_2' v_2'$$



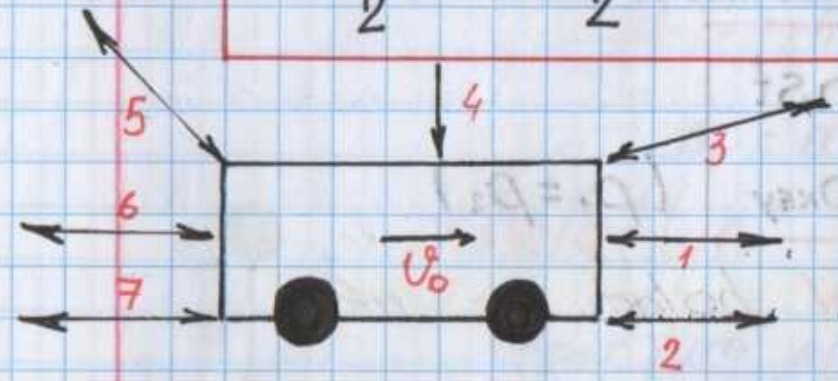
• Bir xil massali jismlar elastik to'qnashsalar tezliklar almashadi.

$$m_1 = m_2 \qquad v_1 = v_2', \quad v_2 = v_1'$$

$$W_K = \frac{m\vartheta^2}{2}$$ Kinetik energiya formulasi

- Elastik to'qnashuv uchun energiyaning saqlanish qonuni quyidagicha bo'ladi:

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



1, 2, 3 da ϑ kamayadi
4 da ϑ o'zgarmaydi
5, 6, 7 da ϑ tezlashadi

- Noelastik to'qnashuv uchun impulsning saqlanish qonuni.

$$m_1\vartheta_1 \pm m_2\vartheta_2 = (m_1 + m_2)\cdot U$$

U – birgalikdagi tezlik.

- Noelastik to'qnashuv uchun energiyaning saqlanish qonuni

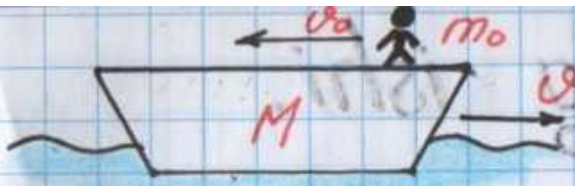
$$W_{av} = W_{key} + Q$$

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

$$W_{key} = \frac{(m_1+m_2)}{2}\cdot U^2$$

$$Q = c\cdot(m_1+m_2)\cdot\Delta t$$

Δt – temperatura
Q – issiqlik miqdori.



$v=0$ Tinch turgan qayiq ustida odam harakatlanse

$$m_0 v_0 = (M_q + m_0) \cdot v$$

$$m_0 \cdot \frac{l}{t} = (M_q + m_0) \cdot \frac{S}{t}$$

$$m_0 \cdot l = (M_q + m_0) \cdot S$$

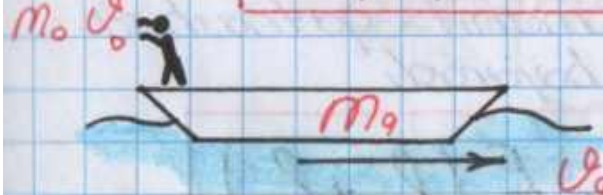
Havo sharida; tepaga parvondan ko'tarilsa

$$m_0 \cdot v_\uparrow = (M + m_0) u_\downarrow$$

$$m_0 \cdot v_\downarrow = (M + m_0) \cdot u_\uparrow$$

Suzuvchi qayiqni oldidan sakrasa, qayiq tezligi va umumiy massa quyidagicha o'zgaradi

$$M_q v_q^{key} = M_q v_q^{av} - m_0 v_0$$



orqasidan sakrasa

$$M_q v_q^{key} = M_q v_q^{av} + m_0 v_0$$

Reaktiv harakat deb, jismning biror qismi undan ajralganda jismning oladigan harakatiga aytiladi.

Raketaning harakati reaktiv harakat.

Kuchning ishi.

Ish deb, jismni energiyasining o'zgarishini xarakterlovchi fizik kattalikka aytiladi. Mexanik ish quyidagicha topiladi.

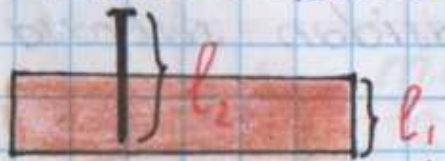
$$A = F \cdot s \cdot \cos\alpha$$

F – kuch
S – ko'chish
α – Kuch va ko'chish orasidagi burchak
A – ish [J] skalyar kattalik

- Aylanma harakatda ish nolga teng.
- Agar jism F kuch ta'sirida h balandlikka ko'tarilsa bajarilgan ish quyidagicha topiladi:

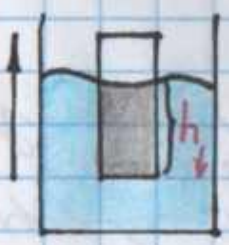
$$A = F \cdot h$$

- Bunda jism massasi e'tiborga olinmaydi.
- Og'irlik kuchining ishi $A = mgh$
- Agar masalada 2 ta muhit qatnashsa o'rtacha kuch ish bajaradi.



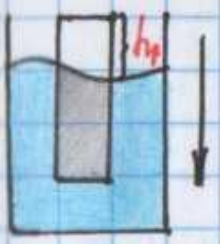
(yogoch va mix)

$$A = \frac{F}{2}(l_1 + l_2)$$



Ko'tarish uchun

$$A_{\uparrow} = \frac{F_{\uparrow}}{2} \cdot h_{\downarrow}$$



Bosish uchun $A_1 = \frac{F_A - mg}{2} \cdot h_1$

Holatlar:

- $a = 0$ $v = const$ (tekis harakat)

$$A = mgh$$

- $a \neq 0$, tezlanish bilan ko'tarilsa

$$A_1 = m(g+a) \cdot h$$

- $a \neq 0$, tezlanish bilan pastga tushsa

$$A_1 = m(g-a) \cdot h$$

Jismga qo'yilgan kuchlarning ishi va jism tezligining o'zgarishi. Kinetik energiya.

Energiya deb, jism ish bajara olish qobiliyatiga aytiladi.

- Energiya barcha turdagi harakatning yagona o'lchovidir.

Energiyaning quyidagi turlari mavjud:

- Mexanik energiya

- elektr energiya
- issiqlik energiyasi
- ichki energiya
- atom energiyasi

.... (va boshqalar)

Mexanik energiya 2 xil bo'ladi:

- **Kinetik energiya**
- **Potensial energiya**

Kinetik energiya deb, jismning harakati tufayli yuzaga keladigan energiyaga aytiladi.

K, E_K, W_K – kinetik energiya [J]

$$W_K = \frac{m\vartheta^2}{2}$$

$$W_K = \frac{p\vartheta}{2} \qquad W_K = \frac{p^2}{2m}$$

(Kinetik energiyaning impuls b-n bog'lanishi)

Jismning tezligi yorug'lik vakuumdagi tezligidan juda kichik bo'lganda bir inersial sanoq sistemasidan ikkinchi inersial sanoq sistemasiga o'tilganda jismning tezligi, impulsi va kinetik energiyasi o'zgaradi; boshqa kattaliklar o'zgarmaydi.

Kinetik energiya haqida teorema.

Bajarilgan ish kinetik energiyaning o'zgarishiga teng.

$$A = \Delta W_k$$
$$\Delta W_k = W - W_0$$
$$A = F \cdot s = ma \cdot s$$
$$S = \frac{\vartheta^2 - \vartheta_0^2}{2a}$$
$$a = \frac{\vartheta^2 - \vartheta_0^2}{2S}$$
$$A = m \cdot \frac{\vartheta^2 - \vartheta_0^2}{2S} \cdot S$$
$$A = \frac{m\vartheta^2}{2} - \frac{m\vartheta_0^2}{2} = W - W_0 = \Delta W_k.$$

$$\boxed{A = \frac{m}{2}(\vartheta^2 - \vartheta_0^2)}$$

- Birligi bir xil bo'lgan kattaliklarni tenglashtirib ishlash mumkin

$$\boxed{A = W_k = W_p \quad \frac{m\vartheta^2}{2} = F \cdot s}$$

Og'irlik kuchining ishi. Yerdan ko'tarilgan jismning Potensial energiyasi.

Potensial energiya deb jismning fazodagi vaziyatiga bog'liq bo'lgan energiyaga aytiladi.

$$\boxed{W_p = mgh}$$

Π, E_p, W_p – potensial energiya [J]

• Ish bilan potensial energiya quyidagicha bog'lanadi.

$$A = -\Delta W_p$$

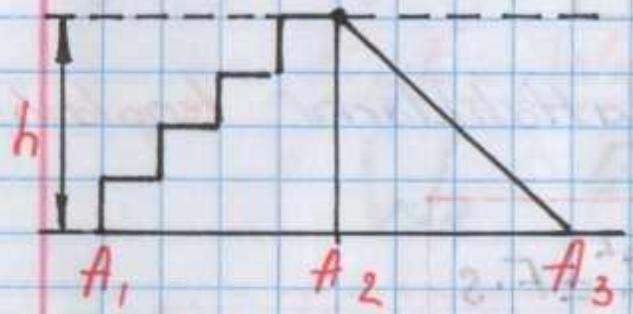
$$A = -(W_p - W_0) = -(mgh - mgh_0)$$

$$\boxed{A = mg(h_0 - h)}$$

$$\boxed{A_\uparrow < 0 \quad A_\downarrow > 0}$$

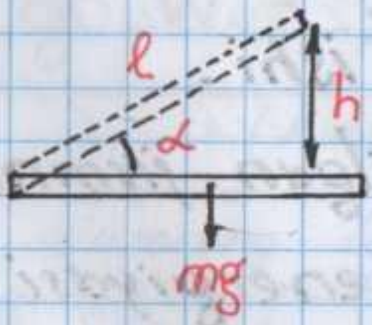
• Og'irlik kuch gorizontal sirtda ish bajarmaydi $A = 0$, $h = 0$

• Agar balandlik bir xil bo'lsa



$$\boxed{A \sim h}$$

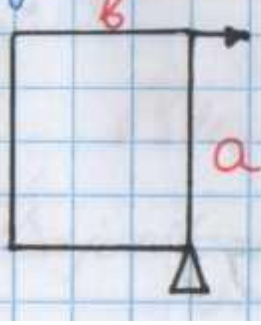
• Xodani h balandlikka ko'tarish dagi ish



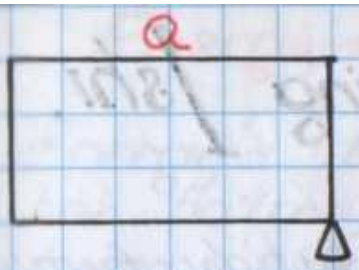
$$\boxed{A = \frac{mg}{2} \cdot h}$$

$$\boxed{A = \frac{mgl}{2} \cdot \sin\alpha}$$

• G'isht (yashik) ni yotqizish uchun ketadigan ish

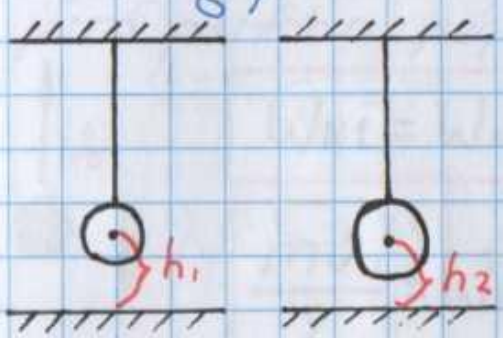


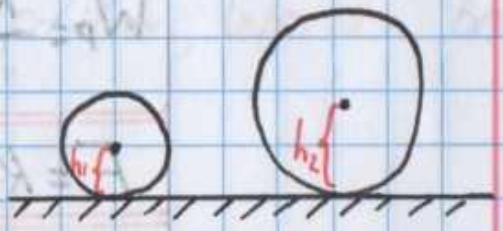
$$\boxed{A = \frac{mg}{2}(a - b)}$$



$$A = mg(a-b)$$

- Metal sharlarni qizdirsak quyidagicha o'zgaradi energiya





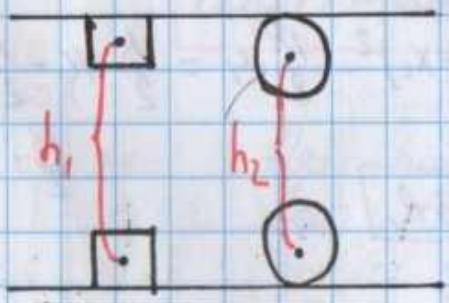
isitsak W_p ortadi.

$h_1 > h_2$ $\quad W = mgh$

$W_1 > W_2$ $\quad W \sim h$

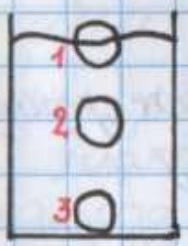
(kamayadi)

- Massasi teng kub va sharni ko'tarishda, shar ko'tarishda kam ish bajariladi.



$h_1 > h_2$, $W_1 > W_2$

- Jism hamma vaqt eng kam potensial energiyaga erishishga intiladi.



$W_1 < W_2 < W_3$ (Po'kak, cho'kadi)

$W_1 > W_2 > W_3$ (temir, cho'kadi)

Elastiklik kuchining ishi.

Prujinaning potensial energiyasi quyidagi formula bilan topiladi.

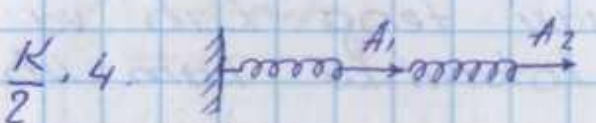
$$W_p = \frac{K \cdot \Delta x^2}{2}$$

$$F = K \cdot \Delta x$$

$$W_p = \frac{F \cdot \Delta x}{2}$$

Masala. Prujina avval 2sm ga so'ngra yana 2sm ga cho'zildi. Birinchi va ikkinchi cho'zilishlarni taqqoslang.

$$A_1 = \frac{K \cdot 2^2}{2} = \frac{K}{2} \cdot 4$$



$$A_2 = A - A_1 = \frac{K}{2} \cdot (x_1 + x_2)^2 - \frac{K}{2} \cdot 4 = \frac{K}{2} \cdot 16 - \frac{K}{2} \cdot 4 = \frac{K}{2} \cdot 12$$

$$\frac{A_2}{A_1} = \frac{\frac{K}{2} \cdot 12}{\frac{K}{2} \cdot 4} = \frac{3}{1} \qquad A_2 = 3A_1$$

To'liq mexanik energiyaning saqlanish qonuni.

Jismning to'liq energiyasi kinetik energiyasi va potensial energiyasi yig'indisiga teng.

$$W_T = W_K + W_P$$

$W_T = const$

$W_K - W_P = const$ $\qquad W_{AVV} = W_{KEY}$

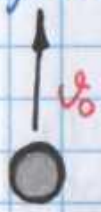
$$W_{K1} + W_{P1} = W_{K2} + W_{P2}$$

Energiyaning Saqlanish Qonuni.

Energiya bordan yo'q bo'lmaydi, yoqdan bor bo'lmaydi, u bir turdan ikkinchi turga o'tadi xolos.

Holatlar:

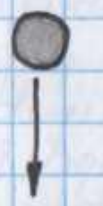
- jism pastdan yuqoriga otilsa, $W_{P1}=0$ bo'ladi.



$$W_{K1} = W_{K2} + W_{P2}$$

$$\frac{m\vartheta_0^2}{2} = W_{K2} + W_{P2}$$

- jism yuqoridan pastga tashlansa, $W_{K1}=0$ bo'ladi.



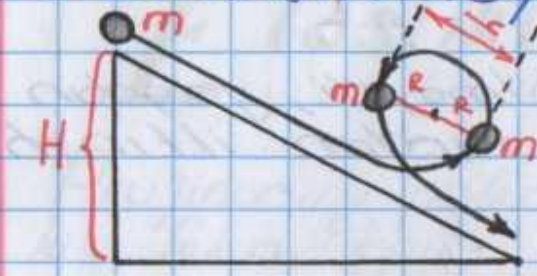
$$W_{P1} = W_{K2} + W_{P2}$$

$$mgh = W_{K2} + W_{P2}$$

- Agar biz h balandlikdan tashlangan jism kinetik va potensial energiyalari quyidagicha bo'ladi.
- Balandlik yarmida kinetik va potensial energiyalari teng bo'ladi.

- Agar jism ϑ_0 boshlang'ich tezlik bilan tik yuqoriga otilsa uning to'liq energiyasi havoning qarshiligi hisobga olinmasa trayektoriyaning barcha nuqtalari da bir xil bo'ladi. Agar havoning qarshiligi hisobga olinsa otilish nuqtasida eng katta, tushush nuqtasida eng kichik bo'ladi.

- O'lik sirtmoq (o'lim sirtmog'i).



$$mg \cdot H = \frac{m\vartheta^2}{2} + mg \cdot h$$

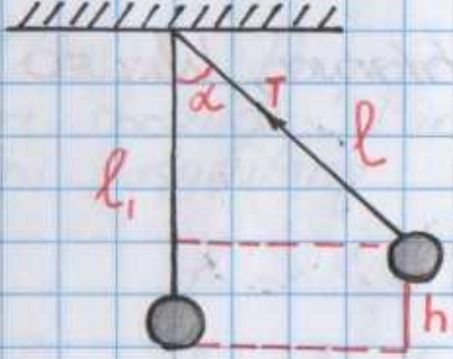
$$\vartheta^2 = g \cdot R$$

$$g \cdot H = \frac{gR}{2} + g \cdot 2R$$

$$H = \frac{R}{2} + 2R$$

$$\boxed{H = 2{,}5 \cdot R}$$

- Matematik maydonik.



$$h = l - l_1$$

$$l_1 = l\cos\alpha$$

$$h = l - l\cos\alpha$$

$$\boxed{h = l \cdot (1 - \cos\alpha)}$$

$$\vartheta = \sqrt{2gh}$$

$$\boxed{\vartheta = \sqrt{2gl(1-\cos\alpha)}}$$

$$\boxed{W_p = mgl \cdot (1-\cos\alpha)}$$

T – ipning taranglik kuchi.

$$T = m(g + a) \qquad a = \frac{\vartheta^2}{l}$$

$$a = \frac{2gl \cdot (1-\cos\alpha)}{l}$$

$$a = 2g \cdot (1-\cos\alpha)$$

$$\boxed{T = mg \cdot (3 - 2\cos\alpha)}$$

Ishqalanish kuchining ishi va Mexanik energiya.

Ishqalanish kuchining bajargan ishi quyidagi formula bilan topiladi.

$$A = F_{ish} \cdot \ell = \mu \cdot N \cdot \ell$$

• Ishqalanish kuchining bajargan ishi trayektoriyaning shakliga bog'liq bo'ladi; qolgan kuchlarning bajargan ishi trayektoriyaning shakliga bog'liq emas.

Bajargan ishi trayektoriyaning shakliga bog'liq bo'lmagan kuchga **konservativ kuch** deyiladi.
Ishqalanish kuchi **nokonservativ kuch** hisoblanadi.

• Energiyaning saqlanish qonuniga asosan bir turdagi energiya boshqa turdagi energiyaga aylanadi.

$$W_p = W_K + Q$$

(h balandlikdan erkin tushayotgan jism)

$$mgh = \frac{mv^2}{2} + Q$$

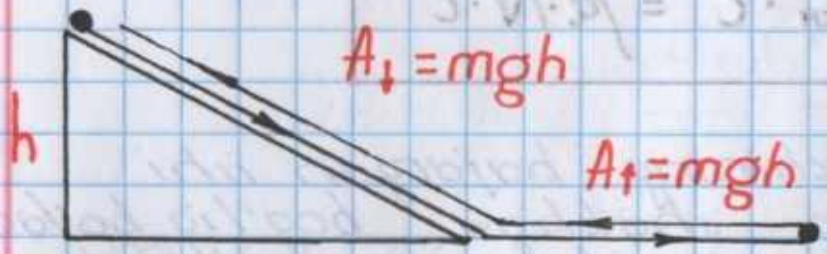
$$Q = c \cdot m \cdot \Delta t$$

Q – issiqlik miqdori
c – issiqlik sig'imi
Δt – temperaturaning o'zgarishi $\Delta t = t - t_0$

Holatlar (xususiy yechimlar)

$$mgh = cm\Delta t$$ (Shorshara)

$$\frac{m\vartheta^2}{2} = cm\Delta t$$ (Benzin)



$$A = 2mgh$$

Jism h balandlikdagi qiyalikdan sirpanib tushib qaytib chiqishga ketgan bo'ladigan ish formulasi

Quvvat.

Jismning ish bajara olish tezligini harakterlovchi fizik kattalik **quvvat** deyiladi.

Vaqt birligi ichida bajarilgan ish **quvvat** deyiladi.

$$N = \frac{A}{t}$$ N – quvvat [W] (watt)

$$1\,W = 1 \cdot \frac{J}{s}$$

$$1\ ot\ kuchi = 735{,}6\ W \approx 736\ W$$

$$N = \frac{F \cdot s \cdot \cos\alpha}{t} = F \cdot \vartheta \cdot \cos\alpha$$

- Tekis harakatda, quvvat $a = 0$, $\vartheta = const$

$$N = F \cdot \vartheta$$

• To'g'ri chiziqli tekis tezlanuvchan harakatda, quvvat. $a \neq 0$

$$N_{o'r} = \frac{F \cdot (\vartheta + \vartheta_0)}{2}$$

Foydali ish koeffitsiyenti (FIK) — bajarilgan umumiy ishning necha foizi yoki qanday qismi foydali ekanligini harakterlovchi kattalik.

$$\eta = \frac{A_F}{A_{um}} \cdot 100\% \qquad \eta < 100\%;\ \eta < 1$$

$$A_{um} = q \cdot m$$

q – yoqilg'ining yonish issiqligi $\left[\frac{J}{kg}\right]^2$

$q \sim 10^6$

$$\eta = \frac{N \cdot t}{q \cdot m} = \frac{N \cdot s}{\vartheta \cdot q \cdot m}$$

$$\eta = \frac{cm\Delta t}{N \cdot t}$$

$$\eta = \frac{F \cdot \vartheta}{N}$$

$$\eta = \frac{\sin\alpha}{\sin\alpha + \mu\cos\alpha}$$

Bosim.

Suyuqliklarning turli yuzali trubalardagi harakati va samolyot qanotining ko'tarish kuchini Bernulli aniqlagan. Bu hodisalar Bernulli qonuni yordamida aniqlanadi.

Bernulli qonuni

Suyuqlik oqimining tezligi katta joyda bosim kichik bo'ladi va aksincha oqim tezligi kichik joyda bosim katta bo'ladi.

$$P_T = P_D + P_S + P_G$$

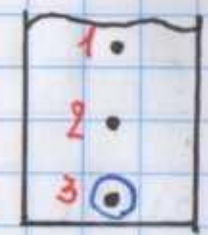
$P_D = \frac{\rho v^2}{2}$ Suyuqlikning harakatdagi bosimi
Dinamik bosim.

$$P = \frac{F}{S} = \frac{ma}{S} = \frac{\rho V a}{S} = \frac{\rho \cdot S \cdot l \cdot a}{S} = \rho l a = \rho l \cdot \frac{v^2}{2l} = \frac{\rho v^2}{2}.$$

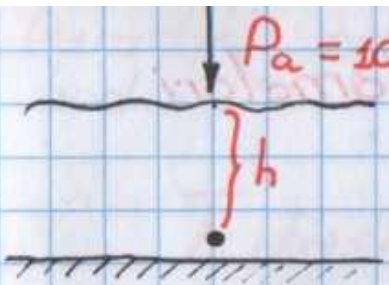
$P_G = \rho g h$ Suyuqlikning chuqurlikdagi bosimi
Gidrostatik bosim

$$P = \frac{F}{S} = \frac{mg}{S} = \frac{\rho V g}{S} = \frac{\rho \cdot S \cdot h \cdot g}{S} = \rho g h.$$

$P_S = \frac{F}{S}$ tinch holatdagi bosim
Statik bosim



3-nuqtada bosim katta bo'ladi.



$$P = P_a + \rho g h$$

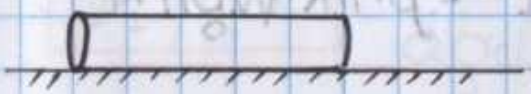
Ko'lning chuqurlikdagi bosimi.

$$P_T = \frac{\rho v^2}{2} + \rho g h + P$$

To'liq bosim hamma vaqt o'zgarmas bo'ladi.

$$\frac{\rho v^2}{2} + \rho g h + P = const$$

$$\frac{\rho v_1^2}{2} + \rho g h_1 + P_1 = \frac{\rho v_2^2}{2} + \rho g h_2 + P_2$$



$v_1 > v_2$ $\quad h = 0$

$P_1 < P_2$

$$\frac{\rho v_1^2}{2} + P_1 = \frac{\rho v_2^2}{2} + P_2$$

$$\frac{\rho}{2}(v_1^2 - v_2^2) = P_2 - P_1$$

Bosim deb yuza birligiga tik ta'sir etuvchi kuchga aytiladi.

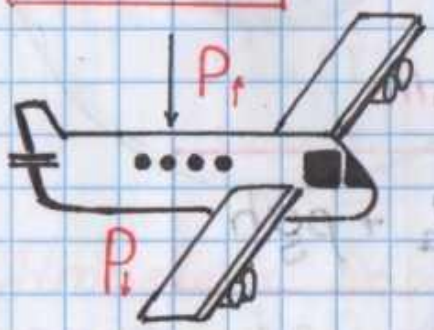
$$P = \frac{F}{S}$$

$$1\ Pa = \frac{N}{m^2}$$

$$P \sim \frac{1}{S} \sim \frac{1}{R^2} \sim \frac{1}{d^2}$$

$$F = P \cdot S$$

Ko'tarish kuchi.



$P_\downarrow > P_\uparrow$

$\Delta P = P_\downarrow - P_\uparrow$ ko'tariladi.

$$F_{K.K} = \Delta P \cdot S = (P_\downarrow - P_\uparrow) \cdot S$$

Uzluksizlik tenglamalari.

$V = S \cdot l = S \cdot v \cdot t$

$\frac{V}{t} = S \cdot v$ $\quad \frac{V}{t} = const$

$S \cdot v = const$

$$\frac{V_1}{t_1} = \frac{V_2}{t_2}$$

$$S_1 \cdot v_1 = S_2 \cdot v_2$$

$$d_1^2 v_1 = d_2^2 v_2$$

$V \sim t$

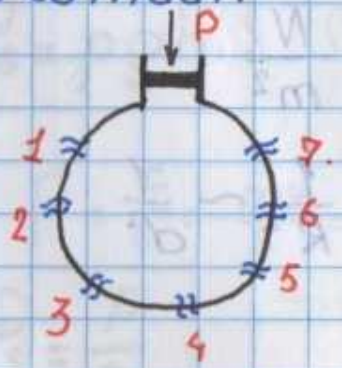
$$R_1^2 v_1 = R_2^2 v_2$$

$v \sim \frac{1}{S}$

$$m = \rho V = \rho \cdot S \cdot l = \rho \cdot \pi R^2 v \cdot t = \rho \cdot \pi R^2 \sqrt{2gh} \cdot t$$

Paskal qonuni

Suyuqlik yoki gazga ta'sir etayotgan tashqi bosim suyuqlik yoki gazning barcha nuqtalariga o'zgarishsiz (bir xil) uzatiladi.



Gidrostatik bosim

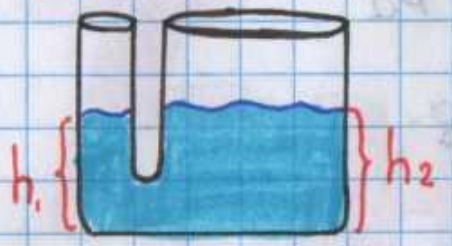
$$P_g = \rho g h$$

$$P_1 = P_a + \rho g h$$

Paradoks, oddiy tasavvurga mos kelmaydigan hodisa.

Tutash idishlar.

Asoslari tutashgan ixtiyoriy shakldagi idishga tutash idish deyiladi.



$$p_1 = p_2$$
$$\rho_1 g h_1 = \rho_2 g h_2$$
$$\rho_1 h_1 = \rho_2 h_2$$

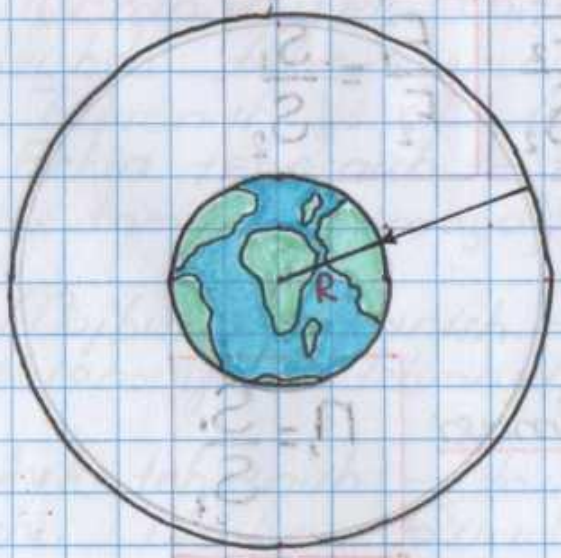
$$\frac{\rho_1}{\rho_2} = \frac{h_2}{h_1}$$

agar, $\rho_1 = \rho_2$ bo'lsa $h_1 = h_2$

agar, $\rho_1 > \rho_2$ bo'lsa $h_1 < h_2$

Atmosfera bosimi.

Yer sharini havo qobig'iga atmosfera deyiladi.



$$P_{at} = \frac{mg}{S}$$

Atmosfera bosimi deb davomi yer radiusi davomida yo'lduvchi havo molekulalarini og'irlik kuchining yuza birligini nisbatiga aytiladi.

Normal atmosfera bosimi Boltiq dengizidagi bosim.

$P_a = 760\ mmHg = 1\ atm = 1\ baros = 101325\ Pa$

$$P_a = 10^5\ Pa$$

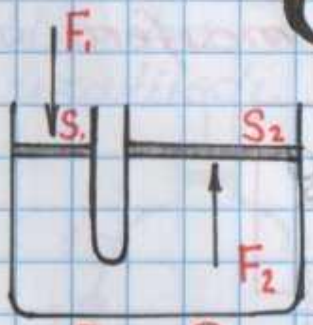
$1\ mmHg = 133,3\ Pa$

$1\ tor = 1\ mm\ Hg.$

$$P_1 = P_0 - \frac{h}{12}$$

$$P_1 = P_0 + \frac{h}{12}$$

Porshenli nasos, Gidravlik press.



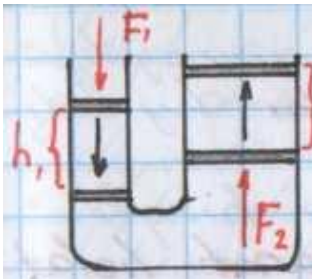
$$\frac{F_1}{S_1} = \frac{F_2}{S_2} \qquad \frac{F_1}{F_2} = \frac{S_1}{S_2}$$

n — kuchdan yutuq

Agar ishqalanish bo'lmasa $n_1 = \frac{S_1}{S_2}$

Agar ishqalanish bor bolsa $n_2 = \frac{F_2}{F_1}$

$n_1 > n_2 \quad F_2 > F_1$



$A_1 = A_2$ $\boxed{F_1 h_1 = F_2 h_2}$

TEBRANISH VA TOLQINLAR.

Tebranma harakat. Tebranma harakat energiyasi.

Tebranish deb davriy yoki deyarli davriy ravishda takrorlanuvchi harakatga aytiladi.

Tebranish 3 xil bo'ladi:

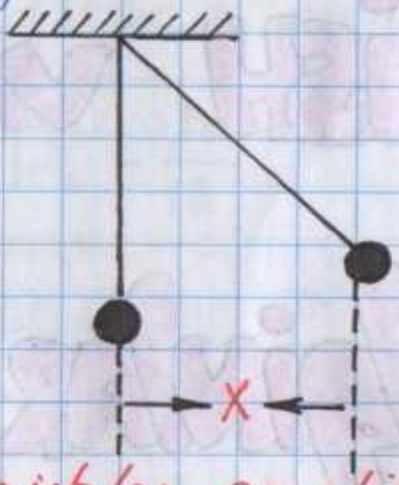
- Erkin tebranish — tashqi kuch ta'siri to'xtasa ham to'xtamaydigan tebranishga aytiladi.
- Majburiy tebranish — tashqi kuch ta'sirida tebranadigan tebranishga aytiladi.
- Avto tebranish — tashqaridan energiya olib ichki kuchlar ta'sirida boladigan tebranishga aytiladi.

Garmonik tebranish — vaqt o'tishi bilan sinus yoki kosinus qonuniga muvofiq boladigan tebranishga

Sinus yoki Cosinus qonunlariga bo'ysinmaydigan tebranish **garmonik tebranishlar** deyiladi.

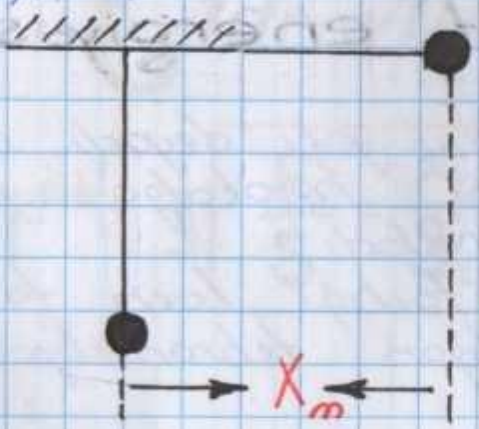
Jismning tinch turgan yoki to'g'ri chiziqli tekis harakatdagi holatiga **muvozanat holat** deyiladi.

Siljish deb, jismning qaralayotgan vaqt momentida muvozanat holatidan ganchalik uzoqligini ko'rsatuvchi fizik kattalikka aytiladi.

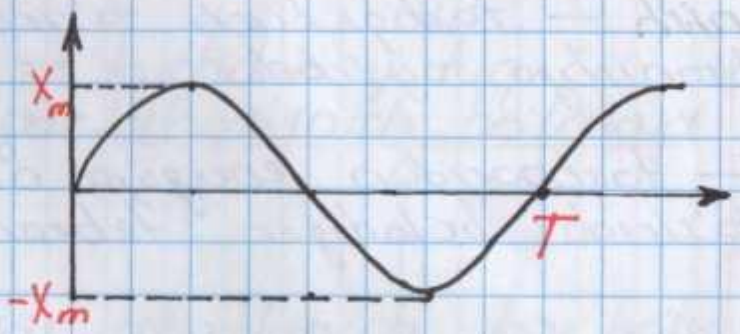


X – siljish [m]

Tebranishlar amplitudasi deb jismning muvozanat vaziyatidan eng katta siljish moduliga aytiladi.



X_m, A – amplituda
maksimal siljish
[m]



- Vaqt o'tishi bilan amplitudasi o'zgarmaydigan tebranishga **so'nmas tebranish** deyiladi
- Vaqt o'tishi bilan amplitudasi o'zgaradigan tebranishga **so'nuvchi tebranish** deyiladi

Tebranish davri deb bir marta to'liq tebranish uchun ketgan vaqtga aytiladi

$$T = \frac{t}{N} \qquad T = \frac{2\pi}{\omega} \qquad T = \frac{1}{\nu}$$

Bir sekunddagi tebranishlar soni **xususiy chastota** deyiladi.

$$\nu = \frac{N}{T} \qquad \nu = \frac{1}{T}$$

ν – chastota [Hz]

Siklik chastota (diraviy) deb 2π sekunddagi tebranishlar soniga aytiladi

$$\omega = \frac{\varphi}{t} \qquad \omega = 2\pi\nu \qquad \omega = \frac{2\pi}{T}$$

ω – siklik (doiraviy) chastota $\left[\frac{rad}{s}\right]\left[\frac{1}{s}\right]$

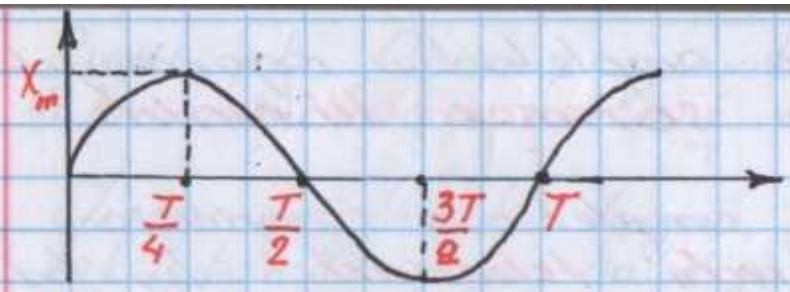
Tebranishlar fazasi deb, doiraviy ravishda o'zgarayotgan fizik kattalikning ixtiyoriy vaqt momentidagi qiymatini xarakterlovchi fizik kattalikka aytiladi.

$$\varphi = \omega t$$

φ – faza

Sinus yoki Kosinusning argumenti fazadir.

$$X = X_m \sin(\omega t)$$
$$X = X_m \cos(\omega t)$$



ℓ – yo'l $\quad \vec{S}$ – ko'chish

$t = \frac{T}{4} \quad \ell = X_m \quad \vec{S} = X_m$

$t = \frac{T}{2} \quad \ell = 2X_m \quad \vec{S} = 0$

$t = \frac{3T}{2} \quad \ell = 3X_m \quad \vec{S} = -X_m$

$t = T \quad \ell = 4X_m \quad \vec{S} = 0$

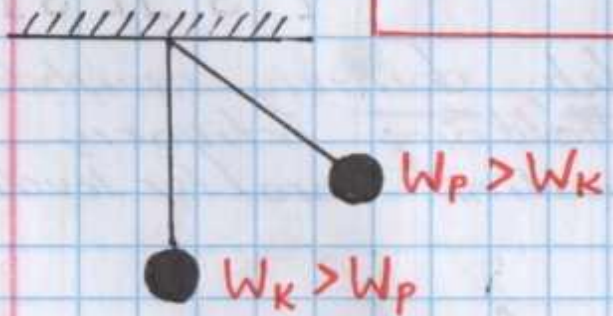
! Bir davr 4 amplitudaga teng $\boxed{\ell = 4X_m}$

- Jismni tebranma harakatga keltiruvchi kuchning kattaligi va yo'nalishi davriy ravishda o'zgarib turadi.

Tebranuvchi jismning maksimal kinetik energiyasi va potensial energiyasi quyidagicha bo'ldi

$$\boxed{W_{K.M} = \frac{mv_m^2}{2}} \qquad \boxed{W_{P.M} = \frac{KX_m^2}{2}}$$

$$\boxed{W_T = \frac{m\omega^2 X_m^2}{2}}$$



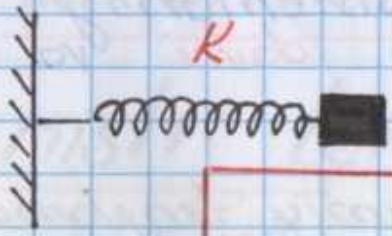
$W_T = const$

$W_T = W_K + W_P$

$W_T \not\sim h$

Prujinali mayatnik.

Agar prujinaga m massali yuk osilsa **prujinali mayatnik** hosil bo'ladi.



$$T = 2\pi \cdot \sqrt{\frac{m}{K}}$$

$$K = \frac{ES}{l_0}$$

$$T \sim \sqrt{\frac{l_0}{S}}$$

$$T = 2\pi \cdot \sqrt{\frac{m l_0}{E \cdot S}}$$

$$\nu = \frac{1}{2\pi} \cdot \sqrt{\frac{K}{m}}$$

$$\omega = \sqrt{\frac{K}{m}}$$

• Agar mayatnik yuksiz bo'lsa, u holda davri, chastotasi va siklik chastotasi quyidagicha bo'ladi.

$$F = k\Delta x$$

$$F = mg$$

$$K = \frac{F}{\Delta x}$$

$$m = \frac{F}{g}$$

$$T = 2\pi \sqrt{\frac{\Delta x}{g}}$$

$$\nu = \frac{1}{2\pi} \sqrt{\frac{g}{\Delta x}}$$

$$\omega = \sqrt{\frac{g}{\Delta x}}$$

Garmonik tebranishlar tenglamasi.

• Tebranuvchi sistemaning xususiy xossalariga uning davri va chastotalari kiradi.

Siljishning umumiy tenglamasi quyidagicha bo'ladi.

$$X_1 = X_m \sin(\omega t + \varphi_0$$

$$X_2 = X_m \cos(\omega t + \varphi_0$$

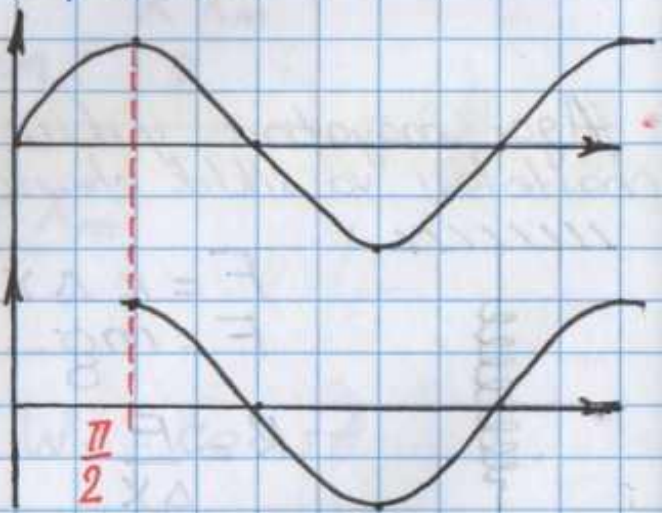
$\varphi = \omega t$ — oxirgi faza

φ_0 — boshlang'ich faza.

• Agar $\varphi_0 = 0$ bo'lsa

$X = X_m \sin \omega t$.

Agar $\varphi_0 = \frac{\pi}{2}$ bo'lsa



Tezlik tenglamasi.

$$\vartheta = X'$$

$X = X_m \sin(\omega t + \varphi_0)$.

$$\vartheta = X_m \cdot \omega \cos(\omega t + \varphi_0)$$

$$X_m \cdot \omega = \vartheta_m$$

$X_2 = X_m \cos(\omega t + \varphi_0)$.

$$\vartheta = -\vartheta_m \sin(\omega t + \varphi_0)$$

Tezlanish tenglamasi.

$$a = \vartheta' = x''$$

$\vartheta_1 = X_m \omega \cdot \cos(\omega t + \varphi_0)$

$$a_1 = -\vartheta_m \omega \sin(\omega t + \varphi_0)$$

$\vartheta_2 = -\vartheta_m \sin(\omega t + \varphi_0)$.

$$a_2 = -a_m \cos(\omega t + \varphi_0)$$

$$a_m = \vartheta_m \omega$$
$$a_m = X_m \omega^2$$

$$a = -\omega^2 x \qquad \omega = \sqrt{\frac{K}{m}} \qquad a = -\frac{K}{m} \cdot x$$

$a = -\frac{K}{m} x$ $\qquad ma = -Kx$

$F = -kx$.

$$F = -k X_m \sin(\omega t + \varphi_0)$$

$x \sim \sin\varphi$ $\qquad$ $x \sim \cos\varphi$

$\vartheta \sim \cos\varphi$ $\qquad$ $\vartheta \sim \sin\varphi$

$a \sim \sin\varphi$ $\qquad$ $a \sim \cos\varphi$.

Masala: Muvozanat vaziyatidan boshlab tebranayotgan jism amplitudasining 2-yarmini davrining qanday qismida bosib o'tadi.

1-usul $X_2 = \frac{A}{2}$ $X_1 = A$

$X_2 = A \sin \frac{2\pi}{T} \cdot t_1$ $X_2 = A \sin \frac{2\pi}{T} \cdot t_2$

$\frac{A}{2} = A \sin \frac{2\pi}{T} \cdot t_1$ $A = A \sin \frac{2\pi}{T} \cdot t_2$

$\sin \frac{2\pi}{T} \cdot t_1 = \frac{1}{2}$ $1 = \sin \frac{2\pi}{T} \cdot t_2$

$\frac{2\pi}{T} \cdot t_1 = \frac{\pi}{6}$ $\frac{\pi}{2} = \frac{2\pi}{T} \cdot t_2$

$t_1 = \frac{T}{12}$ $t_2 = \frac{T}{4}$

$t = \frac{T}{4} - \frac{T}{12} = \frac{T}{6}$.

2-usul. $T - 2\pi$

$t - \frac{\pi}{6}$

$t_1 = \frac{T}{12}$

yarmi ya'ni $\frac{1}{2}$ da

$\sin\alpha = \frac{1}{2}$

$\alpha = \frac{\pi}{6}$

$T - 2\pi$

$t - \frac{\pi}{2}$

$t_2 = \frac{T}{4}$

$t = t_2 - t_1 = \frac{T}{6}$.

Tebranma harakatdagi kinetik va potensial energiya... To'liq energiya.

$X = X_m \sin \omega t \quad v = v_m \cos \omega t \quad v_m = X_m$

$$W_K = \frac{mv^2}{2} = \frac{m}{2} \cdot v_m^2 \cos^2 \omega t = \frac{m}{2} X_m^2 \omega^2 \cos^2 \omega t$$

$$W_P = \frac{kx^2}{2} = \frac{k}{2} \cdot X_m^2 \sin^2 \omega t = \frac{m\omega^2 X_m^2}{2} \sin^2 \omega t$$

$$W_T = W_K + W_P = \frac{m X_m^2 \omega^2}{2} (\underbrace{\cos^2 \omega t + \sin^2 \omega t}_{1}) =$$

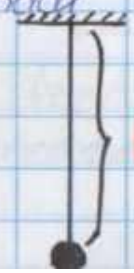
$$= \frac{m X_m^2 \omega^2}{2}.$$

$$\omega = \sqrt{\frac{k}{m}} \qquad k = \omega^2 m$$

Matematik Maydnik.

Cho'zilmaydigan vaznsiz ipga osilgan og'irlik kuchi ta'sirida tebranuvchi jismga **matematik maydnik** (agar muhitda bo'lsa garshilik kuchi hisobga olinadi) deyiladi.

- Juda kichik burchaklarda $5° - 8°$ da matematik maydnik **garmonik tebranadi**.
- Fizik maydnikda hamma parametrlar hisobga olinadi. Matematik maydnikda esa hisobga olinmaydi, faqat ip uzunligi hisobga olinadi.



- tekis harakatlansa, $\vartheta = const$, $a = 0$

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$ davri

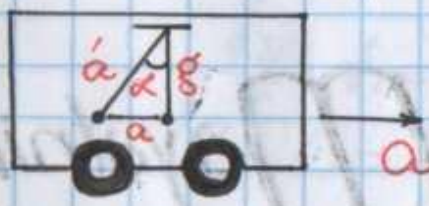
$$\nu = \frac{1}{2\pi}\cdot\sqrt{\frac{g}{\ell}}$$ chastotasi

$$\omega = \sqrt{\frac{g}{\ell}}$$ siklik chastotasi

$$g = \gamma\cdot\frac{m}{R^2}$$ erkin tushish tezlanishi

$$g_h = \gamma\cdot\frac{m}{(R+h)^2}$$ biror h balandlikdagi erkin tushish tezlanishi

- tezlanish bilan harakatlansa, $a \neq 0$.



$$tg\alpha = \frac{a}{g}$$

$$T = 2\pi\sqrt{\frac{\ell}{a'}} = 2\pi\sqrt{\frac{\ell}{\sqrt{a^2+g^2}}}$$

- yuqorigа tezlanish bilan harakatlansa

$$T_1 = 2\pi\cdot\sqrt{\frac{\ell}{g+a}}$$

- pastgа tezlanish bilan harakatlansa

$$T_1 = 2\pi\sqrt{\frac{\ell}{g-a}}$$

$W_T = W_P + W_K$

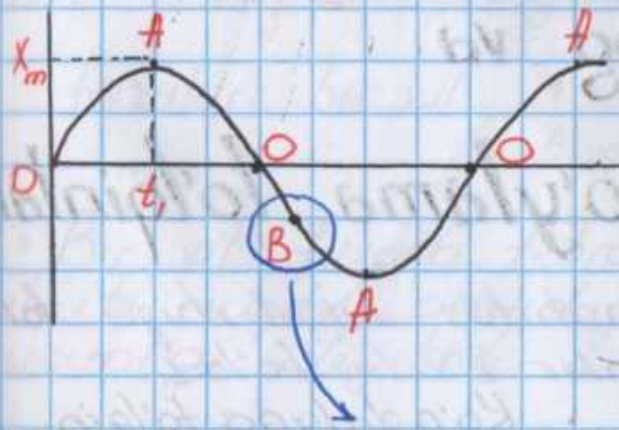
$W_K = \frac{m\vartheta^2}{2}$ $\qquad W_T = const$

$W_P = \frac{Kx^2}{2}$ $\qquad W_K + W_P = const$

• Har chorak davrda kinetik energiya potensial energiyaga, potensial energiya esa kinetik energiyaga aylanadi.

Har yarim davrda kinetik energiya kinetik energiyaga, potensial energiya esa potensial energiyaga aylanadi.

Bir davr mobaynida kinetik energiya 2 marta potensial energiyaga, potensial energiya ham 2 marta kinetik energiyaga aylanadi.



$A(\cdot)$ $t_1 = \frac{T}{4}$ $W_K = 0$ $W_T = W_P = \frac{Kx^2}{2}$

$O(\cdot)$ $t_2 = \frac{T}{2}$ $W_P = 0$ $W_T = W_K = \frac{m\vartheta^2}{2}$

$A(\cdot)$ $t_3 = \frac{3T}{4}$ $W_K = 0$ $W_T = W_P = \frac{Kx^2}{2}$

$O(\cdot)$ $t_4 = T$ $W_P = 0$ $W_T = W_K = \frac{m\vartheta^2}{2}$.

$B(\cdot)$ ixtiyoriy nuqta $W_T = W_K + W_P = \frac{Kx^2}{2} + \frac{m\vartheta^2}{2}$

• Davrning 8 dan bir qismida $t = \frac{T}{8}$ kinetik energiya bilan potensial energiya tenglashadi.

$$t = \frac{T}{8}$$

$$W_K = W_P$$

• Vaznsizlik sharoitida prujinali soat va termometr dan foydalanish mumkin

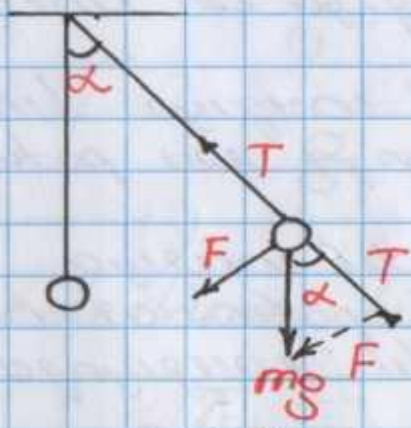
Xususan ushbu mavzuda quyidagi formulalarni qo'llash mumkin.

$h = l(1 - \cos\alpha)$ balandlik

$\vartheta = \sqrt{2gh} = \sqrt{2gl(1-\cos\alpha)}$ tezlik

$T = mg(3 - 2\cos\alpha)$ taranglik

$\vartheta = 2\pi R\nu$.



$(mg)^2 = T^2 + F^2$

$T = mg\cos\alpha$

$F = mg\sin\alpha$.

Ko'ndalang va Bo'ylama to'lqinlar

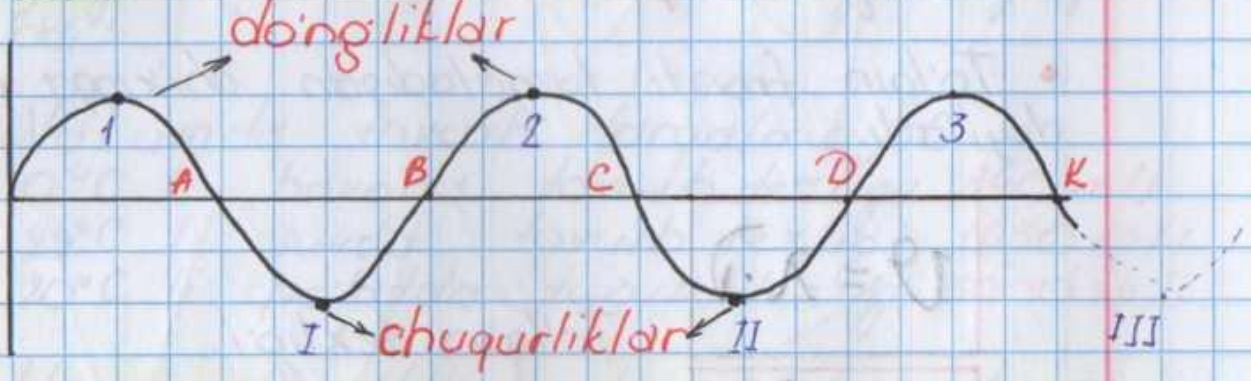
Tebranishlarning muhitda tarqalishiga **to'lqin** deyiladi. To'lqinlar 2 xil bo'ladi:

- Ko'ndalang to'lqin
- Bo'ylama to'lqin

Ko'ndalang to'lqin deb, tarqalish yo'nalishi tebranish yo'nalishiga perpendikulyar bo'lgan to'lqinlarga aytiladi.

Bo'ylama to'lqin deb, tarqalish yo'nalishi tebranish yo'nalishiga teng bo'lgan to'lqinlarga aytiladi.

- Tovush va **pryjina** bo'ylama to'lqin golganlari bo'ndalang to'lqin.
- Qattiq jism va suyuqliklarda = ko'ndalang to'lqinlar ham, bo'ylama to'lqinlar ham tarqaladi.
- Gazlarda faqat bo'ylama to'lqinlar tarqaladi.

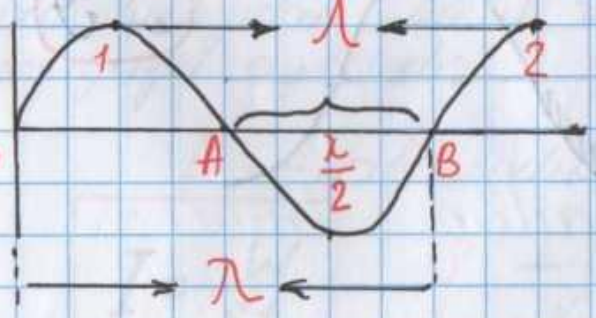


To'lqinning vaqt o'qi bilan kesishgan nuqtalari **tugun** deyiladi (A, B, C, D, K, O).

fazalari bir xil 1 va 2 va 3; O va B va D;
A va C va K; I va II va III

- Bir xil fazada tebranuvchi eng yaqin ikkita nuqta orasidagi masofaga **to'lqin uzunligi** deyiladi.

λ – to'lqin uzunligi [m]



$$OA = AB = \frac{\lambda}{2}$$

• Bir xil fazada tebranayotgan nuqtalarning giametrik o'rniga **to'lqin sirti** deyiladi.

$$\ell = N \cdot \lambda$$

N – to'lqinlar soni.

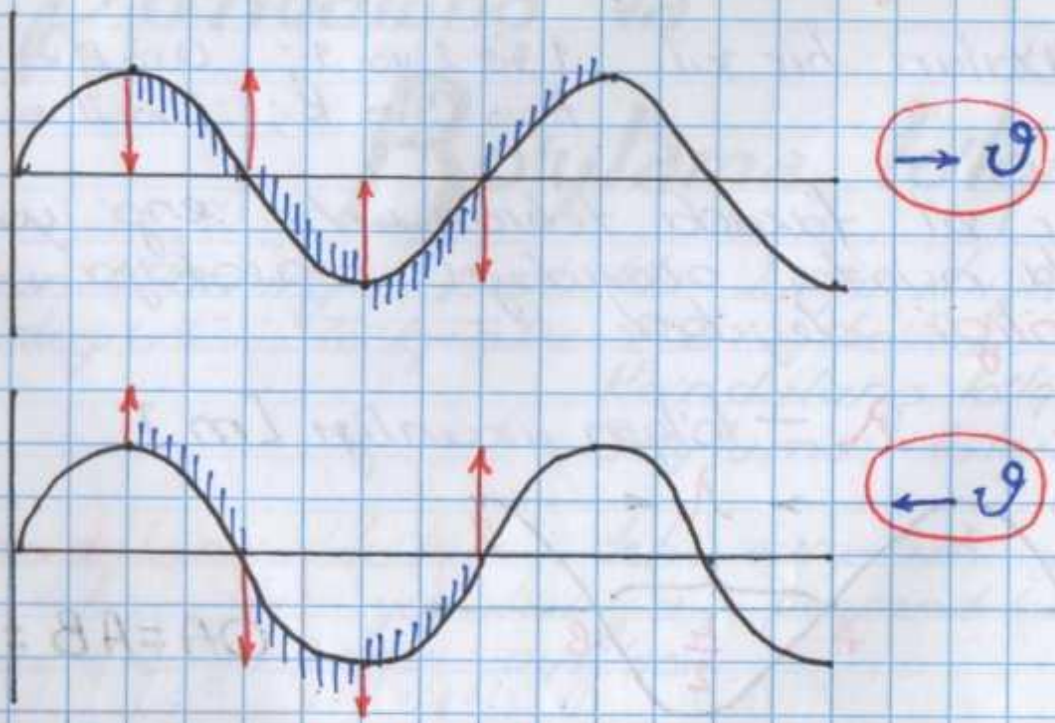
• To'lqin sirti yetib borgan va to'lqin manbaidan eng uzoqdagi nuqtalarning giometrik o'rniga **to'lqin fronti** deyiladi.

• To'lqin fronti tarqaladigan chiziqqa **nur** deyiladi.

$$\vartheta = \lambda \cdot \nu$$

$$\vartheta = \frac{\lambda}{T}$$

To'lqin tezligi.



Tovushning Xossalari.

Chastotasi 16 (20) Hz dan 20000 Hz gacha to'lqinlarga tovush deyiladi.

- Tovushning tarqalish tezligi tovush tarqalayotgan muhitning xossalariga bog'liq bo'ladi:

Vakumda tovush tarqalmaydi.
0°C li havoda tovush tezligi 340 m/s.
20°C li suvda tovush tezligi 1450 m/s
20°C li po'latda tovush tezligi 5000 m/s.

- Harqanday to'lqin, tovush ham bir muhitdan 2-muhitga o'tganda to'lqin uzunligi va tezligi o'zgaradi. Chastotasi o'zgarmaydi.

$$\nu = \frac{\vartheta}{\lambda} \qquad \vartheta \sim \lambda \qquad \nu = const$$

(To'lqin) Tovush intensivligi deb tovush to'lqinlari tarqalish yo'nalishiga perpendikulyar (tik) joylashgan tekislikning yuza birligidan birlik vaqt oralig'ida o'tuvchi energiyaga aytiladi.

I — intensivlik $\left[\frac{J}{m^2 s}\right]$

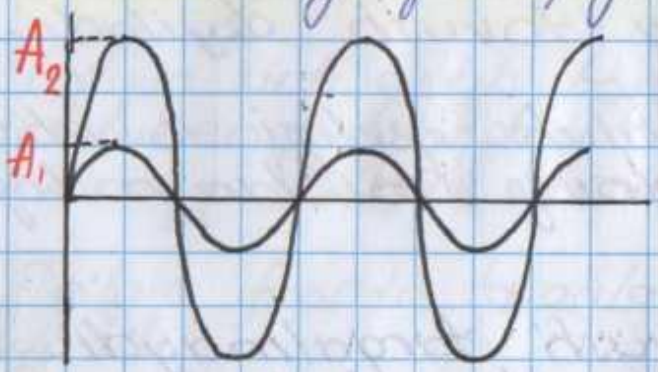
$$I = \frac{W}{St}$$

S — yuza
t — vaqt
W — energiya

• Tovushning balandligi chastotasiga to'g'ri proporsional

$$\nu \sim h$$

• tovushning qattiqligi amplitudaga bog'liq



$$A_1 < A_2$$

A_2 – qattiqroq.

$$\nu_2 > \nu_1 \qquad T_2 < T_1$$

• To'lqinlar orasidagi fazalar farqi bilan yo'llar farqi quyidagicha bog'langan.

$$\Delta\varphi = \frac{2\pi \cdot \Delta\ell}{\lambda}$$

$\Delta\varphi$ – fazalar farqi
$\Delta\ell$ – yo'llar farqi

• Ikkita tovushning maksimumlar va minimumlar sharti quyidagicha.

Maksimumlar sharti:

Yo'llar farqi juft son marta yarim to'lqin uzunligiga teng bo'lsa bu tovush eshitiladi.

$\Delta l = l_1 - l_2$

$\Delta l = 2n \cdot \frac{\lambda}{2}$ $\quad n = 1, 2, 3, \ldots$

$$\Delta l = \lambda \cdot n$$

Minimumlar sharti:

Yo'llar farqi tog son marta yarim to'lqin uzunligiga teng bo'lsa bu tovush eshitilmaydi.

$$\Delta l = (2n+1) \cdot \frac{\lambda}{2}$$

- Chastotasi 16 Hz dan kichik bo'lgan to'lqinlarga infra tovush deyiladi
- Chastotasi 20000 Hz dan katta bo'lgan to'lqinlar ultra tovush deyiladi

$h = \frac{v \cdot t}{2}$ balandlikni topish formulasi

Energiya zichligi hajm birligidagi energiyaga aytiladi.

$$\underline{w} = \frac{W}{V}$$

$\underline{w}$ – energiya zichligi $\left[\frac{J}{m^3}\right]$

$W = \frac{x_m^2 m v^2}{2}$ $\quad \omega = 2\pi\nu$

$W \sim \nu^2$ $\quad \frac{w - \nu^2}{\underline{w} - \omega^2}$

Molekular Fizika

Molekulalarning massasi. Modda miqdori.

Molekulyar fizika moddalarning tuzilishi va xossalari, ular tarkibi topgan molekulalarning uzluksiz va tartibsiz harakatining natijasidir deb hisoblanuvchi tasavvurlar asosida o'rganuvchi fizikaning bo'limidir.

• Barcha moddalar molekulalardan tuziladi.

Molekula deb moddaning barcha xossalarini o'zida saqlagan eng mayda zarrachaga aytiladi.

• Molekulalar atomlardan tuziladi.

Atom deb kimyoviy elementning barcha xossalarini o'zida saqlagan eng mayda zarrachaga aytiladi.

• Atom musbat zaryadlangan yadro va manfiy zaryadlangan elektron'dan iborat.

$X^{A}_{(Z)}$ elektronlar soni

H_2O da 3 ta atom bor (HOH)

$H_1 O_{16} H_1$ 10 ta elektron bor.

Molekulyar fizika 2 qismdan iborat:
- molekulyar kinetik nazariya (MKN)
- Termo dinamika (TD)

- Barcha moddalar atom va molekulalardan tuzilgan degan nazariya molekulyar kinetik nazariyadir.

Molekulyar kinetik nazariya 3 ta qoidaga asoslanadi:

- Har qanday jism molekulalardan tuzilgan.
- Molekulalar uzluksiz va xaotik (tartibsiz) harakatda bo'ladi
- Molekulalar orasida elektro magnit harakterga ega bo'lgan tortish va itarishish kuchlari mavjud.

Molekulalarning chiziqli o'lchami (diametri) $d \sim 10^{-10}\ m$ tartibida bo'ladi

Molekulalarning massasi $m_0 \sim 10^{-27}\ kg$ tartibida bo'ladi.

Bu sonlar juda kichik bo'lganligi uchun nisbiy atom massa tushunchasi kiritiladi. Nisbiy atom massa sifatida uglerod (C_6^{12}) izotopining 1/12 qismiga nisbatan olinadi

A — nisbiy atom massa [m.a.b], [u]

$$A = \frac{m_a}{\frac{1}{12} m_c}$$

X_z^A A nisbiy atom massa.

Nisbiy molekulyar massaning formulasi quyidagicha.

$$M_r = \frac{m_o}{\frac{1}{12} m_c}$$

M_r — nisbiy molekular massa [m.a.b], [u]
m_c — uglerod atom massasi
m_o — bitta molekula massasi

• Uglerod tabiatda eng ko'p tarqalgan.

Jismlarda atom va molekulalar soni juda ko'p bo'ladi. Shuning uchun **modda miqdori** tushunchasi kiritiladi.

Modda miqdori deb moddadagi molekula yoki atomlar sonining 12 gramm uglerodidagi atomlar sonidan necha marta katta ekanligini ko'rsatuvchi qiymatga aytiladi.

• 12 gramm atomlar soniga **avogadro son** yoki **avogadro doimiysi** deyiladi.

ν — modda miqdori [mol]

$$\nu = \frac{N}{N_A}$$

$N_A = 6,022 \cdot 10^{23}$ 1/mol

$$N_A = 6 \cdot 10^{23}$$

• Har qanday moddaning 1 molida $6 \cdot 10^{23}$ ta atom bor.

1 mol moddaning massasiga **molyar massa** deyiladi.

M, μ — molyar massa [Kg/mol]

$$M = \frac{m}{\nu}$$

$$M = m_0 \cdot N_A$$

$$M = A \cdot 10^{-3}$$

$X_Z^{(A)}$

Ko'p uchraydigan moddalarning molyar massalari.

Vodorod (atomi) (H) - $M = 10^{-3}$ kg/mol
Vodorod (gazi, molekula) (H_2) - $M = 2 \cdot 10^{-3}$

Kislorod (atomi) (O) - $M = 16 \cdot 10^{-3}$
Kislorod (gazi, molekula) (O_2) - $M = 32 \cdot 10^{-3}$

Geliy (He) - $M = 4 \cdot 10^{-3}$

Suv (H_2O) - $M = 18 \cdot 10^{-3}$

Azot (atom) (N) - $M = 14 \cdot 10^{-3}$
Azot (gaz, molekula) (N_2) - $M = 28 \cdot 10^{-3}$

Havo $M = 29 \cdot 10^{-3}$

Metan (CH_4) - $M = 16 \cdot 10^{-3}$

Uglerod (C) - $M = 12 \cdot 10^{-3}$

Karbonat angidrid (CO_2) - $M = 44 \cdot 10^{-3}$

Moddadagi **molekulalar soni** quyidagi formula bilan topiladi:

$$M = \frac{m}{D} \qquad D = \frac{N}{N_A} \qquad D = \frac{m}{M}$$

$$N = D \cdot N_A$$

$$N = \frac{m}{M} \cdot N_A$$

$$N = \frac{\rho \cdot V}{M} \cdot N_A \qquad m = \rho V \qquad V = S \cdot d$$

$$N = \frac{\rho \cdot S \cdot d}{M} \cdot N_A \qquad m = \rho \cdot S d.$$

Brown harakati deb, suyuqlik yoki gazga solingan zarrachaning tartibsiz harakatiga aytiladi.

1827-yilda Shotland botanigi Robert Brovn tajribada kuzatgan.

Brovn harakati 3 xil xususiyatga ega

- Brovn harakati uzluksiz va to'xtovsiz boladi
- Brovn harakati zarrachaning o'lchamiga bog'liq bo'lib, zarraning materialiga bog'liq emas
- Tempera tura ortsa zarrachaning tezligi ortadi.

Ideal gaz. Gaz MKN ning asosiy tenglamas

• Ideal gaz Real gazning modelidir.

Ideal gaz da molekulalar orasida o'zaro ta'sir kuchi, molekulalarning o'zaro ta'sir potensial energiyasi, molekulalarning hajmi va shakli hisobga olinmaydi

• Ular faqat to'qnashganda ta'sirlashadi deb hisoblanadi.

Modda konsentratsiyasi deb hajm birligidagi molekulalar soniga aytiladi

n – konsentratsiya $[m^{-3}]$

$$n = \frac{N}{V}$$

$$n = \frac{m \cdot N_A}{M \cdot V}$$

$$n = \frac{\rho \cdot N_A}{M}$$

$M = m_0 N_A$.

$$n = \frac{\rho}{m_0}$$

$$\rho = m_0 \cdot n$$

Aralashmaning zichligi quyidagi formula bilan topiladi.

$$\rho = \frac{m_1 + m_2 + \ldots + m_n}{V_1 + V_2 + \ldots + V_n}$$

Gaz molekulalarining idish devoriga beradigan kopdan kop zarbalari **gaz bosimini** hosil qiladi. va u quyidagiga teng.

$$P = \frac{1}{3} \cdot n \cdot m_0 \cdot \vartheta^2$$

P — bosim
ϑ^2 — o'rtacha kvadratik tezlik.

$p = n \cdot m_0$.

$$P = \frac{1}{3} \cdot p \cdot \vartheta^2$$

$\frac{1}{3}\vartheta^2$ gaz molekulalarining tartibsiz harakati isboti.

MKN ning asosiy tenglamalari:

$$P = \frac{1}{3} \cdot n \cdot m_0 \vartheta^2 \quad \frac{\cdot 2}{\cdot 2}$$

Surat va maxrajga 2 ni kopay tirsak, unda:

$$P = \frac{2}{3} n \cdot \frac{m_0 \vartheta^2}{2} \qquad \frac{m\vartheta^2}{2} = W_k$$

$$P = \frac{2}{3} \cdot n \cdot W_k$$

$$P = n \cdot K \cdot T$$

K — Bolsmon doimiysi.
$K = 1{,}38 \cdot 10^{-23}$

T — obsolyut temperatura.

$$P = \frac{N}{V} KT$$

• Normal sharoitda (me'yoriy shoiroit).

$$P_0 = 10^5\ Pa \qquad T_0 = 273\ K$$

$$n = \frac{P_0}{KT_0}$$

• Normal sharoitda har qanday molekulalaning konsentratsiyasi bir xil.

d ← molekulalar orasidagi masofa

$$d = \sqrt[3]{V}$$

$$n = \frac{P_0}{KT_0} \qquad n = \frac{N}{V}$$

$$\frac{N}{V} = \frac{P_0}{KT_0}$$

$$V = \frac{NKT_0}{P_0}$$

• Normal sharoitda har qanday gaz molekulalari orasidagi masofa

$$d = \sqrt[3]{\frac{KT_0}{P_0}} \approx 3{,}3 \cdot 10^{-9}\ m$$

$$d = \sqrt[3]{V} = \sqrt[3]{\frac{m_0}{\rho}}$$

$$d = \sqrt[3]{\frac{M}{N_A \cdot \rho}}$$ Molekula o'lchami.

• Agar, d_1 — molekula orasidagi masofa
d_2 — molekula chizig'i o'lchami bo'lsa

Gazlarda $\boxed{\frac{d_1}{d_2} = 10}$

Suyuqlik, Qattiq jismlarda $\boxed{\frac{d_1}{d_2} = 1}$

Absolut temperatura.
Molekulalarning o'rtacha
Kinetik energiyasi.

$$p = nkT \qquad p = \frac{2}{3} n W_K$$

$$\cancel{n}kT = \frac{2}{3}\cancel{n}W_K$$

$$\boxed{T = \frac{2W_K}{3 \cdot K}}$$

W_K — kinetik energiya [J]
T — absolut temperatura [K]
$K = 1{,}38 \cdot 10^{-23}$ [J/K]

$$T \sim W_K$$

• Temperatura kinetik energiyasi o'lchovidir.

$$W_K = \frac{m\vartheta^2}{2} \qquad T \sim \vartheta^2$$

$$K = \frac{2W_k}{3T}$$

Bolsman doimiysining fizik ma'nosi quyidagicha: 1 kelvin temperaturaga kinetik energiyaning ulushini harakterlaydi yoki temperaturaning energetik birligi joul bilan absolyut shkaladagi birligi kelvinni bir-biriga bog'laydi.

- Agar jismlar sistemasi, termodinamik muvozanatda yoki issiqlik muvozanatda, izotermik jarayon deyilsa bu sistemada <u>temperatura</u> bir xil bo'ladi.

- Masalalarda «erkin siljiydigan porshen ostida ...», «og'zi ochiq idish», «izobarik jarayon» deyilsa <u>bosim</u> o'zgarmas hisoblanadi

- Masalalarda «berk idish», «izoxorik jarayon» deyilsa <u>hajm</u> özgarmas deyiladi.

- Agar gazning ma'lum qismi chiqim ketdi deyilsa, gazning massasi tamayqan bo'ladi. Masalan, gazning 80% chiqib ketdi deyilsa,

$$m_2 = m_1 - 0{,}8m_1$$
$$m_2 = 0{,}2m$$

4 xil temperatura shkalasi bor:

- Riomer shkalasi.

$$^\circ R = 0{,}8t \qquad t - [^\circ C]$$

- Farangeyt shkalasi

$$^{\circ}F = 32 + \frac{9}{5}t$$

- Selsiy shkalasi

Selsiy shkalasi 0 nuqta sifatida normal atmosfera bosimida muzning erishi, 100 nuqtasifatida suvning qaynashi

- Kelvin shkalasi, Absolyut shkala, Termodinamik shkala

$$T - [K]$$

Kelvin shkalasida 0 nuqta sifatida atom va molekulalar harakatdan to'xtaydigan temperatura olingan bu temperaturaga obsolyut 0 temperatura deyiladi. 0 kelvin sovuqni chegarasi, bundan past harorat yo'q

$$T = (t + 273)\ K$$

$$t = (T - 273)\ ^{\circ}C$$

$$\Delta t = \Delta T.$$

Gaz molekulalarning o'rtacha tezligi.

Gaz molekulalarining tezligini tajribada birinchi bo'lib 1920-yili Shtern aniqlagan.

Gaz molekulalarining o'rtacha tezligi quyidagi formulalar orqali topiladi.

$$P = \frac{1}{3} n m_0 \vartheta^2.$$

$$\vartheta = \sqrt{\frac{3P}{n m_0}} \qquad \vartheta = \sqrt{\frac{3P}{\rho}} \qquad \vartheta = \sqrt{\frac{3KT}{m_0}}$$

$$\vartheta = \sqrt{\frac{3RT}{M}} \qquad \vartheta = \sqrt{\frac{3KN_AT}{M}} \qquad m_0 = \frac{M}{N_A}.$$

$$K \cdot N_A = R \qquad R = 8{,}31 \ J/mol \cdot K$$

R – universal gaz doimiysi

Ideal gaz holatining tenglamasi.

Gaz holatini ifodalovchi 3 ta fizik kattalikka

P – bosim [Pa]
V – hajm [m^3]
T – temperatura [K]

makroskopik parametr yoki termodinamik parametr deyiladi.

3 ta parametrni bir-biriga bog'lovchi tenglamaga holat tenglamasi deyiladi va quyidagicha bo'ladi.

$$\frac{PV}{T} = const$$ Klapeyron tenglamasi (holat tenglamasi)

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

• Ixtiyoriy m massali uchun Mendeleyev – Klapeyron tenglamasi o'rinli

$$PV = \frac{m}{M} RT$$

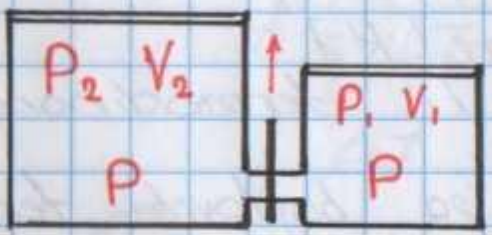
$$PV = \nu RT \qquad \frac{m}{M} = \nu$$

$$PV = \frac{N}{N_A} RT \qquad \frac{N}{N_A} = \nu$$

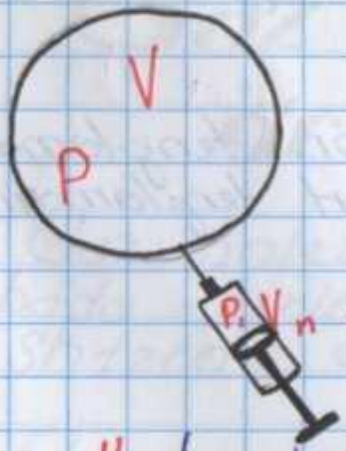
$$P = \frac{mRT}{MV} = \frac{\rho RT}{M} \qquad m = \rho V$$

• Aralashma bosimi

$$P = \frac{P_1V_1 + P_2V_2 + \dots P_nV_n}{V_1 + V_2 + \dots V_n}$$



$$P_1V_1 + P_2V_2 = P(V_1 + V_2)$$



$$PV = P_1(V + KV_n)$$

$$P = nP_1 \qquad n$$ – bosim ortishi

$$nP_1V = P_1(V + KV_n)$$

$$nV = V + KV_n$$ dom to'rilsa

$$\frac{V}{n} = V - KV_n$$

dan so'ralsa.

n — bosim kamayishi.

«Dalton» qonuni quyidagicha.

Bir-biriga kimyoviy aralashmaydigan gazlarning umumiy bosimi har bir gazning parsial (alohida) bosimlarining yig'indisiga teng bo'ladi;

$$P = P_1 + P_2 + P_3 + \dots + P_n$$

Fizikada 2 xil kattalikla bor:

- additiv kattaliklar
- noodditiv kattaliklar.

Additiv Kattaliklar — to'g'ridan-to'g'ri qo'shib boladigan kattaliklardir. ($m, V, V_{...}$)

Noodditiv Kattaliklar — to'g'ridan-to'g'ri qo'shib bolmaydigan kattaliklardir. ($M, t, T...$)

$$\vec{V} = \vec{V}_1 + \vec{V}_2$$

$$\frac{m}{M} = \frac{m_1}{M_1} + \frac{m_2}{M_2}.$$

Gaz qonunlari

Uchta parametrdan bittasi o'zgarmas bo'lib qolgan 2tasi orasidagi bog'lanishga gaz qonunlari deyiladi.

Boyl - Mariot qonuni.

Agar ma'lum bir massali gazning temperaturasi o'zgarmas bo'lsa bosim bilan hajmning ko'paytmasi ham o'zgarmas bo'ladi.

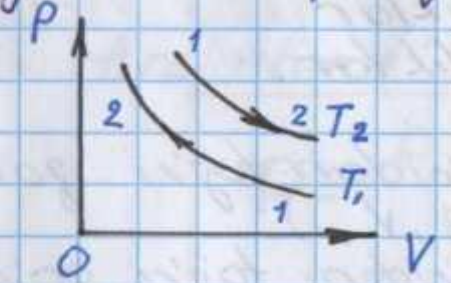
$T = const$ $\quad PV = const$

$$P_1V_1 = P_2V_2$$

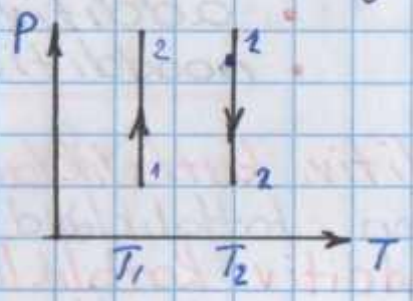
Izotermik jarayon

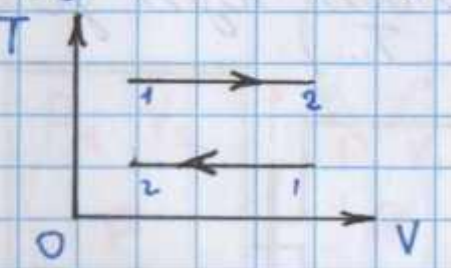
$$P \sim \frac{1}{V} \quad V \sim \frac{1}{P}$$

• Grafiklarda temperatura o'zgarmas bo'lgan chiziqlarga izotermalar deyiladi.



$T_1 < T_2$





Geey - Lyussak qonuni.

Agar ma'lum bir massali gazning bosimi o'zgarmas bo'lsa gaz hajmining temperaturasiga nisbati ham o'zgarmas bo'ladi.

$P = const$ $\quad \frac{V}{T} = const.$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Izobarik jarayon

$V \sim T$,

• Agar gaz o'zgarmas bosimda isitilsa uning hajmi ortadi.

$$V = V_0(1 + \alpha t)$$

V — $t°C$ dagi hajmi
V_0 — $0°C$ dagi hajmi
α — hajmiy kengayish koeffitsiyenti

$$\alpha = \frac{1}{273\,K}$$

$$\frac{V}{T} = \frac{V_0}{T_0} \qquad \alpha = \frac{1}{T_0}$$

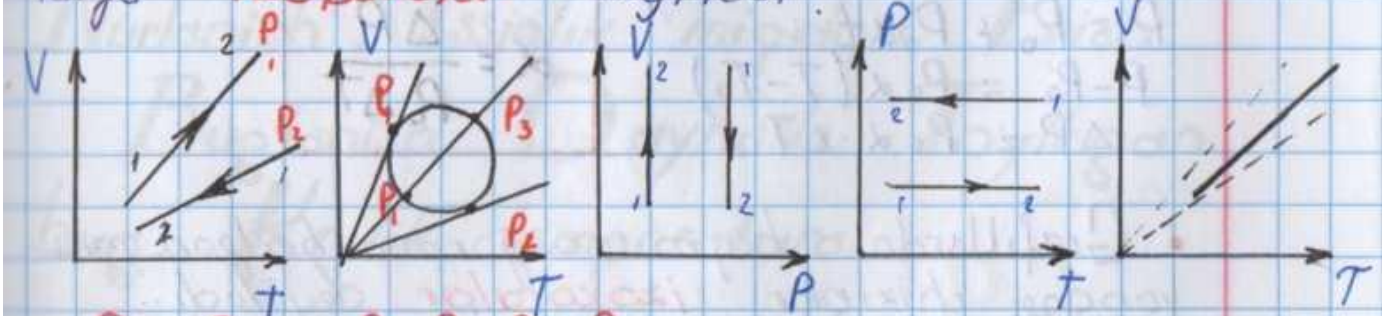
$$\frac{V}{T} = V_0 \cdot \alpha$$

$$\alpha = \frac{V}{T \cdot V_0}$$ Hajmiy kengayish koeffitsiyenti.

$$V = V_0 + V_0 \alpha t$$
$$V - V_0 = V_0 \alpha (T - T_0)$$
$$\Delta V = V_0 \cdot \alpha \cdot \Delta T$$

$$\alpha = \frac{\Delta V}{V_0 \Delta T}$$

• Grafiklarda bosim o'zgarmas bo'lgan chiziq larga izobaralar deyiladi.



$P_2 > P_1$ $P_4 > P_3 = P_1 > P_2$

Sharl qonuni

Sharl qonuni quyidagicha: agar ma'lum bir massali gazning hajmi o'zgarmas bo'lsa gaz bosimining temperaturaga nisbati ham o'zgarmas bo'ladi.

$$V = const \qquad \frac{P}{T} = const.$$

$$\boxed{\frac{P_1}{T_1} = \frac{P_2}{T_2}}$$

Izoxorik jarayon

$P \sim T.$

- Agar gaz o'zgarmas hajmda isitilsa uning posimi ortadi.

$$\boxed{P = P_0(1 + \alpha t)}$$

$$\frac{P}{T} = \frac{P_0}{T_0} \qquad \alpha = \frac{1}{T_0}$$

$$\boxed{\alpha = \frac{P}{P_0 T}}$$

$$\frac{P}{T} = P_0 \cdot \alpha.$$

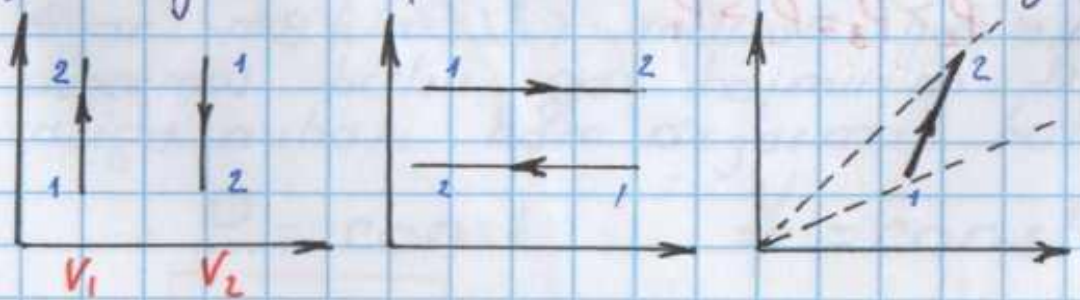
$$P = P_0 + P_0 \alpha t$$

$$P - P_0 = P_0 \alpha (T - T_0)$$

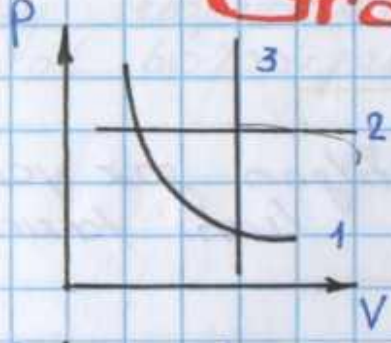
$$\Delta P = P_0 \alpha \cdot \Delta T.$$

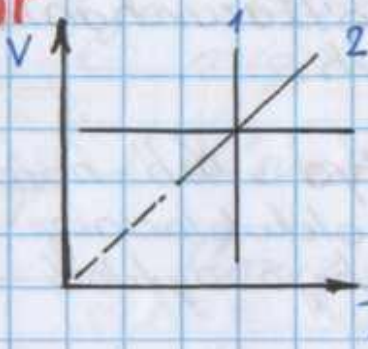
$$\boxed{\alpha = \frac{\Delta P}{P_0 \Delta T}}$$

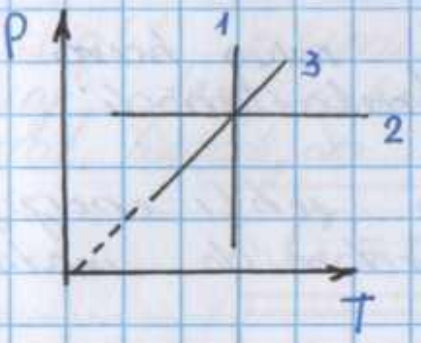
- Grafiklarda hajm o'zgarmas bo'lgan jarayondagi chiziqlar *izoxoralar* deyiladi.



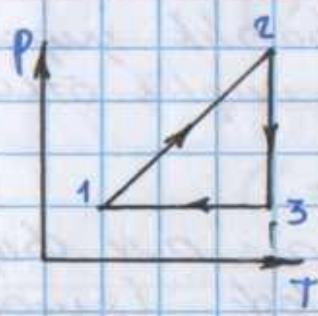
Grafiklar

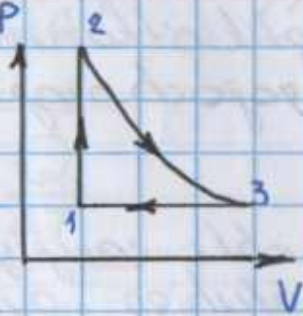


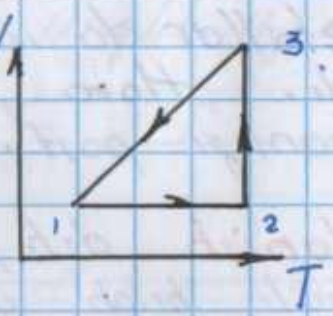




1 - izoterma
2 - izobara
3 - izoxora.







Issiqlik o'tkazuvchanlik. **K**onveksiya. **N**urlanish. **I**ssiqlik miqdori. **E**rish. **B**ug'lanish. **Q**aynash. **T**o'yingan bug'. **K**ritik temperatura.

Issiqlik uzatish 2-xil usulda bo'ladi
- ish bajarish
- issiqlik almashish

Ichki energiyani ish bajarmasdan uzatishga issiqlik almashish deyiladi.
Issiqlik almashish 3 turga bo'linadi:

- Konveksiya
- Issiqlik o'tkazuvchanlik
- Nurlanish.

Konveksiya deb notekis isitilgan gaz yoki suyuqlik molekulalarining og'irlik kuchi ta'sirida ko'chishiga aytiladi.

- Issiq havo oqimi yuqoriga, sovuq havo oqimi pastga qarab harakatlanadi.

Issiqlik o'tkazuvchanlik da ichki energiya molekulalarning harakati yordamida uzatiladi (molekulalar ko'chmaydi).

- Metallar da issiqlik o'tkazuvchanlik yuqori bo'ladi. Havo, yog'ochning issiqlik o'tkazuvchanligi past.

Nurlanish deb, ichki energiyani nur chiqarish yo'li bilan uzatishga aytiladi (quyosh, olanga).

Issiqlik almashish jarayonida jism olgan yoki yo'qotgan energiyaga **issiqlik miqdori** deyiladi.

- Jism isiganda issiqlik miqdori oladi, sovuganda beradi.

Q — issiqlik miqdori [J]

$$Q = cm\Delta t = cm(t_2 - t_1)$$

c — solishtirma issiqlik sig'imi $\left[\frac{J}{Kg \cdot K}\right]$

Solishtirma issiqlik sig'imi deb 1 kg modda

ning temperaturasini 1 K ga oshirish uchun kerak bo'lodigan issiqlik miqdoriga aytiladi.

$$c = \frac{Q}{m\Delta T}$$

$C_{suv} = 4200$ J/kg·K

$C_{muz} = 2100$ J/kg·K

Issiqlik sig'imi deb berilgan massali jismning temperaturasini 1 K ga isitish uchun kerak bo'lodigan issiqlik miqdoriga aytiladi.

$$C = cm$$

$$Q = C\Delta T$$

$$C = \frac{Q}{\Delta T}$$

C — issiqlik sig'imi $\left[\frac{J}{K}\right]$.

Qattiq jismlarning suyuqlikka aylanish jarayoniga erish deyiladi.

Jism erishni boshlaydigan temperaturaga erish temperaturasi deyiladi.

Erishga teskari jarayon qotish yoki kristallanish deyiladi.

- Erish temperaturasi qotish temperaturasiga teng. Jism eriyotganda va qotayotganda temperatura o'zgarmaydi.

Muz 0°C da eriydi, suv 0°C da muzlaydi.

$$t_{erish} = t_{qotish}$$

• Jism erigonda oladigon issiqlik miqdori quyidagicha topiladi.

$$Q_{er} = \lambda m$$

$$Q_{qot} = -\lambda m$$

λ – solishtirma erish issiqligi. [J/kg]

Solishtirma erish issiqligi erish temperaturasidagi 1 kg moddani butunlay suyuqlikka aylantirish uchun kerak bo'ladigon issiqlik miqdoriga aytiladi.

$$\lambda = \frac{Q}{m} \qquad \lambda_{muz} = 330 \cdot 10^3 \text{ J/kg}.$$

Masala: –10°C li 3 kg muzni 20°C li suvga aylantirish uchun qancha issiqlik miqdori kerak bo'ladi.

$$Q = Q_{muz.is} + Q_{muz.er} + Q_{suv.is}$$

$$Q_{muz.is} = C_m m_m (0 - t°) = 2100 \cdot 3 \cdot 10 = 63 \cdot 10^3$$

$$Q_{muz.er} = \lambda m_m = 330 \cdot 10^3 \cdot 3 = 990 \cdot 10^3$$

$$Q_{suv.is} = C_s m_m (t - 0) = 4200 \cdot 3 \cdot 20 = 252 \cdot 10^3$$

$$Q = 63 \cdot 10^3 + 990 \cdot 10^3 + 252 \cdot 10^3 = 1305 \cdot 10^3 \text{ J}.$$

• Agar m_1 massali va t_1°C haroratli suvga m_2 massali muz solinsa

A. muz to'liq erishi uchun

$$Q_{suv} = Q_{muz}$$

$$c_1 m_1 t_1 = \lambda \cdot m_2$$

B. muz erishi uchun $t_2 < 0$

$$Q_{suv} = Q_{muz}$$

$$c_1 m_1 t_1 = c_2 m_2 t_2 + \lambda m_2$$

C. $Q_{suv} > Q_{muz}$.

$$c_1 m_1 (t_1 - t) = c_2 m_2 t_2 + \lambda m_2 + c_1 m_2 t$$

D. $Q_{suv} < Q_{muz}$

$$\Delta Q = \frac{m_q}{\lambda}$$

m_q — erimay qolgan muz.

Suyuqlikning bugga aylanish hodisasiga **bug'lanish** deyiladi.

Bug'lanish deb suyuqlikning erkin sirtidagi tezligi (energiyasi) katta molekulalarning suyuqlikni tark etish hodisasiga aytiladi.

Erkin sirt deb suyuqlikning idish devoriga tegmay turgan sirtiga aytiladi.

- Bug'lanish modda turiga, temperaturaga, erkin sirt yuziga va suyuqlik ustidagi haroning holatiga (shamolda tez bug'lanadi) bog'liq.

• Jism bug'langanda oladigan issiqlik miqdori quyidagiga teng:

$$Q_{bug'} = Lm$$

r, L – solishtirma bug'lanish issiqligi [J/kg]

Solishtirma bug'lanish issiqligi deb 1 kg suyuqlikni batamom bug'ga aylantirish uchun kerak bo'ladigan issiqlik miqdoriga aytiladi.

Bug'lanishga teskari jarayon **kondensatsiya** deyiladi.

$$Q_{kon} = -Lm$$

$$r_{bug'} = r_{kond.}$$

$L_{suv} = 2{,}26 \cdot 10^6$ J/kg ≈ $2{,}3 \cdot 10^6$ J/kg.

• 1 kg bug'ning ichki energiyasi o'sha temperaturadagi 1 kg suvning ichki energiyasidan 2,26 MJ ga ortiq.

! Modda isiganda, eriganda, bug'langanda, sublimatsiyada, issiqlik yutadi, ichki energiyasi ortadi, massasi ham ortadi.

Modda soviganda, kristallanganda (qotganda) kondensatsiyada issiqlikni chiqaradi, ichki energiyasi kamayadi, massasi ham kamayadi.

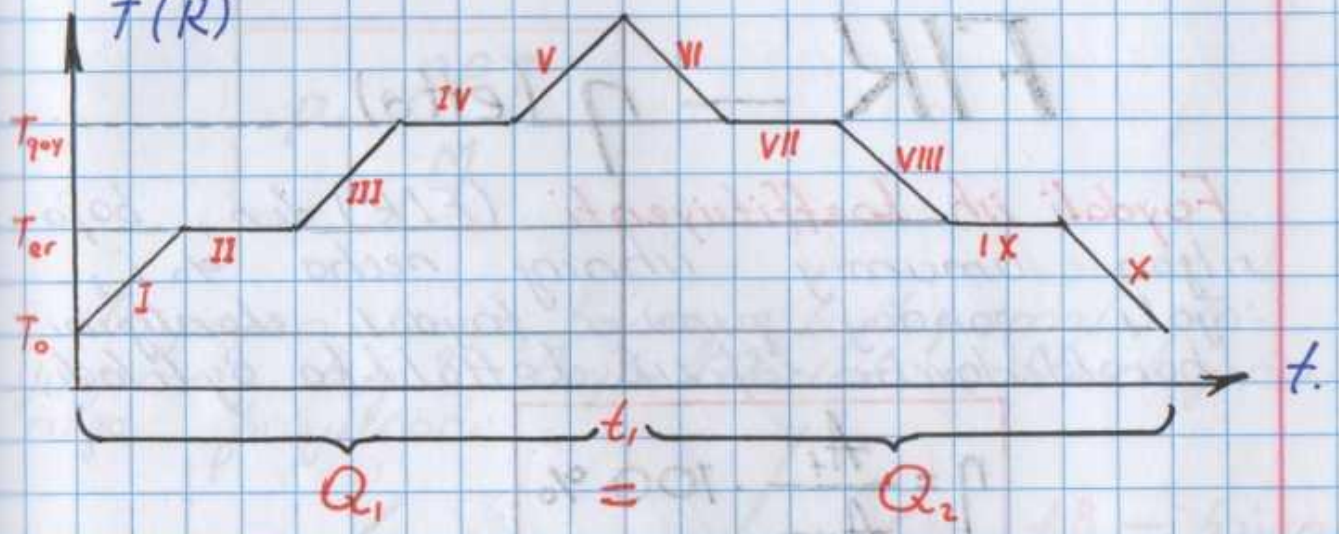
Suyuqlikning butun hajmidan bug' ajralib chiqish hodisasi **qaynash** deyiladi.

Qaynash deb isiyotgan suyuqlikda hosil bo'ladigan tez kattalashadigan pufak ichidagi bosim tashqi bosimga tenglashish hodisasiga aytiladi.

Suyuqlik qaynashni boshlaydigan temperatura **qaynash temperaturasi** deyiladi.

• Suyuqlik qaynayotganda temperatura o'zgarmaydi. Qaynash temperaturasi tashqi bosimga to'g'ri proporsional. Normal atmosfera bosimida suv 100°C da qaynaydi.

• Jismga issiqlik berilganda vaqtga bog'lanish grafigi quyidagicha.



I — qattiq jismning isishi
II — erish
III — suyuqlikning isishi
IV — qaynash
V — bug'ning ishishi
VI — bug'ning sovishi
VII — kondensatsiya
VIII — suyuqlikning sovishi
IX — kristallanish yoki qotish
X — qattiq jismning sovishi

$$t = \frac{m_1 t_1 + m_2 t_2}{m_1 + m_2}$$

Aralashmaning temperaturasi.

• Yoqilgi yonganda ajraladigan issiqlik miqdori quyidagicha topiladi:

$$Q = qm$$

q — solishtirma yonish issiqligi. [J/kg].

$$q = \frac{Q}{m}$$

$q \sim 10^6$ J/kg.

FIK — η (etta)

Foydali ish koeffitsiyenti (FIK) deb, bajarilgan umumiy ishning necha % i, yoki qanday qismi foydali ekanligini harakterlovchi fizik kattalikka aytiladi.

$$\eta = \frac{A_t}{A_{um}} \cdot 100\ \%$$

$$\eta = \frac{Nt}{q \cdot m} \qquad \eta = \frac{cm\Delta T}{qm} \qquad \eta = \frac{cm_s\Delta t}{m_i g h}$$

$$\eta = \frac{Ns}{\vartheta qm} \qquad \eta = \frac{cm\Delta T}{Nt} \qquad \eta = \frac{mgh}{Nt}.$$

O'zining suyuqligi bilan dinamik muvozanatda bo'lgan bug'ga to'yingan bug' deyiladi. To'yinmagan bo'lsa to'yinmagan bug' deyiladi.

Bug'lanish kondensatsiyadan ustun bo'lsa to'yinmagan bug' bo'ladi.

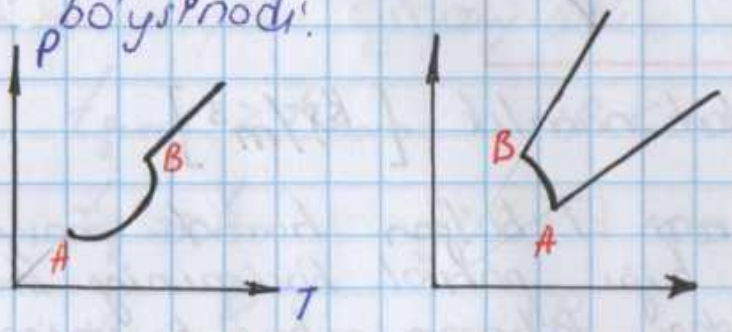
Dinamik muvozanat deb, ma'lum vaqt ichida suyuqlikdan uchib chiqayotgan molekulalar sonining shu vaqt ichida suyuqlikka qaytib tushayotgan molekulalar soniga teng bo'lishiga aytiladi.

- To'yingan bug' bosimi quyidagi formula bilan topiladi.

$$p = nkT$$

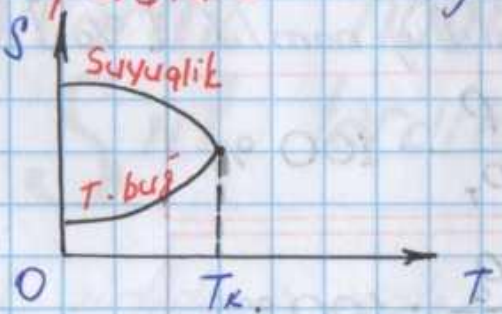
$$p = \frac{\rho RT}{M}$$

- To'yingan bug' hajmga bog'liq emas. To'yingan bug' Boyl-Mariot, Sharl qonuniga bo'ysinadi.



AB — to'yingan bug'.

Suyuqlik bilan uning to'yingan bug'ining fizik xossalari bir xil bo'ladigan temperaturaga **kritik temperatura** deyiladi.



$T_k = 375°C$.

- Gazlarda kritik temperatura manfiy bo'lodi. gazlarni suyultirish uchun ularni kritik temperaturagacha sotish kerak keyin siqish kerak

Havoning namligi.

Tarkibida suv bug'i bo'lgan havoga **nam havo** yoki **namlik** deyiladi.

Absolut namlik

- Havodagi suv bug'ining miqdoriga **absolut namlik** deyiladi.
- Havodagi suv bug'ining zichligiga **absolut namlik** deyiladi.
- Berilgan haroratda havodagi suv bug'ining bosimiga **absolut namlik** deyiladi.
- $1\ m^3$ havodagi suv bug'ining massasiga **absolut namlik** deyiladi.

$$\rho_A = \frac{m}{V}$$

ρ_A – absolut namlik $[Kg/m^3]$

Temperaturasi T bo'lgan harodo mavjud bo'lgan suv bug'i parsial bosimining shu temperaturadagi to'yingan bug' bosimiga nisbatining % larda olingan qiymatiga **nisbiy namlik** deyiladi.

φ – nisbiy namlik [%]

$$\varphi = \frac{\rho}{\rho_T} \cdot 100\ \%$$

$$\varphi = \frac{\rho_a}{\rho_T} \cdot 100\ \%$$

Faqat suv bug'ining bosimiga **parsial bosim** deyiladi.

$$\varphi_{or} = \frac{\rho_1 V_1 + \rho_2 V_2}{V_1 + V_2}$$

Aralashmaning nisbiy namligi.

- Normal hayot kechirish uchun nisbiy namlik 40-60 % bo'lishi kerak.
- Nisbiy namlik avgust psixrometr yordamida o'lchanadi.
- Nisbiy namlikni shudring nuqtasi orqali o'lchaydigan asbob **gigrometr** deyiladi.

Shudring nuqtasi deb suv bug'i to'yinadigan temperaturaga aytiladi.

Namlik 100 % bo'ladigan temperaturaga **shudring nuqtasi** deyiladi.

$t_{quruq} > t_{nam}$ $\varphi < 100\%$

$t_q = t_n$ $\varphi = 100\%$. $\varphi \sim \frac{1}{T}$

$$\varphi = \frac{p}{p_t} \cdot 100\% = \frac{p}{nkT} \cdot 100\%$$

Kapillarlik hodisalari. Sirt taranglik.

Suyuqlik sirtidagi molekulalarni suyuqlikning ichiga qarab tortib turuvchi kuchga **sirt taranglik kuchi** deyiladi.

Suyuqlik sirtini chegaralovchi chiziqqa qo'yilgan sirt yuzasi bo'ylab perpendi-

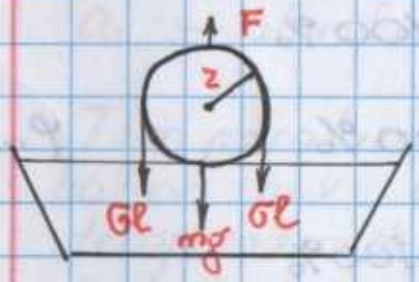
kuluyor yönalgan va yuzani minimal ho-latgacha kichraytirishga intiladigan kuchga sirt taranglik kuchi deyiladi.

$$F = \sigma \cdot \ell$$

F – sirt taranglik kuchi [N]
σ – sirt taranglik koeffitsiyenti [N/m]
ℓ – uzunlik [m]

$$mg = \sigma \ell$$

$$2\sigma \ell = mg$$



$$F = 2\sigma \ell + mg$$

$$\ell = 2\pi r$$

- Sirt taranglik koeffitsiyenti temperatura ortishi bilan suyuqliklarda kamayadi, gazlarda ortadi.
- Vakumda suyuqliklar shar shaklida boladi.
- Suyuqlik sirtidagi molekulalarning potensial energiyasiga sirt energiyasi deyiladi.

$$F = \sigma \cdot \ell$$

$$A = W = U = F \cdot \ell = \sigma \ell \cdot \ell = \sigma S$$

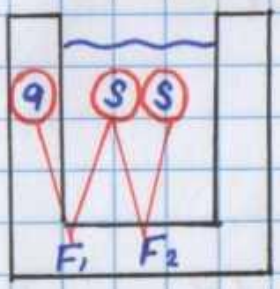
$U = \sigma S$ | $\sigma = \frac{U}{S}$ $[J/m^2]$

$A = \Delta U$
$A = \sigma \cdot \Delta S$.

Shar uchun

$A = \sigma(S_1 - S_1)$ | $A = 2\sigma \Delta S = 2\sigma(S_2 - S_1)$

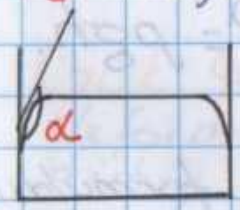
doira : $S = \pi R^2$
shar : $S = 4\pi R^2$.



1. $F_1 > F_2$ bo'lsa hoʻllaydi
2. $F_1 < F_2$ bo'lsa. hoʻllamaydi

hoʻllaydi hoʻllamaydi.

F_1 – qattiq jism va suyuqlik molekulalari tortishish kuchi
F_2 – suyuqlik molekulalari o'zaro tortishish kuchi.

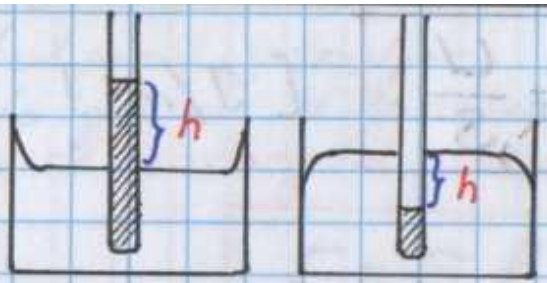


α – o'tmas (hoʻllamaydi)

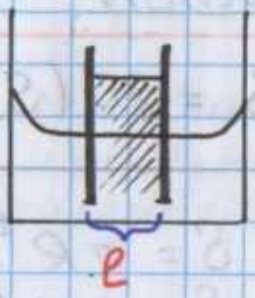
α – o'tkir (hoʻllaydi)

Diametri juda kichik boʻlgan naylarga kapilliar naylar yo kapillyarlar deyiladi.

• Agar kapillarni hoʻlovchi suyuqlikka tushirsak suyuqlik kapillyardan yuqoriga koʻtariladi. Hoʻllamaydigan naylarga tushirsak pastga tushadi.



$$h = \frac{2\sigma}{\rho_s g r} \qquad h = \frac{4\sigma}{\rho g d}$$



$$h = \frac{2\sigma}{\rho g \ell}$$

ℓ – plastinka orasidagi masofa.

$$N = \frac{m}{m_1} = \frac{V}{V_1} = \frac{V}{S \cdot h} = \frac{V}{\pi r^2 \cdot \frac{2\sigma}{\rho g \cdot r}}$$

$$N = \frac{V \rho g}{2\pi r \sigma}$$

N – tomchilar soni

$$h = \frac{2\sigma}{\rho g r} \qquad \rho g h = \frac{2\sigma}{r} \qquad P = \rho g h.$$

$$P = \frac{2\sigma}{r}$$

(Lapas formulasi)

Qattiq jismning mexanik xossalari.

$\Delta \ell = \ell - \ell_0$

$\Delta \ell$ – absolyut uzayish.

$$\varepsilon = \frac{\Delta \ell}{\ell_0} \cdot 100\%$$

ε – nisbiy uzayish.

$$F = k \cdot \Delta l$$ Guk qonuni

Mexanik kuchlanish — deb, yuza birligiga ta'sir etuvchi elastiklik kuchiga aytiladi.

$$\sigma = \frac{F}{S}$$

σ — mexanik kuchlanish, mustahkamlik [Pa]

$$F = mg = \rho V g = \rho S l g$$

$$\sigma = \frac{\rho S l g}{S} = \rho l g$$

$$\sigma = \rho l g$$

$$\sigma = (\rho - \rho_s) l g$$

Guk qonuni quyidagicha: kichik deformatsiyalarda mexanik kuchlanish nisbiy uzayishga to'g'ri proporsional.

$$\sigma = E \cdot |\varepsilon|$$

E — elastiklik moduli (Yung moduli) [Pa]
ε — nisbiy uzayish (epsilon)

Yung moduli deb, nisbiy uzayishi 1ga teng bo'lgandagi mexanik kuchlanishga aytiladi.

Yung moduli deb moddani ikki barobar cho'zish uchun kerak bo'ladigan mexanik kuchlanishga aytiladi.

$$E = \frac{\sigma}{|\varepsilon|}$$

$\frac{F}{S} = E|\varepsilon|$ $F = E|\varepsilon| \cdot S.$

$\varepsilon = \frac{\Delta \ell}{\ell_0}$

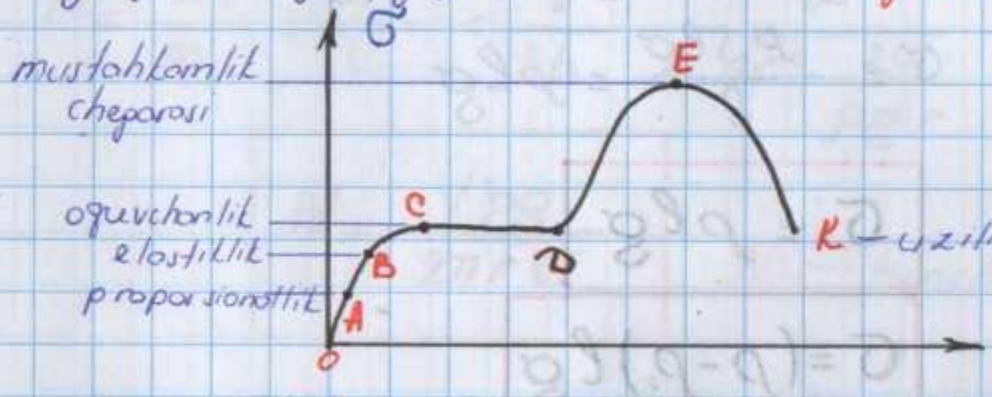
$$F = \frac{E \cdot S}{\ell_0} \cdot |\Delta \ell|$$

$$K = \frac{ES}{\ell_0}$$

$$F = K \cdot |\Delta \ell|$$

K — bikirlik.

Mexanik kuchlanishning nisbiy uzayishga bog'liqlik grafigiga cho'zilish diagrammasi deyiladi.



$\sigma(\varepsilon)$ — cho'zilish diagrammasi

- Diagrammaning OA qismida Guk qonuni bajariladi.
- Qattiq jismlar isitsak kengayadi, sovutsak torayadi.

Qattiq jismlar 2 turga bo'linadi:
- Kristal jismlar
- Amorf jismlar.

Kristallar deb atom va molekulalari fazoda aniq tartibli vaziyatlar egallab joylashadigan qattiq jismlarga aytiladi.

- Kristallar aniq erish haroratiga ega. Kristallarga — metallar, muz, qor, ...

Amorflar deb atom va molekulalari fazoda aniq tartibli vaziyatlar egallamaydigan qattiq jismlarga aytiladi.

- Past temperaturada amorflar – qattiq jismlardek, Yuqori temperaturada — suyuqlik xossalarini namoyon qiladi.

- Amorf jismlarga — shisha, parafin, rezina, mum, poletilen, ...

Kristallarning fizik xossalari (qattiqligi elektr o'tkazuvchanligi, issiqlik o'tkazuvchanlik...) turli yonalishda turlicha bolsa Anizotropiya deyiladi.

Kristalning fizik xossalari turli yonalishida bir xil bolsa izotropiya deyiladi.

- Amorflar izotropdir. Kristallar (monokristallar) anizotropdir.

Termodinamika Asoslari

Ichki energiya.

Termodinamika — turli jarayonlarda molekulalarning issiqlik tartibsiz harakati tufayli energiyaning birinchi turdan 2-turga aylanishining miqdoriy qonunlarini o'rganadi.

Jismni tashkil qilgan zarrachalarning kinetik va potensial energiyalarining yig'indisiga **ichki energiya** deyiladi.

U — ichki energiya [J]

$$U = W_k + W_p$$

- Gazlarda $W_p = 0$ $U = W_k$
- Suyuqliklarda $W_p \approx W_k$ $U = W_p + W_k$
- Qattiq jismlarda $W_k \approx 0$ $U = W_p$

$$N \cdot W_k = \frac{3}{2} \cdot kT \cdot N$$

$$U = N \cdot W_k$$

$$U = \frac{3}{2} kT \frac{m}{M} \cdot N_A \qquad N = \frac{m}{M} \cdot N_A.$$

$$U = \frac{3}{2} \frac{m}{M} \cdot RT \qquad k \cdot N_A = R$$

$$U = \frac{3}{2} \nu RT \qquad \nu = \frac{m}{M}$$

$$U = \frac{3}{2} PV$$

- Xona, idish ichida ichki energiya o'zgarmaydi.

$$\Delta U = \frac{3}{2} \nu R \Delta T \qquad \Delta U = \frac{3}{2} kN \Delta T$$

$$\Delta U = \frac{3}{2} P \Delta V$$

Ichki energiyaning o'zgarishi.

Termodinamikada ish.

Agar gazning hajmi o'zgarsa bu gaz ish bajaradi:

$$A = P\Delta V$$

$$A = P(V_2 - V_1)$$

$$A_t = -A$$

A_t — tashqi kuchlarning gaz ustida bajargan ishi
A — gazning bajargan ishi

- Gaz kengaysa $V_2 > V_1$

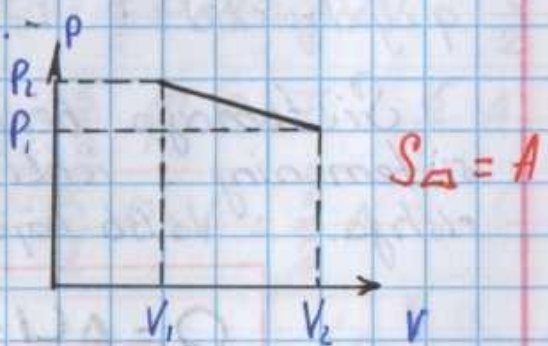
  $A > 0$ $A_T < 0$

  ΔU — kamayadi.

- Gaz siqilsa $V_2 < V_1$

  $A < 0$ $A_T > 0$

  ΔU — ortadi.



$$A = \frac{P_2 + P_1}{2} \cdot (V_2 - V_1)$$

- Izoxorik jarayonda ish bajarilmaydi $A = 0$ $V = const$
- Izobarik jarayonda eng katta ish bajariladi.

$$A = p \cdot \Delta V$$

$$P \Delta V = \nu R \Delta T$$

$$A = \nu R \Delta T$$

$$R = \frac{A}{\nu \Delta T}$$

Universal gaz doimiysi ning fizik ma'nosi quyidagicha: 1 mol ideal gazni izobarik ravishda 1 kelvinga isitishda bajarilgan ishga teng.

$$R = 8{,}31 \quad J/mol \cdot K$$

Termodinamikaning birinchi qonuni.

Termodinamikaning birinchi qonuni issiqlik hodisalariga tadbiq qilingan energiyaning saqlanish qonunidir. Bu qonun quyidagicha:

Sistemaga berilgan issiqlik miqdori sistemaning ichki energiyasini o'zgartirishga va ish bajarishga sarf bo'ladi.

$$Q = \Delta U + A$$

Q — sistemaga berilgan issiqlik miqdori.

$$Q = \Delta U - A \quad \text{(tashqi)}$$

$$-Q = \Delta U + A \quad \text{Issiqlik uzatiladi.}$$

$$-Q = \Delta U - A$$ Issiqlik uzatishda tashqi kuch

- Izotermik jarayon uchun.

$\Delta T = 0$ $\quad \Delta U = \frac{3}{2} \nu R \Delta T = 0$

$$Q = A$$ $$Q_T = P\Delta U$$

- Izoxorik jarayon uchun

$\Delta V = 0$ $\quad A = 0.$

$$Q = \Delta U$$ $$Q_V = \frac{3}{2} \nu R \Delta T$$

$Q = \frac{3}{2} \frac{m}{M} R\Delta T \Rightarrow Q_V = cm\Delta T$

$$C = \frac{3R}{2M}$$ (Mayer formulasi)

- Izobarik jarayon uchun.

$\Delta P = 0$ $$Q_P = \Delta U + A$$

$Q_P = \Delta U + A = \frac{3}{2} P\Delta V + P\Delta V = \frac{5}{2} P\Delta V =$

$= \frac{5}{2} \frac{m}{M} R\Delta T = \frac{5}{2} A.$

$$Q_P = \frac{5}{2} P\Delta V = \frac{5}{2} A$$

$Q_P = Q_V + \frac{m}{M} R\Delta T$ $\quad (P\Delta V = \nu R\Delta T)$

$Q_P = c_P m\Delta T$

$c_P m\Delta T = \frac{3}{2} \frac{m}{M} R\Delta T + \frac{m}{M} R\Delta T$

$c_P = \frac{5R}{2M}$ $$c_P = c_V + \frac{R}{M}$$

• Adiabatik jarayon uchun

$Q = 0$ $\boxed{A = -\Delta U}$ $\boxed{\Delta U = -A}$

Adiabatik jarayon deb sistemaning atrof muhit bilan issiqlik almashmaydigan jarayonga aytiladi.

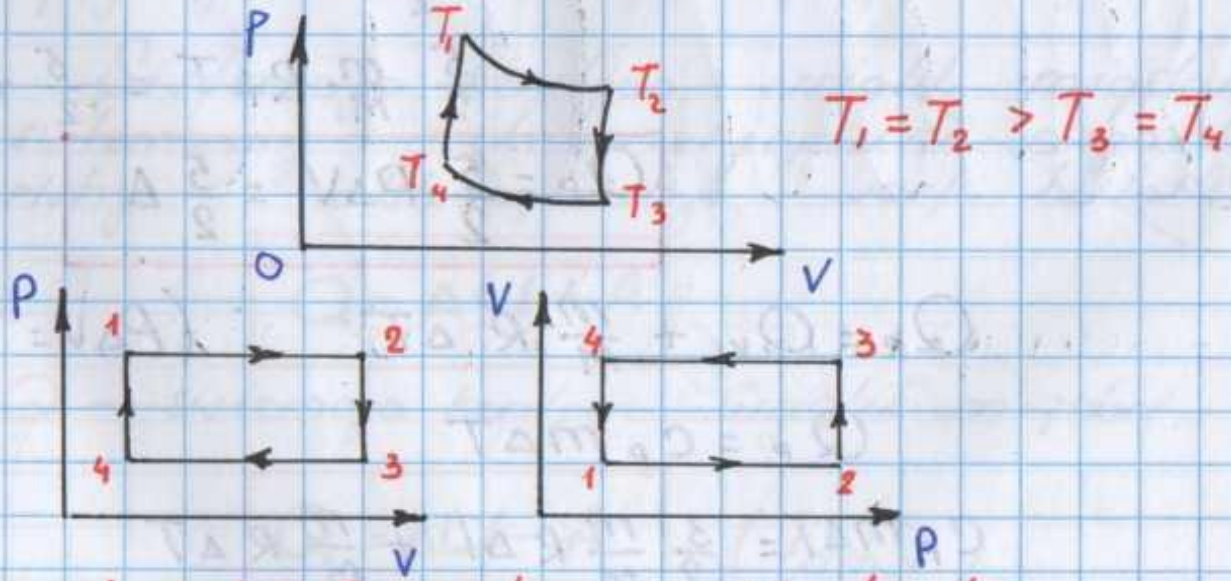
• Adiabatik jarayon Kalori etr da amalga oshadi.

• Adiabata chizigi izoterma chizigidan kora tikroq va pastroqdan otadi.

$\Delta P_a > \Delta P_T$.

Foydali ish koeffitsiyenti katta bolgan mashinalarga karno mashinalari deyiladi.

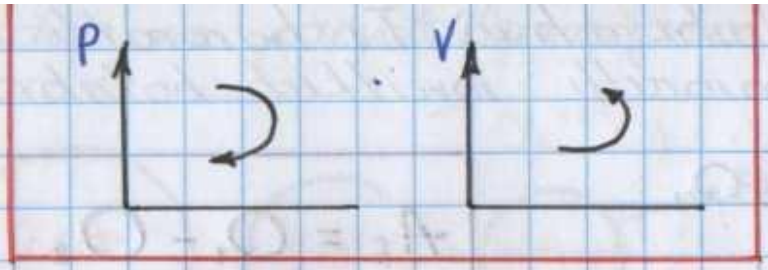
• Karno sikli 2 ta adiabata va 2ta izotermadan iborat boladi.



$T_1 = T_2 > T_3 = T_4$

$4 \to 1 \to 2$ da issiqlik berilgan

$2 \to 3 \to 4$ da issiqlik olingan



Termodinamikaning 2-qonuni
(Klauzyus)

Ichki energiya o'z-o'zidan temperaturasi pastroq jismdan temperaturasi yuqori jismga o'ta olmaydi.

Termodinamikaning 2-qonuni tabiatdagi jarayonlarning yo'nalishini ko'rsatadi. Tabiatdagi jarayonlar qaytmasdir. Bu qonun abadiy dvigatel yaratib bo'lmasligini isbotlaydi.

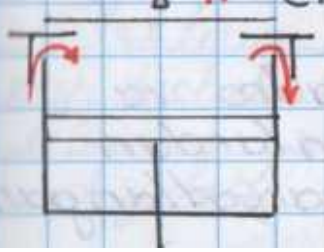
Issiqlik dvigatelining FIK

Issiqlik dvigateli deb issiqlik energiyasini mexanik energiyasiga aylantiruvchi qurilmalarga aytiladi.

Issiqlik dvigatellariga bug' trubinasi, ichki yonuv dvigatellari, reaktiv dvigatellar va boshqalar kiradi.

Ichki yonuv dvigatellari 4 taktda ishlaydi

1. Kiritish (so'rish)
2. Siqish
3. Ish yo'li (ish bajarish)
4. Chiqarish



$$n = \frac{\nu}{2}$$

Porshendagi chaqnash ko'rsoni

• Dvigatel ishlashi uchun T_1 haroratli isitgich, T_2 haroratli sovutkich bo'lishi k-k.

$$A_f = Q_1 - Q_2$$

$$A_{um} = Q_1$$

$$\eta = \frac{Q_1 - Q_2}{Q_1} \cdot 100\%$$

real moshinaning FIK

$$\eta = \frac{A_f}{A_{um}} \cdot 100\%$$

$$\eta = \frac{T_1 - T_2}{T_1} \cdot 100\%$$

Ideal masinaning FIK.

$\eta_{idel} > \eta_{Redl}$

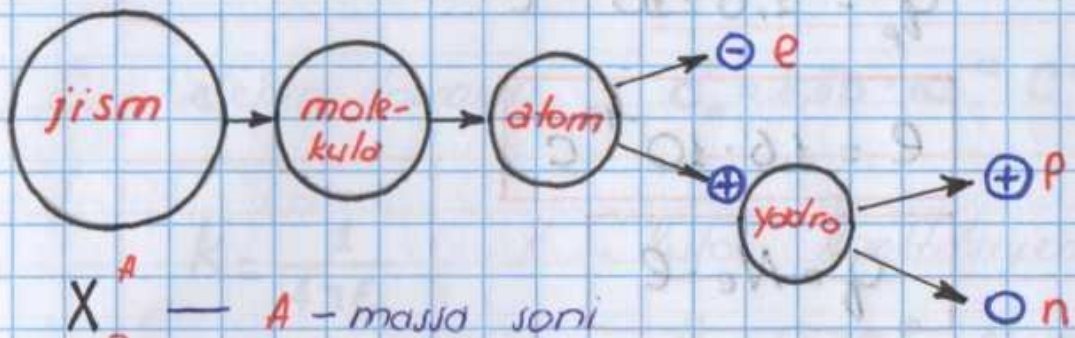
ELEKTRO DINAMIKA

Elektr zaryad. Kulon qonuni.

Barcha jismlar molekulalardan tuzilgan. Molekulalar esa atomlardan tashkil topadi.

• Atom musbat zaryadlangan yadro va manfiy zaryadlangan elektronlardan iborat yadro esa musbat zaryadlangan

proton va zaryadlanmagan neytronlardan iborat.



X^{A}_{q} — A – massa soni
q – zaryadi.

e^{0}_{-1}	elektron	$m_e = 9{,}1 \cdot 10^{-31}$ Kg
p^{1}_{1}	proton	$m_n = m_p = 6{,}67 \cdot 10^{-27}$ Kg
n^{1}_{0}	neytron.	$m_p = 1836 \cdot m_e$

q – zaryad [C], [Kl] (Kulon).

• Agar jism zaryadsiz (neytral) bolsa bu jismdagi elektronlar soni protonlar soniga teng boladi.

1. $q = 0$ bolsa, $N_e = N_p$ boladi (neytral).
2. $q < 0$ bolsa, $N_e > N_p$ (manfiy)
3. $q > 0$ bolsa, $N_e < N_p$ (musbat)

• Agar jism manfiy zaryadlansa, u jism elektron qabul giladi va uning massasi ortadi.
Agar jism elektron yo'qotsa bu jism musbat zaryadlanib, qoladi va uning massasi kamayadi.

Elektron va protonning zaryadi tabiatdagi eng kichik zaryadlar. Shuning uchun ularning zaryadlariga elementar zaryad deyiladi.

$$q_e = e = -1,6 \cdot 10^{-19}\ C$$

$$q_p = 1,6 \cdot 10^{-19}\ C$$

$$e = 1,6 \cdot 10^{-19}\ C$$

$$q = N_e \cdot e$$

Masalan, Agar jism 2ta elektron qabul qilsa bu jismning zaryadi $q = -3,2 \cdot 10^{-19}\ C$ bo'ladi

Agar jism 1ta elektron yo'qotsa, uning zaryadi $q = +1,6 \cdot 10^{-19}\ C$ bo'ladi

Elektr zaryadining saqlanish qonuni

Yopiq sistemadagi barcha zarralar zaryadlarning algebraik yig'indisi o'zgarmasdir

$$\sum q = const$$

Zaryadli zarralar o'zaro ta'sir kuchiga **elektr kuchi** yoki **Kulon kuchi** deyiladi

Kulon kuchini birinchi bo'lib fransiyalik fizik olim Sharl Kulon aniqlagan

Kulon qonuni (Elektrostatikaning asosiy qonuni) quyidagicha

Vakumda joylashgan qo'zg'almas nuqtaviy ikkita zaryadning o'zaro ta'sir kuchi zaryad miqdorlari modullarining ko'paytmasiga to'g'ri proporsional va ular orasidagi masofaning kvadratiga teskari proporsional va zaryadlarni tutashtiruvchi to'g'ri chiziq bo'ylab yo'nalgan.

$$F_{e1} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{|q_1| \cdot |q_2|}{r^2}$$

ε_0 — elektr dəimiyyəsi. $\varepsilon_0 = 8{,}85 \cdot 10^{-12}\ C^2/N \cdot m^2$

$$k = \frac{1}{4\pi\varepsilon_0}$$

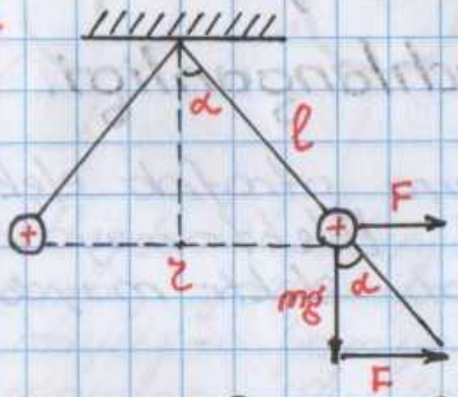
k — Kulon koeffitsiyenti $k = 9 \cdot 10^9\ N \cdot m^2/C^2$

$$F_{e1} = k \cdot \frac{|q_1| \cdot |q_2|}{r^2}$$

Xüsusi hallar:

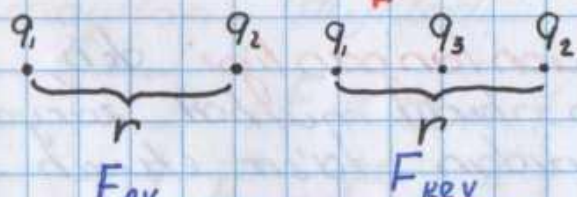
- $F = G \cdot \frac{m^2}{r^2}$ $F = k \cdot \frac{q^2}{r^2}$

$$Gm^2 = kq^2$$

- 

$$\sin\alpha = \frac{x}{2l} \qquad \sin\alpha \approx tg\alpha$$

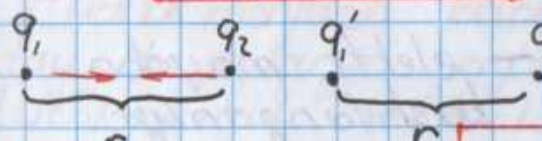
$$tg\alpha = \frac{F}{mg} \qquad \frac{x}{2l} = \frac{k q_1 q_2}{mgr^2}$$

- 

$$F_{AV} = \frac{k q_1 q_2}{r^2}$$ (Oraya zaryad qoşulsa)

$$F = \frac{k q_1 q_3}{r_2^2}$$

$$F_{KEY} = F + F_{AV}$$

- 

$$q_1' = \frac{q_1 + q_2}{2}$$

$$F = k\frac{|q_1'|^2}{r^2}$$ (Zaryadlanan zərrəcəklər təkrizilib, əvvəlki halatına qaytarılsa)

- Zaryad hamma vaqt jismning sirtida joylashadi.
- Zaryad shar va tekislikda sirt bo'ylab tekis taqsimlanadi, boshqa figuralarda sirt bo'ylab notekis joylashadi (qirralarida ko'proq joylashadi).

Yuza birligiga to'g'ri keladigan zaryadga **zaryadning sirt zichligi** deyiladi.

$$\sigma = \frac{q}{S}$$

σ – zaryadning sirt zichligi $[C/m^2]$

$$q = \sigma \cdot S$$

Elektr maydon. Maydon kuchlanganligi.

Har qanday zaryadli zarra atrofida elektr maydoni mavjud bo'ladi. Elektr maydonining kuch xarakteristikasi elektr maydon kuchlanganligidir.

Elektr maydon kuchlanganligi deb, maydonga kiritilgan birlik musbat zaryadga maydon tomonidan ta'sir etuvchi kuchga aytiladi.

Yo'nalishi kuch yo'nalishi bilan bir xil bo'ladi.

$$\vec{E} = \frac{\vec{F}}{q}$$

E – elektr maydon kuchlanganligi

$\left[\frac{N}{C}\right], \left[\frac{V}{m}\right]$

$$F = Eq$$

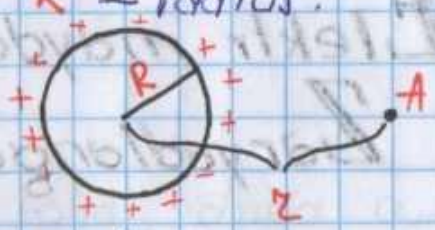
• Nuqtaviy zaryadning maydon kuchlanganligi quyidagicha topiladi.

$$E = k \cdot \frac{q}{r^2}$$

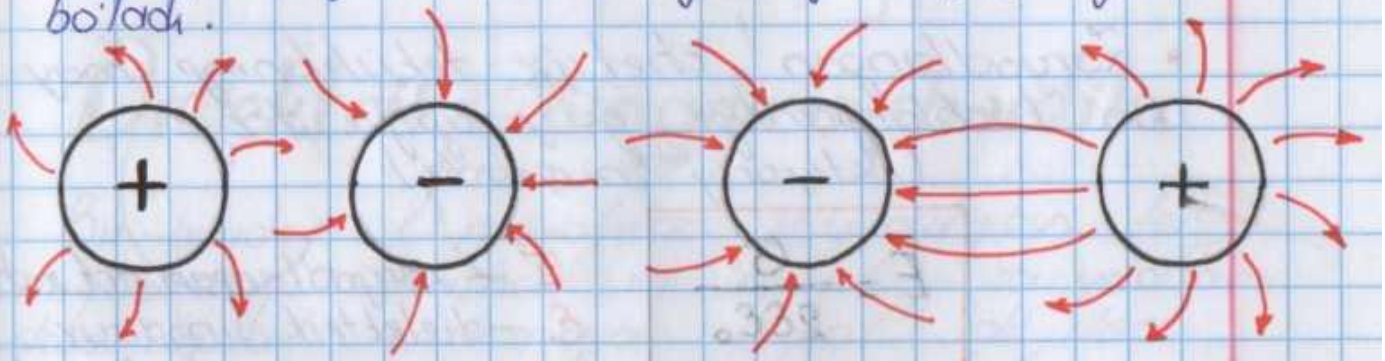
$$E = \frac{k \cdot q}{(R+r)^2}$$

r – zaryaddan kõrilayotgan nuqtagacha masofa.

R – radius.



• Elektr maydon kuchlanganligi quyidagicha boʻladi.



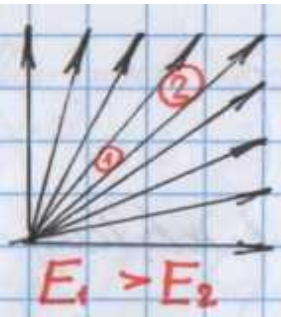
Maydon kuchlanganligi miqdor jihatdan ham, yoʻnalish jihatdan ham õzgarmaydigan (jarayon) maydonga **bir jinsli maydon** deyiladi.

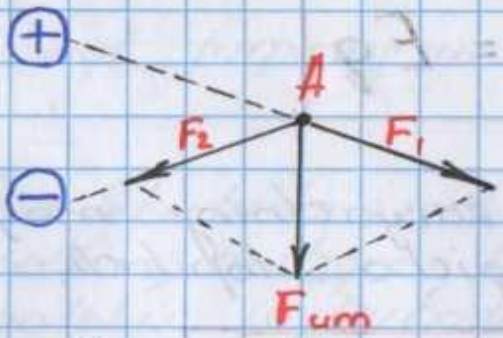
$$E = const.$$

$$\vec{F}_1 = \vec{F}_2 = \vec{F}_3 = \ldots.$$

} elektr maydonning bir jinsli bõlish sharti.

Elektr maydon kuch chiziqlari deb, shunday chiziqlarga aytiladiki maydonning kuchlanganlik vektorlari uning har bir nuqtasiga urinmalar boʻylab yõnaladi.





• Agar bir xil isholi zaryadlar oralig'idagi masofada bo'lsa, E=0 bo'lgan nuqta modul jihatdan kichikroq zaryad tomonda bo'ladi.

Elektr maydon kuch chiziqlari. Zaryadlangan shar va tekislik maydonlari.

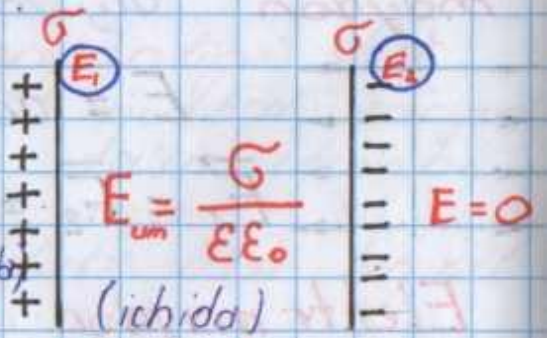
• Zaryadlangan cheksiz tekislikning maydon kuchlanganligi quyidagiga teng (ixtiyoriy nuqtada)

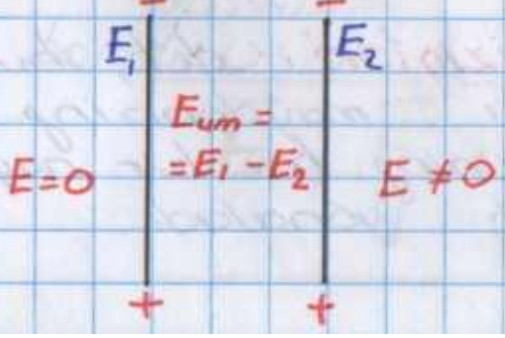
$$E = \frac{\sigma}{2\varepsilon\varepsilon_0}$$

σ — zaryadlangan sirt zichlik
ε — dielektrik singdiruvchanlik

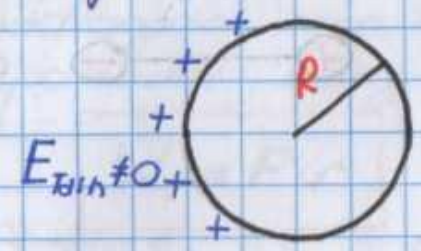
• Musbat va manfiy zaryadlangan 2 ta parallel tekislik oralig'idagi maydon kuchlanganligi quyidagiga teng.

$$E = \frac{\sigma}{\varepsilon\varepsilon_0}$$





• Zaryadlangan sfera ichida $E=0$, tashqarida $E \neq 0$



$R > r \quad E=0$

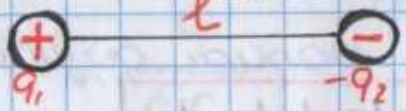
• Agar sfera ichida zaryad bolsa ichida $E \neq 0$, tashqarida $E=0$ boladi

$E=0.$

• Agar sfera ichida zaryad bolsa, ichida $q_{um}=0$ boladi

Dielektrik Singdiruvchanlik.

Bir-biridan l masofada joylashgan teng miqdordagi musbat va manfiy zaryadlardan iborat sistemaga dipol deyiladi.

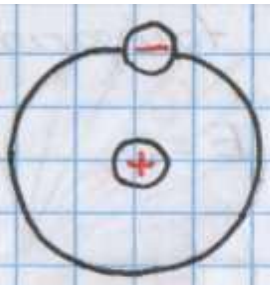


$|q_1| = |-q_2|.$

• Qutubli dielektriklar dipollardan iborat boladi. Bunday dielektriklar elektr maydonga kiritilsa, tashqi maydonni susaytiradi va dipollar orasidagi maydon yonalishida joylashadi. Dielektrik ichida $E \neq 0$ boladi.

Dipollar ikki xil boladi: qutubsiz dipol
qutubli dipol

Qutubsiz depol deb, musbat va manfiy zaryadlarning massa markazlari ustma-ust tushma tushmaydigan dipollarga aytiladi



qutubsiz dipol

qutubli dipol

Qutubli dipollar deb, musbat va manfiy zaryadlarning massa markazlari ustma-ust tushmaydigan dipollarga aytiladi.

Dielektrik singdiruvchanlik deb, zaryadli zarralarning muhitdagi o'zaro ta'sir kuchi vakumdagi o'zaro ta'sir kuchidan necha marta kichikligini ko'rsatuvchi fizik kattalikka aytiladi.

$$\varepsilon = \frac{F_{VAK}}{F_{MUH}}$$

Havo, vakum uchun $\varepsilon = 1$
Suv uchun $\varepsilon = 81$
O'tkazgich uchun $\varepsilon = \infty$
Qutubli dielektrik uchun $\varepsilon = 0$.

- Muhitda kulon qonuni quyidagicha.

$$F = k \cdot \frac{|q_1| \cdot |q_2|}{\varepsilon r^2}$$

Zaryadlangan jismning elektrostatik maydondagi potensial energiya. Potensial.

○ Zaryadlangan zarralar orasidagi o'zaro ta'sir potensial energiyasi quyidagiga teng.

$$W_p = F \cdot r$$

$W_p \cdot eV = W_p \cdot 16 \cdot 10^{-19}$ J (elektron Volt).

$$F = k \cdot \frac{q^2}{\varepsilon r^2}$$

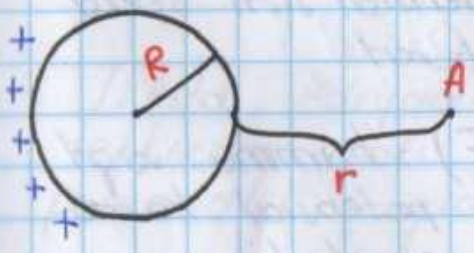
$$W_p = k \cdot \frac{q^2}{\varepsilon r} \qquad W_p = \frac{k|q_1||q_2|}{\varepsilon r}$$

Elektrmaydon potensiali deb birlik musbat zaryadning potensial energiyasiga aytiladi.

φ – elektr maydon potensiali [V]

$$\varphi = \frac{W_p}{q} \qquad 1V = 1\,\frac{J}{C} \qquad \varphi \sim W_p$$

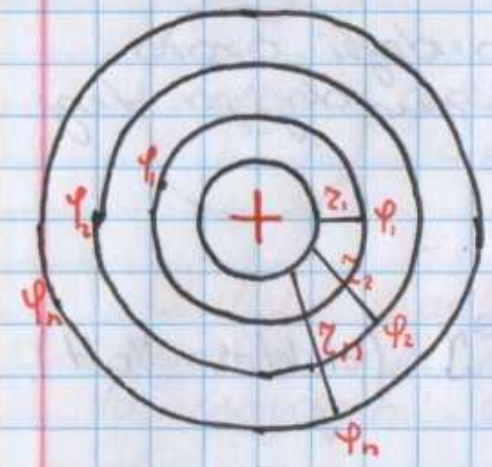
$$\varphi = k \cdot \frac{q}{\varepsilon r}$$ (nuqtaviy zaryadga ning potensiali)



$$\varphi = k \cdot \frac{q}{(R + r)}$$

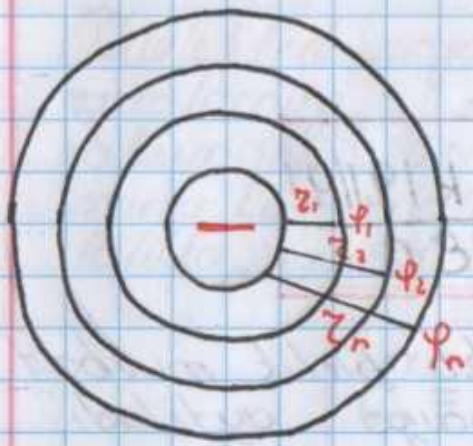
• Potensial 2 marta kamayadigan nuqtada maydon kuchlanganligi 4 marta kamayadi.

$$E \sim \frac{1}{r^2} \qquad \varphi \sim \frac{1}{r}$$



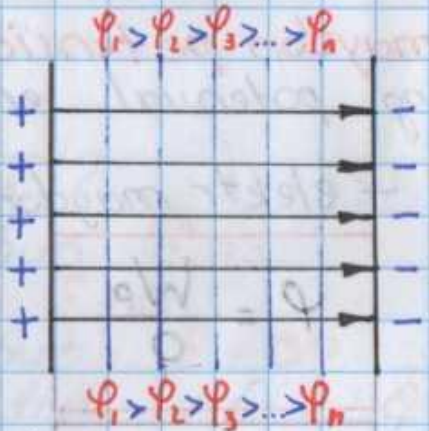
$$\varphi = k\frac{q}{\varepsilon r} \qquad \varphi \sim \frac{1}{r}$$

$$\boxed{\varphi_1 > \varphi_2 > \varphi_3 > \dots > \varphi_n}$$



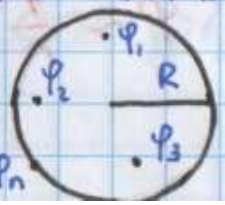
$$\varphi = -k\frac{q}{\varepsilon r}$$

$$\boxed{\varphi_1 < \varphi_2 < \varphi_3 < \dots < \varphi_n}$$



Potensiallari bir xil bo'lgan nuqtalarning geometrik o'rniga **ekvipotensial sirt** deyiladi.

- Nuqtaviy zaryadning ekvipotensial sirti sfera (konsentrik aylana) dan iborat.
- Maydon kuchlanganligi (E) hamma vaqt sirtga perpendikulyar bo'lib potensial kamayadigan tomonga qarab yo'naladi.
- Biror jismning potensiali uning barcha nuqtalarida bir xil bo'lib sirtidagi potensialga teng bo'ladi.



$$\boxed{\varphi_1 = \varphi_2 = \varphi_3 = \varphi_n = k\cdot\frac{q}{R}}$$

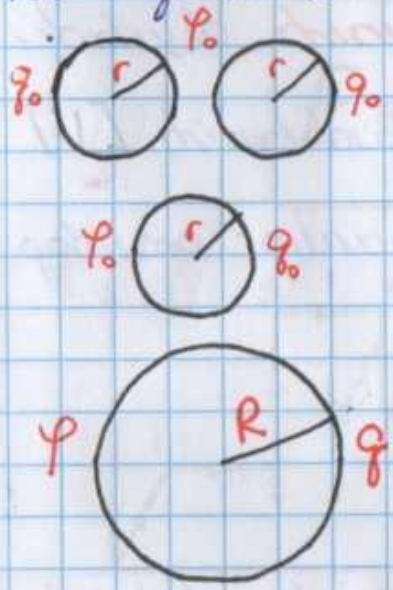
• Potensial skalyar kattalik bo'lib algebraik jihatdan qo'shiladi.

$$\varphi_{um} = \varphi_1 + \varphi_2 + \dots + \varphi_n$$

$$\varphi_{um} = k\frac{q_1}{r_1} + k\frac{q_2}{r_2} \dots + k\frac{q_n}{r_n}$$

Xususiy hollar:

• q_0 zaryadga ega bo'lgan r radiusli tomchilar qo'shilib R radiusli tomchini hosil qilsa.



$$\varphi_0 = \frac{k q_0}{r} \qquad q = q_0 \cdot n.$$

$$\varphi = \frac{k q}{R} \qquad V = V_0 \cdot n$$

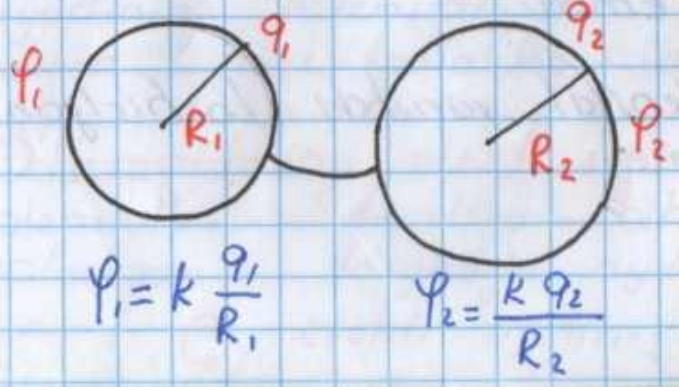
$$\frac{4}{3}\pi R^3 = \frac{4}{3}\pi r^3 \cdot n.$$

$$R = \sqrt[3]{n} \cdot r$$

$$\varphi = k \cdot \frac{n \cdot q_0}{\sqrt[3]{n} \cdot r_0} = k\frac{q_0}{r} \cdot \frac{n}{\sqrt[3]{n}} = \varphi_0 \cdot \sqrt[3]{n^2}$$

$$\frac{\varphi}{\varphi_0} = \sqrt[3]{n^2}$$

• Ikkita zaryadlangan zarralar bir-biriga tekkizilsa yoki ulansa unda umumiy potensial quyidagiga teng bo'ladi



$$\varphi_1 = k\frac{q_1}{R_1} \qquad \varphi_2 = \frac{k q_2}{R_2}$$

$$\varphi_{um} = \frac{k(q_1 + q_2)}{R_1 + R_2}$$

$$\varphi_{um} = \frac{\varphi_1 R_1 + \varphi_2 R_2}{R_1 + R_2}$$

• $\varphi_1 > \varphi_2$ bo'lsa

$k\frac{q_1}{R_1} > k\frac{q_2}{R_2}$ (zaryadlar bir-biriga tekkizilganda)

$q_1 R_2 > q_2 R_1$ (1 dan 2 ga zaryad oqib o'tadi)

• (q) $\varphi = k\frac{q}{R}$ — $\varphi \sim \frac{1}{R}$

(σ) $\varphi = k\frac{\sigma \cdot 4\pi R^2}{R} = k\sigma 4\pi R$ — $\varphi \sim R$

$q = \sigma \cdot S$.

Potensiallar ayirmasiga **kuchlanish** deyiladi.

$$\boxed{U = \varphi_1 - \varphi_2}$$ U – kuchlanish [V]

• Potensiallar va maydon kuchlanganligi orasidagi bog'lanish

$$\boxed{U = Ed}$$

d – masofa
E – maydon kuchlanganligi

• Zaryadni elektr maydonida ko'chirishda bajariladigan ish quyidagiga teng.

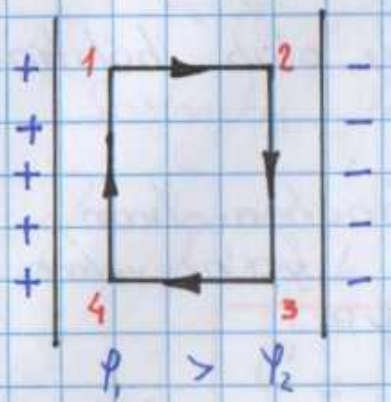
$$\boxed{A = q(\varphi_1 - \varphi_2) = q \cdot U = q \cdot E \cdot d}$$

! Bu yerda bajarilgan ish trayektoriyaning shakliga bog'liq emas.

• Zaryadni ekvipotensial ravishda ko'chirilgan ish nolga teng.

$$W_k = \frac{m\vartheta^2}{2}$$

$$W_k = qU$$



$\varphi_1 > \varphi_2$

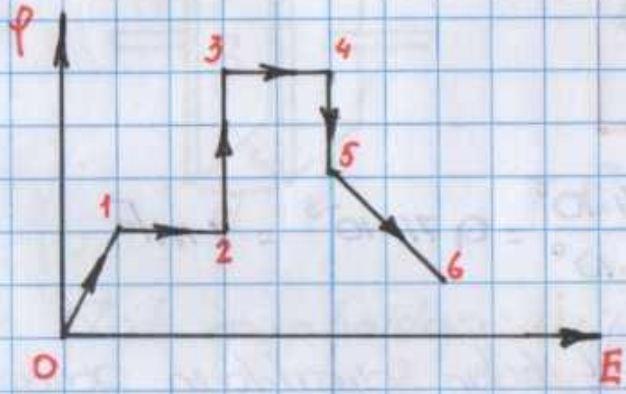
$A_{1,2} = +q(\varphi_1 - \varphi_2)$ ⊕

$A_{1,2} = -q(\varphi_1 - \varphi_2)$ ⊖

$\Delta W_{1,2}$ ⊕ da W_k kamayadi

$\Delta W_{1,2}$ ⊖ da W_k ortadi.

$$E = \frac{\varphi_1 - \varphi_2}{d} = \frac{U}{d}$$



$1 \to 2$, $3 \to 4$ } da $E = 0$

qolgan hollarda $E \neq 0$

Elektr sig'imi. Kondensatorlar.

O'tkazgichning elektr sig'imi deb o'tkazgich zaryadining potensialiga nisbati bilan o'lchanadigan fizik kattalikka aytiladi.

O'tkazgichning elektr sig'imi deb o'tkazgich potensialini 1 voltga oshirish uchun kerak boladigan zaryadga aytiladi.

C – elektr sig'imi [F] (Farada)

$$C = \frac{q}{\varphi} \qquad 1F = \frac{1C}{1V} \qquad C \sim q$$

- Sig'im jismlarning zaryad to'play olish holatini anglatadi.
- Sig'im zaryadga ham, kuchlanishga ham, tok kuchiga ham bog'liq emas ya'ni ular o'zgarsa ham sig'im o'zgarmaydi.
- O'tkazgichning sigimi jismning geometrik o'rniga, o'lchamiga va jism joylashgan muhitga bog'liq bo'ladi.

$$C_{SHar} = 4\pi\varepsilon_0\varepsilon R$$

$$C = \frac{\varepsilon R}{K}$$

$R_{yer} = 65 \cdot 10^5 \quad \varepsilon = 1 \qquad C = \frac{64 \cdot 10^5}{9 \cdot 10^9} = 0{,}71 \cdot 10^{-3} = 1\,mF$

Bir biridan dielektrik bilan ajratilgan qoplamaqarshi jsborali zaryadlangan ikkita o'tkazgichdan iborat sistemaga **kondensator** deyiladi.

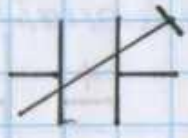
O'tkazgichlarga **qoplamalar** deyiladi. Qoplamalarni shakliga ko'ra kondensatorlar yassi, sferik, silindrik, va boshqa turlarga bo'linadi.

Ishlash tizimiga ko'ra kondensatorlar 3 xil bo'ladi
- O'zgarmas sig'imli kondensatorlar
- O'zgaradigan sigimli kondensatorlar
- Sozlovchi kondensatorlar.

O'zgarmas sig'imli kondensatorlar toki o'tkazmaydi

O'zgaradigan sig'imli kondensatorlar toki o'tkazadi

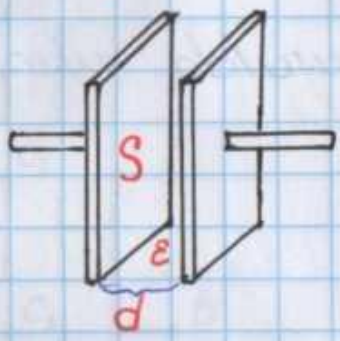
Sozlovchi kondensatorlar



- Har qanday kondensator sig'imi quyidagi formula orqali topiladi.

$$C = \frac{q}{U}$$

Qoplamlari yassi (tekis) sirtdan iborat kondensatorga **yassi kondensator** deyiladi.



$$C = \frac{\varepsilon \varepsilon_0 S}{d}$$

Yassi kondensator sig'imi.

$$C \sim \frac{\varepsilon S}{d} \qquad \varepsilon_0 = 8{,}85 \cdot 10^{-12}$$

- Tok manbaidan uzilgan kondensator.

$q = const$

$$U = \frac{q}{C} = \frac{1}{C} \sim \frac{d}{\varepsilon S}$$

- Tok manbaiga ulangan kondensator

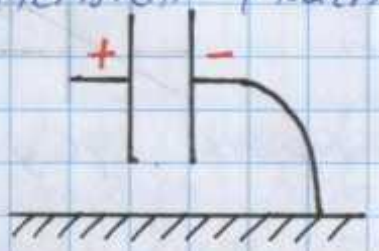
$U = const$

$$q = U \cdot C \sim C \sim \frac{\varepsilon S}{d}$$

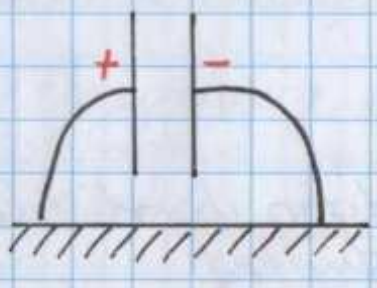
- Yassi kondensator plastinkalari orasiga uchinchi plastinka kiritilsa uning sig'imi o'zgarmaydi

• Zaryadlangan kondensatorning istalgan qutblardan biri yerga ulansa uning potensiali (kuchlanishi) o'zgarmaydi.

Agar ikkita qutbi ham yerga ulansa uning potensiali (kuchlanishi) nolga teng.



$u = const.$

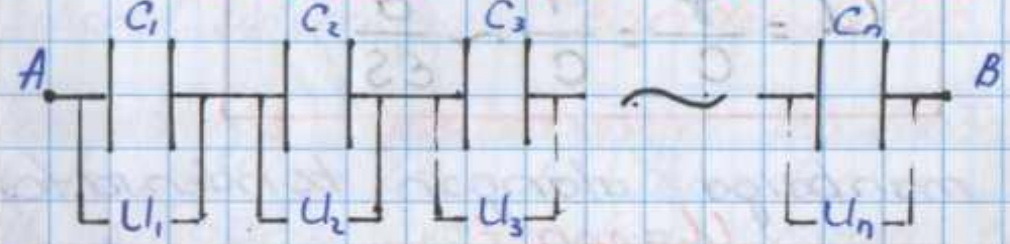


$u = 0.$

Kondensatorlar uch xil usulda ulanadi.

- ketma-ket
- Parallel
- Aralash.

Kondensatorlarni Ketma-ket ulash.



- Ketma-ket ulaganda zaryadlar bir xil bo'ladi.

$$q_1 = q_2 = q_3 = \dots = q_n$$

$$U_{AB} = U_1 + U_2 + U_3 + \dots + U_n$$

$C = \frac{q}{U}$ $U = \frac{q}{C}$ $\boxed{U \sim \frac{1}{C}}$

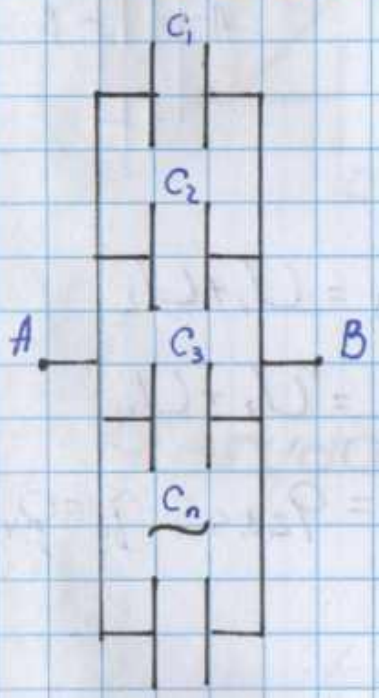
Agar $C_1 > C_2$ bo'lsa $U_1 < U_2$ bo'ladi

$$\boxed{\frac{1}{C_{k.k}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots + \frac{1}{C_n}}$$

Agar $C_1 = C_2 = C_3 = \dots = C_n = C_0$ bo'lsa, ularni ketma-ket ulasak, umumiy sig'im:

$$\boxed{C_{um} = \frac{C_0}{n}}$$

Parallel ulash.



- Parallel ulashda kuchlanishlar bir xil bo'ladi.

$$\boxed{U_1 = U_2 = U_3 = \dots = U_n}$$

$$\boxed{q_{um} = q_1 + q_2 + q_3 + \dots + q_n}$$

$q = CU$ $q \sim C$

agar $C_1 > C_2$ bo'lsa, $q_1 > q_2$ bo'ladi

$$\boxed{C_{um} = C_1 + C_2 + C_3 + \dots + C_n}$$

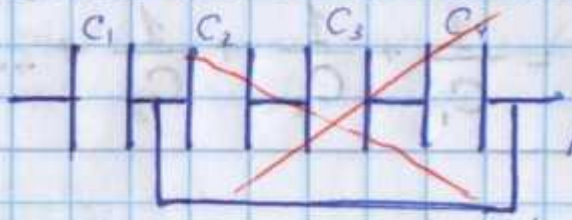
Agar $C_1 = C_2 = C_3 = \dots = C_n = C_0$ bo'lsa, ularni ketma-ket emas parallel ulasak, umumiy sig'im:

$$\boxed{C_{um} = n \cdot C_0}$$

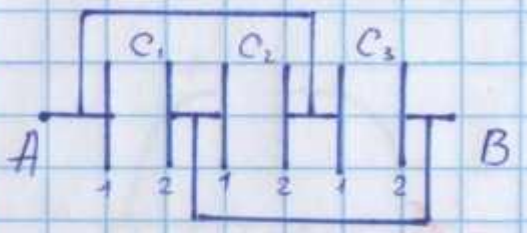
$$C_{par} = n^2 \cdot C_{k.k}$$

Parallel va ketma-ket ulash orasidagi bog'lanish.

Misollar:

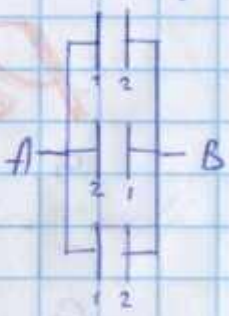


Bu qism ishlamaydi. Chunki boshi va oxiri bir nuqtada, o'zi-o'ziga ulanib qolgan

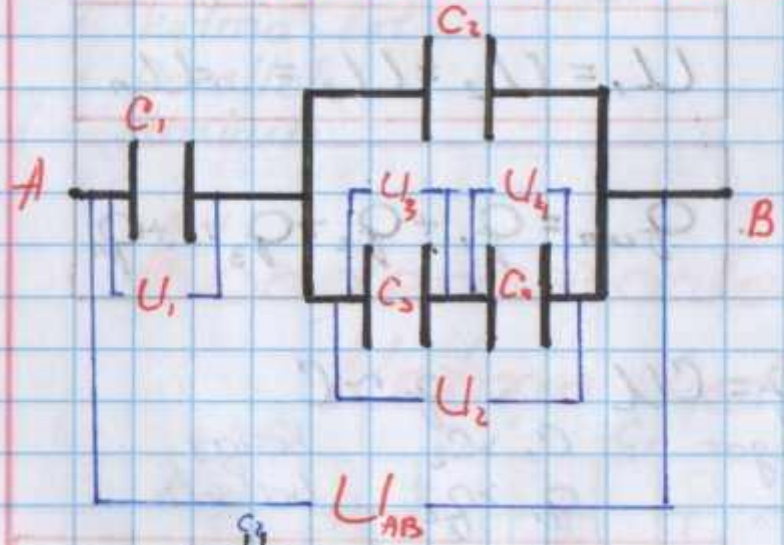


Bu sistema parallel ulangan

$C_1 + C_2 + C_3 = C_{um}$



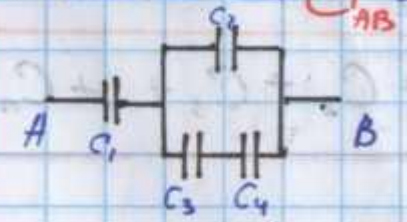
Aralash ulash.



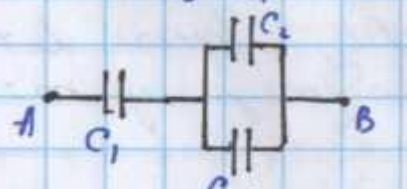
$U_{AB} = U_1 + U_2$

$U_2 = U_3 + U_4$

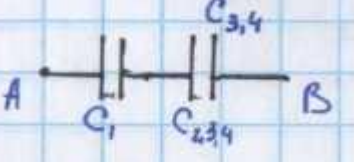
$q_1 = q_{2,3,4}$ $q_3 = q_4$



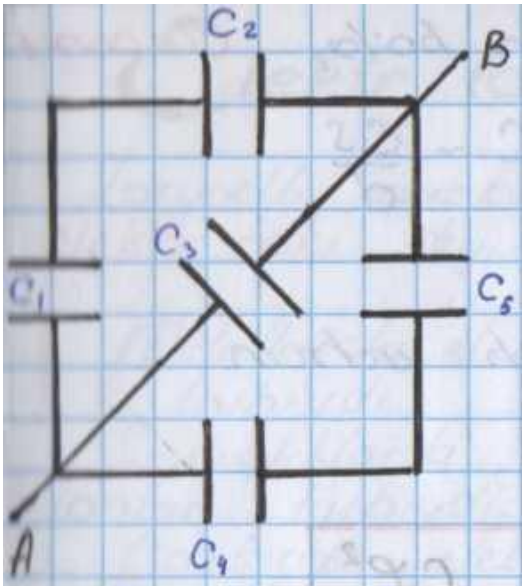
$$\frac{1}{C_{3,4}} = \frac{1}{C_3} + \frac{1}{C_4}.$$

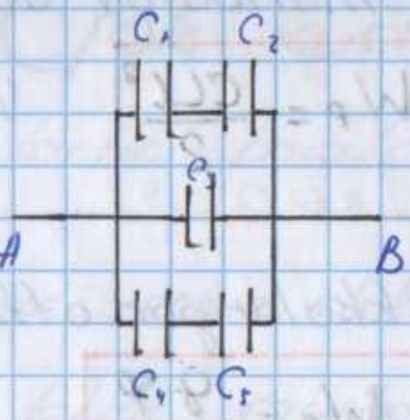


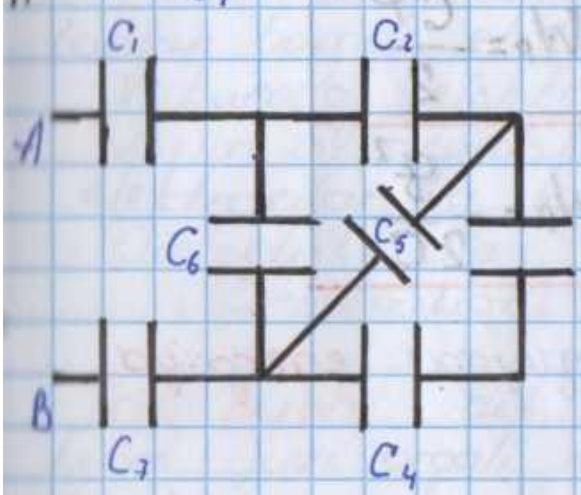
$$C_{2,3,4} = C_2 + C_{3,4}$$

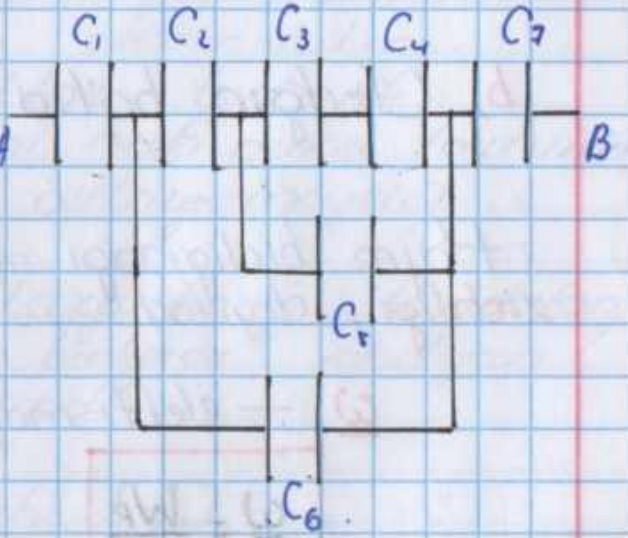


$$\frac{1}{C_{um}} = \frac{1}{C_1} + \frac{1}{C_{2,3,4}}$$









Zaryadlangan Kondensator energiyasi.

Kondensator energiyasi uning qoplamalari orasida bo'ladi.

Istalgan kondensatorning potensial energiyasi

$$W_p = \frac{qU}{2}$$

- Tok manbaidan uzilgan bo'lsa $q = const$

$$W_p = \frac{q^2}{2C} \qquad C = \frac{\varepsilon \varepsilon_0 d}{S} \qquad W_p \sim \frac{1}{C} \sim \frac{d}{\varepsilon S}$$

• Tok manbaiga ulangan bo'la, $U = const$

$$W_p = \frac{CU^2}{2} \qquad W_p \sim C \sim \frac{\varepsilon S}{d}$$

• Yakkalangan o'tkazgich uchun

$$W_p = \frac{q\varphi}{2}$$

a) Ulangan bo'lsa $W_p = \frac{C\varphi^2}{2}$

b) Uzilgan bo'lsa $W_p = \frac{q^2}{2C}$

Hajm birligidagi energiyaga energiya zichligi deyiladi.

ω — elektr maydon energiya zichligi.

$$\omega = \frac{W_p}{V} \qquad \left[\frac{J}{m^3}\right]$$

$$\omega = \frac{\varepsilon\varepsilon_0 E^2}{2}$$

$W_p = \frac{CU^2}{2}$ $U = Ed$ $V = S \cdot d$. $C = \frac{\varepsilon\varepsilon_0 \cancel{d} S}{d}$.

$$\omega = \frac{\frac{CU^2}{2}}{S \cdot d} = \frac{CE^2 d^2}{2 \cdot S \cdot d} = \frac{\varepsilon\varepsilon_0 S \cdot E^2 \cancel{d^2}}{\cancel{d} \cdot 2 \cdot S\cancel{d}} = \frac{\varepsilon\varepsilon_0 E^2}{2}.$$

Elektr toki. Tok kuchi.

Zaryadli zarralarning tartibli harakatiga elektr toki deyiladi.

! Metallarda elektr tokini erkin elektronlar tashiydi
Suyuqliklarda elektr tokini musbat va manfiy ionlar tashiydi.
Gazlarda elektr tokini musbat va manfiy ionlar hamda elektronlar tashiydi.
Vakuumda elektr tokini elektronlar tashiydi
Yarim o'tkazgichlarda elektr tokini elektronlar va kovaklar tashiydi
Dielektriklarda tokni hech nima tashimaydi (Dielektriklar tok o'tkazmaydi)

Tok kuchi deb o'tkazgichning ko'ndalang kesim yuzi orqali vaqt birligida o'tadigan zaryad miqdoriga aytiladi.

I – tok kuchi [A]

$$I = \frac{\Delta q}{\Delta t} \qquad I = q'$$

• Agar tok kuchi chiziqli qonunda o'zgarsa o'rtacha tok kuchi quyidagicha topiladi

$$I_{o'rt} = \frac{I + I_0}{2}$$

$$q = I_{or} \cdot t$$

O'zgarmas tok uchun, $I = \frac{q}{t}$ $q = Ne$.

$$I = \frac{eN}{t} \qquad e = 1{,}6 \cdot 10^{-10}\ C$$

$$I = q_0 n S \vartheta$$ n – konsentratsiya $[m^{-3}]$

$$I = e n S \vartheta$$

Masala, $I = 4 + 3t$ → boshlang'ich dsak

$t = 2$

$$q = 4t + \frac{3t^2}{2} = 8 + 3 \cdot 2 = 14C.$$

2-usul. $I = I_0 + xt$

$I_0 = 4 \quad t = 2$

$I = 4 + 3 \cdot 2 = 10$

$$I_{o'rt} = \frac{10+4}{2} = 7$$

$q_{o'rt} = I_{o'r} \cdot t = 7 \cdot 2 = 14C.$

• Elektr tokining tezligi deyilganda elektronning tezligi tushunilmaydi, elektr maydonning tarqalish tezligi tushuniladi.

$$C = 3 \cdot 10^8 \, m/s$$

$\vartheta = 0{,}1 \, mm/s$ – elektronning tartibli tezligi

$$\vartheta \sim \frac{1}{T}.$$

1 Amper shunday o'zgarmas tokning kuchidirki, bu tok vakuumda bir-biridan 1 metr masofada joylashgan 2 ta parallel cheksiz uzun, yuzasi juda kichik bo'lgan to'g'ri o'tkazgichlardan o'tgan ular orasida o'tkazgichning har bir metr uzunligida $2 \cdot 10^{-7} N$ o'zaro ta'sir kuchini vujudga keladi.

• Tok kuchi skalyar kattalik ammo ishorali kattalik yani yo'nalishga ega.

• Tokning yo'nalishi sifatida ⊕ musbatdan ⊖ manfiyga tomon yo'nalish qabul

qilingan. Elektronlarning harakatiga qarama-qarshi.

Elektr tokining 3 xil ta'siri bor:

- Issiqlik ta'siri (tok o'tayotgan o'tkazgich qiziydi)

! Vakumda va o'ta o'tkazgichlardan tok o'tganda issiqlik ta'siri kuzatilmaydi.

- Kimyoviy ta'sir.
Suyuqliklardan va gazlardan tok o'tsa kimyoviy ta'sir kuzatiladi. Metallarda kuzatilmaydi.

- Magnit ta'siri (asosiy ta'sir)
Har qanday muhitdan tok o'tsa magnit ta'siri mavjud.

Tok zichligi deb, o'tkazgichning ko'ndalang kesim yuzi orqali vaqt birligida musbat zaryad harakati yo'nalishida o'tkazgich zaryadiga miqdor jihatdan teng bo'lgan vektor kattalik.

j – tok zichligi $[A/m^2]$.

$$j = \frac{I}{S} \qquad I = \frac{q}{t} \qquad j = \frac{q}{t \cdot S}$$

$$I = q_0 n S v \qquad I = e n S v$$

$$j = q_0 n v \qquad j = e n v$$

Zanjirning bir qismi uchun Om qonuni. Qarshilik

Zanjirning EYuK bo'lmagan qismi uchun Om qonuni

Tok kuchi kuchlanishga to'g'ri, qarshilikka teskari proporsional.

$$I = \frac{U}{R}$$ R – qarshilik [Ω]

• Qarshilik tok kuchiga ham, kuchlanishga ham, zaryadga bog'liq emas, ular o'zgarsa ham qarshilik o'zgarmaydi.

$R \not\sim U$ $R \not\sim I$

• Qarshilik moddaning turiga va geometrik o'lchamlariga bog'liq.

$$F_{o'r} = \rho_s \cdot \frac{\ell}{S}$$

ρ_s – solishtirma qarshilik [Ωm].

$m = \rho V = \rho S V$.

$\ell = \frac{m}{\rho S}$ $S = \frac{m}{\rho \ell}$.

$$R = \rho_s \frac{m}{\rho S^2} \qquad R = \rho_s \frac{\rho \ell^2}{m}$$

Qarshilikka teskari kattalikka o'tkazuvchanlik deyiladi.

G – o'tkazuvchanlik [sm] (semens)

$$G = \frac{1}{R} \qquad G = \frac{S}{\rho_s \ell}$$

$$1\,sm = \frac{1}{1\Omega}$$

$$j = \frac{I}{S} \qquad j = \frac{U}{RS} = \frac{U}{\rho_s \ell} \qquad U = E\ell$$

$$I = \frac{U}{R} \qquad j = \frac{E\ell}{\rho_s \ell} = \frac{E}{\rho_s}$$

$$R = \rho_s \frac{\ell}{S}$$

$$E = j\rho_s$$ Om qonuni differensial shaklı

- Agar ketma-ket ulansa $I = const$

$$j = \frac{I}{S} \qquad j \sim \frac{1}{S}$$

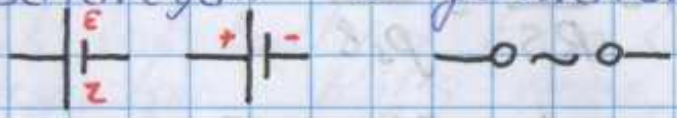
- Agar parrallel ulansa $U = const$

$$j = \frac{U}{S\ell} \qquad j \sim \frac{1}{\ell} \qquad j \neq S.$$

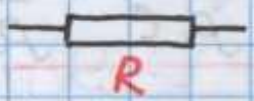
Eleketr zanjirlar O'tkazgichlarni ketma-ket va parallel ulash.

Elektr zanjirning tarkibiy qismlariga quyidagilar kiradi.

- tok manbai (galvanik element, akkumulator batareyasi va generator)



- Istemolchi



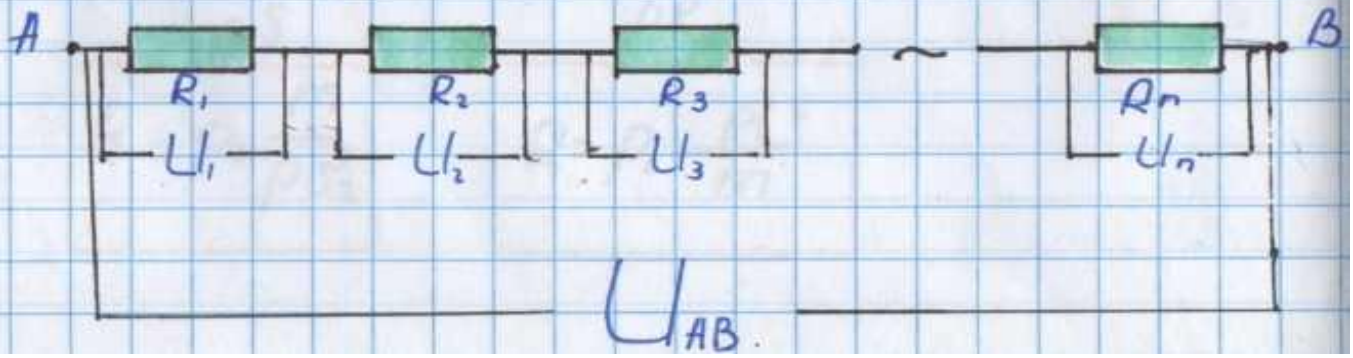
- Uzvchi simlar
- Kalit

- Elektr o'lchov asboblari

ampermetr voltmetr Galvanometr.

O'tkazgichlarni uch xil usulda ulash m-n.

Ketma-ket ulash.



- O'tkazgichlarni ketma-ket ulashda tok kuchi bir xil boladi.

$$I_1 = I_2 = I_3 = \dots = I_n$$

$$U_{AB} = U_1 + U_2 + U_3 + \dots + U_n$$

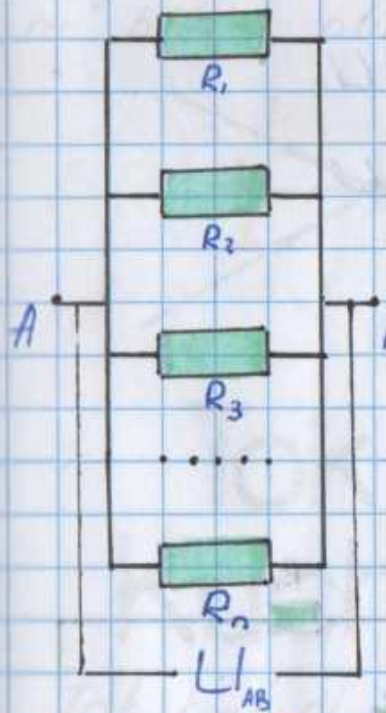
$$R_{AB} = R_1 + R_2 + R_3 + \dots + R_n$$

- Agar $R_1 > R_2$ bolsa, $U_1 > U_2$ boladi, chunki $U = IR$ $U \sim R$.

- Agar $R_1 = R_2 = R_3 = \dots = R_n = R_0$ bolsa,

$$R_{KK} = n \cdot R_0$$

Parallel ulash.



- O'tkazgichlarni parallel ulashda kuchlanishlar bir xil boladi.

$$U_1 = U_2 = U_3 = \dots = U_n$$

$$I_{AB} = I_1 + I_2 + I_3 + \dots + I_n$$

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots + \frac{1}{R_n}$$

- Agar $R_1 > R_2$ bolsa, $I_1 < I_2$ boladi. chunki $I = \frac{U}{R}$ $I \sim \frac{1}{R}$

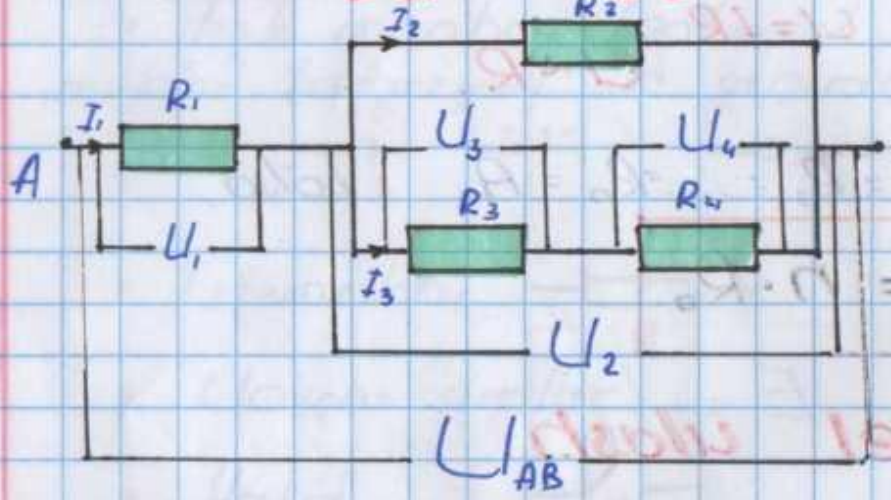
- $R_1 = R_2 = R_3 = \dots = R_n = R_0$ bo'lsa.

$$R_p = \frac{R_0}{n}$$

- Bir xil o'tkazgichlarni ketma-ket va parallel ulashdagi bog'lanish.

$$R_{KK} = n^2 R_p$$

Aralash ulash.



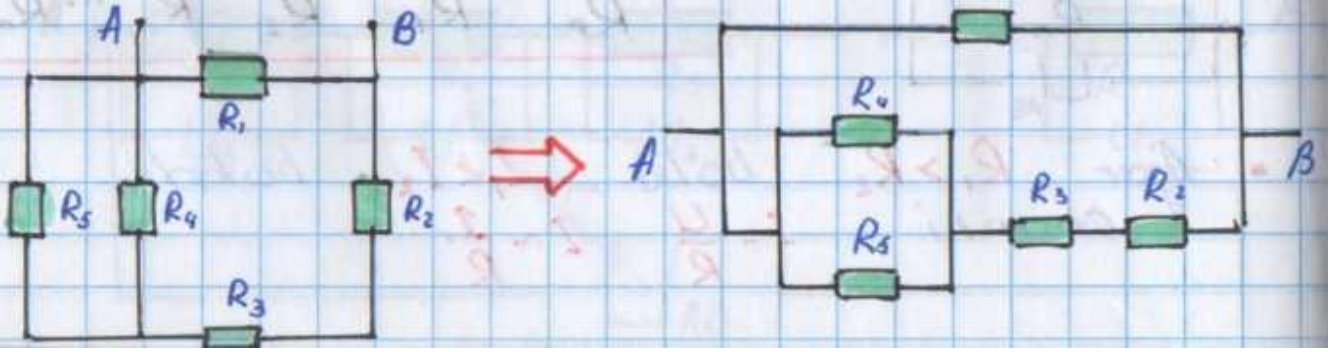
$I_① = I_2 + I_3$ $\quad U_{AB} = U_1 + U_2$

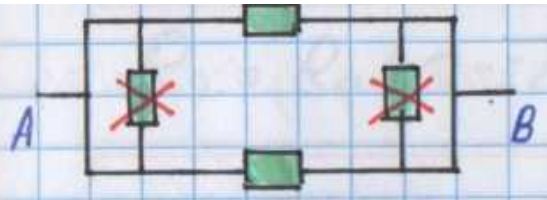
$I_3 = I_4$. $\quad U_2 = U_3 + U_4$.

$R_{3,4} = R_3 + R_4$.

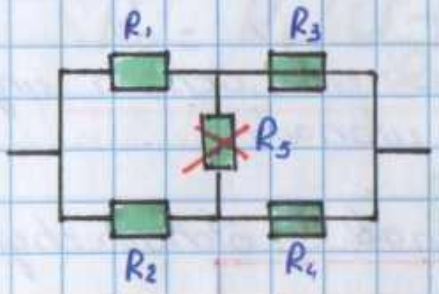
$$\frac{1}{R_{2,3,4}} = \frac{1}{R_{3,4}} + \frac{1}{R_2}$$

$R_{AB} = R_1 + R_{2,3,4}$.





Bu qismlar ishlamaydi

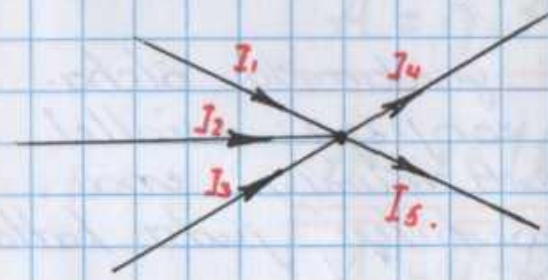


$$\frac{R_1}{R_2} = \frac{R_3}{R_4} \qquad R_5 = 0$$

Bu qism ishlamaydi

Iyogan Krixgoff ning birinchi qoidasi

Tugunda uchrashuvchi toklarning algebraik yig'indisi nolga teng bo'ladi. Tugunga keluvchi toklar musbat ishora bilan, Tugundan chiquvchi toklar manfiy ishora bilan olinadi.



$$I_1 + I_2 + I_3 - I_4 - I_5 = 0$$

$$I_2 + I_3 + I_1 = I_4 + I_5.$$

Tok kuchi va Kuchlanishni o'lchash.

Tok kuchini o'lchashda **ampermetr** dan foydalaniladi. Ampermetr elektr zanjiriga ketma-ket ulanadi. Ampermetrni parallel ulash mumkin emas. Chunki ampermetrni qarshiligi juda kichik bo'ladi

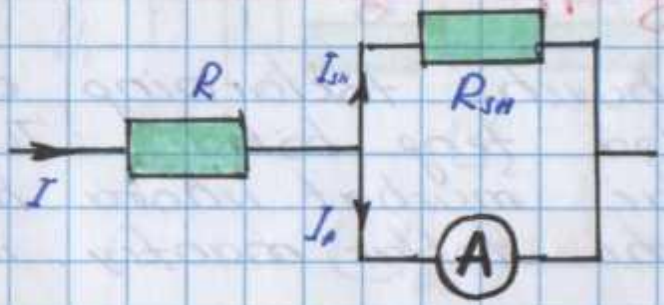
$R_A \ll R$

- Ampermetrni sezgirligini oshirish uchun unga parallel ravishda **shunt** ulanadi.

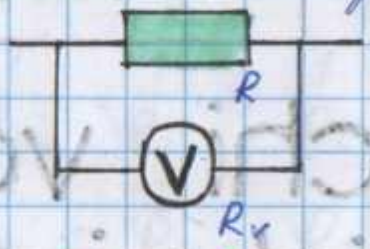
n — sezgirlik, bo'lim qiymati, o'lchash chegarasi

$$R_{SH} = \frac{R_A}{n-1} \qquad n = \frac{I}{I_A}$$

$$R_{SH} = \frac{R_A}{\frac{I}{I_A} - 1} = \frac{R_A I_A}{I - I_A}$$



- Kuchlanish **voltmetr** yordamida o'lchanadi. Voltmetr elektr zanjiriga parallel ulanadi. Ketma-ket ulash mumkin emas. Chunki voltmetrni qarshiligi juda katta bo'ladi.

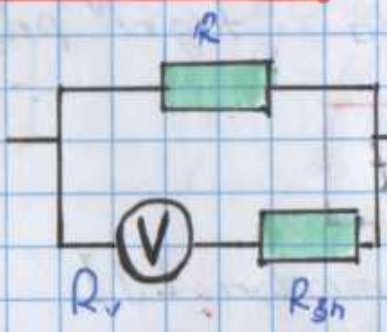


$R \gg R_V$

- Voltmetrni sezgirligini oshirish uchun unga ketma-ket ravishda **qo'shimcha qarshilik** ulanadi.

$$R_q = R_n(n-1) \qquad n = \frac{U}{U_v}$$

$$R_q = R_v\left(\frac{U-U_v}{R_v}\right)$$



- Galvanometr ham ampermetrdek ishlaydi

O'zgarmas tokning ishi va quvvati.

Elektr tokining ishi quyidagi formulalardan topiladi.

$$A = q(\varphi_1 - \varphi_2) \qquad \varphi_1 - \varphi_2 = U$$

$$A = IUt \qquad q = I \cdot t$$

$$A = I^2Rt \quad \text{(ketma-ket)}$$

$$A = \frac{U^2}{R} \cdot t \quad \text{(parallel)}$$

$$A \cdot kW \cdot h = A \cdot 36 \cdot 10^5\ J$$

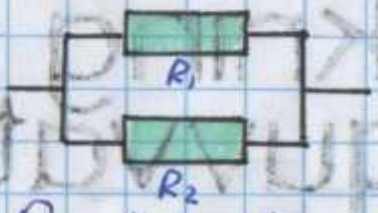
Joul-Lens qonuni quyidagicha.

O'tkazgichdan tok o'tganda ajralib chiqadigan issiqlik miqdori tok kuchining kvadratiga qarshilik va tokning o'tish vaqtining ko'paytmasiga to'g'ri proporsional bo'ladi.

$$Q = I^2Rt$$

Q – issiqlik miqdori [J]

Ketma-ket ulanishda $R_1 > R_2$ bo'lsa $Q_1 > Q_2$ bo'ladi. Chunki $Q \sim R$.



Parallel ulanishda $R_1 > R_2$ bo'lsa $Q_1 < Q$ bo'ladi. Chunki $Q = \frac{U^2}{R}t$ va $Q \sim \frac{1}{R}$.

$$Q = I^2Rt = \frac{U^2}{R^2} \cdot Rt = \frac{U^2}{R}t$$

- Vaqtlar kuydi qarshiliklar kabi qo'shiladi.

$$t_{k.k} = t_1 + t_2 + t_3 + \dots t_n$$

$$\frac{1}{t_p} = \frac{1}{t_1} + \frac{1}{t_2} + \frac{1}{t_3} \dots + \frac{1}{t_n}$$

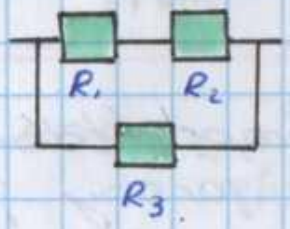
- Parallel va ketmaket ulashda vaqtlar orasida bog'lanish

$$t_{k.k} = n^2 t_p$$

Masala. Uchta bir xil o'tkazgichlarni parallel ulasak suv 6 min da qaynaydi.

$t_p = 6$

$n = 3$.



$t_1 = 36$

$t_2 = 18$

$\frac{1}{t_x} = \frac{1}{36} + \frac{1}{18} = \frac{1}{12}$

$t = 12$ sek.

Elektr tokining quvvat quyidagi formulalar orqali topiladi.

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

P – quvvat. [W] (vatt)

$$P = I \cdot U$$

$$P = I^2 R$$ Ketma-ket

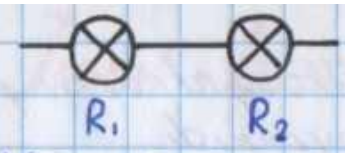
$$P = U^2/R$$ parallel

- Quvvatlar xuddi kondensatorlar singari qo'shiladi.

$$\frac{1}{P_{k.k}} = \frac{1}{P_1} + \frac{1}{P_2} + \frac{1}{P_3} + \dots + \frac{1}{P_n}$$

$$P_p = P_1 + P_2 + P_3 + \dots + P_n$$

$$N_1 = \frac{P}{n^2}$$ Bittasining ishlayotgan quvvati.



• Ikki xil quvvatli lampalar ketma-ket ulansa, $R_1 < R_2$ bölsa, R_1 lampa charoqlab yonadi.

$N_1 > N_2$ böladi.

Masala. 50 va 100 vattlik lampochkalar ketma-ket ulansa, har biri qanday quvvat bilan ishlaydi.

$N_1 - ?$ $N_2 - ?$

$I = \frac{U}{R_1+R_2}$

$P = \frac{U^2}{R}$

$R_1 = \frac{U^2}{P_1}$

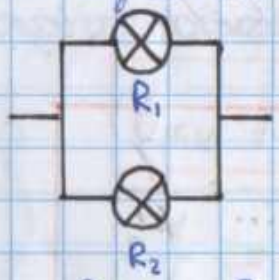
$R_2 = \frac{U^2}{P_2}$

$$N_1 = IR^2 = \left(\frac{U}{R_1+R_2}\right)^2 \cdot R_1 = \left(\frac{U^2}{\frac{U^2}{P_1}+\frac{U^2}{P_2}}\right)^2 \cdot \frac{U^2}{P_1} =$$

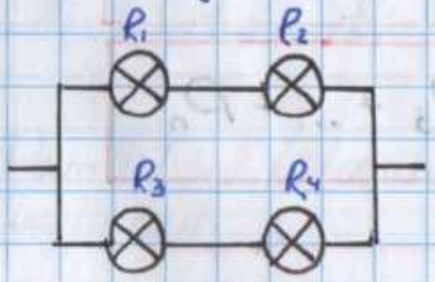
$$= \left(\frac{1}{\frac{1}{P_1}+\frac{1}{P_2}}\right)^2 \cdot \frac{1}{P_1} = \frac{P_1^2 P_2^2}{(P_1+P_2)^2} \cdot \frac{1}{P_1} = \frac{P_1 P_2^2}{(P_1+P_2)^2}$$

$$N_2 = \frac{P_2 P_1^2}{(P_1+P_2)^2}$$

• Har xil quvvatli lampochkalar parallel ulansa katta quvvatlisi charoqlab yonadi.



$R_1 < R_2$ bölsa, $N_1 < N_2$ böladi.



$R_1 < R_2 < R_3 < R_4$ bo'lsa, R_3 charoqlab yonadi.

Chunki, R_1 va R_2 ketma-ket ulangan shuning uchun $P_1 > P_2$ böladi, R_3 va R_4 ham shunday

R_1 va R_3 ketma-ket ulangan sharoit uchun $P_1 < P_3$ bo'ladi.

$$\eta = \frac{A_f}{A_{um}} \cdot 100\% = \frac{N_f}{N_{um}} \cdot 100\%$$

Ish va quvvatning foydali ish koeffitsiyenti.

$$\cos\varphi = \frac{P_f}{P_{um}} = \frac{P_f \cdot R}{U^2}$$

$\cos\varphi \sim \frac{1}{U^2}$

$\cos\varphi$ – quvvat koeffitsiyenti, energiya isrofi.

EYK. To'liq zanjir uchun Om qonuni.

Elektr yurituvchi kuch (EYK) deb, birlik musbat zaryadni zanjir bo'ylab ko'chirishda tashqi (chet) kuchlarning bajargan ishiga aytiladi.

$\mathcal{E}$ – elektr yurituvchi kuch [V]

$$\mathcal{E} = \frac{A_T}{q}$$

To'liq zanjir uchun Om qonuni:

Tok kuchi EYK ga to'g'ri proporsional, to'liq qarshilikka teskari proporsional.

$$I = \frac{\mathcal{E}}{R + r}$$

R – tashqi qarshilik
r – ichki qarshilik.

Qisqa tutashuv toki $R = 0$, $I_q > I$

$$I_q = \frac{\mathcal{E}}{r}$$

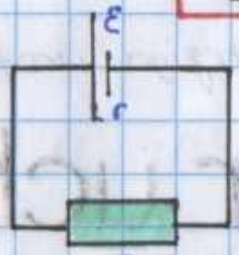
Lyogan Krixgoffning ikkinchi qoidasi.

Zanjirdagi EYK larning yig'indisi zanjir qismlaridagi kuchlanish tushuvlari yig'indisiga teng.

$$\sum \mathcal{E} = \sum U$$

$U = IR.$

$$\sum \mathcal{E} = \sum IR$$



$$I = \frac{\mathcal{E}}{R+r}$$

$IR + Ir = \mathcal{E}.$

$U_R = IR \qquad U_r = Ir.$

$$U_R + U_r = \mathcal{E}$$

FIK

$$\eta = \frac{U}{\mathcal{E}} \cdot 100\%$$

$$\eta = \frac{R}{R+r} \cdot 100\%$$

Kuchlanish EYKni qanday qismini tashkil qiladi degan savolga javob beradi

- Zanjirning bajargan ishi va quvvati:

$$A_R = Q_R = I^2Rt = \left(\frac{\mathcal{E}}{R+r}\right)^2 Rt$$ Tashqi

$$A_r = Q_r = I^2rt = \left(\frac{\mathcal{E}}{R+r}\right)^2 rt$$ Ichki

$$A_{um} = Q_{um} = I^2(R+r)t = \frac{\mathcal{E}^2}{R+r} \cdot t$$ umumiy

} zanjirning bajargan ishi

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

Quvvat.

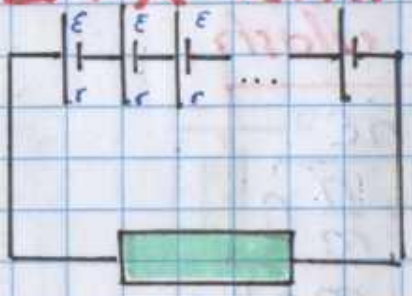
$$P_R = I^2 R = \left(\frac{\mathcal{E}}{R+r}\right)^2 R$$

$$P_r = I^2 r = \left(\frac{\mathcal{E}}{R+r}\right)^2 r$$

$$P_{um} = I^2 (R+r) = \frac{\mathcal{E}^2}{R+r}$$

- Zanjirda eng katta quvvat ajralishi uchun $R = r$ bo'lishi kerak.

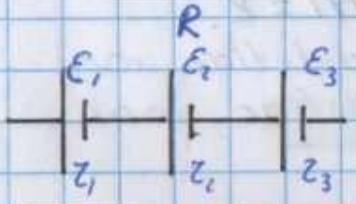
EYK larni ketma-ket ulash.



n — ketma-ket ulangan EYK lar soni.

$$I = \frac{\mathcal{E} \cdot n}{R + n \cdot r}$$

$$\mathcal{E}_{um} = n\mathcal{E}$$

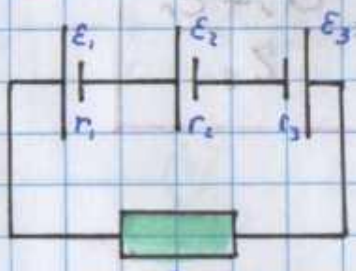


EYK lar xar xil bo'lsa,

$$\mathcal{E}_{um} = \mathcal{E}_1 + \mathcal{E}_2 + \mathcal{E}_3$$

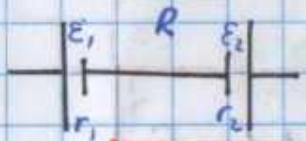
$$I = \frac{\mathcal{E}_1 + \mathcal{E}_2 + \mathcal{E}_3}{R + r_1 + r_2 + r_3}$$

$$r_{um} = r_1 + r_2 + r_3$$

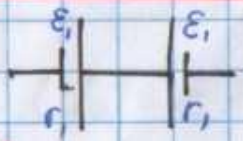


$$\mathcal{E}_{um} = \mathcal{E}_1 + \mathcal{E}_2 - \mathcal{E}_3$$

$$r_{um} = r_1 + r_2 + r_3.$$



yoki

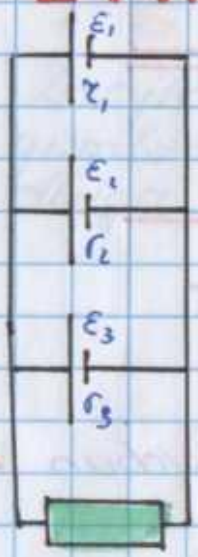


bo'lsa

$$\mathcal{E}_{um} = |\mathcal{E}_1 - \mathcal{E}_2|$$

$$r_{um} = r_1 + r_2$$

EYK larni parallel ulash.

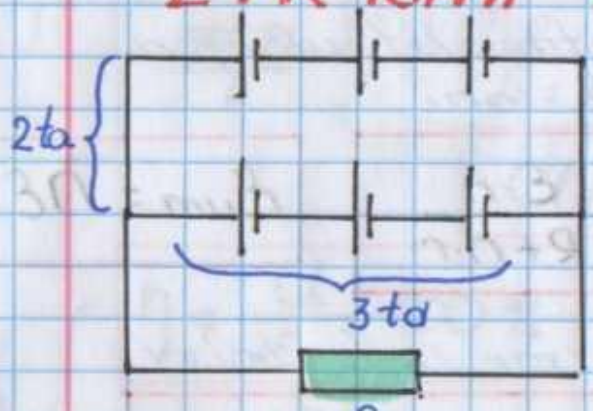


$$\mathcal{E}_{um} = \mathcal{E}$$

$$I_p = \frac{\mathcal{E}}{R + \frac{r}{m}}$$

m — parallel ulangan EYK lar soni.

EYK larni Aralash ulash.

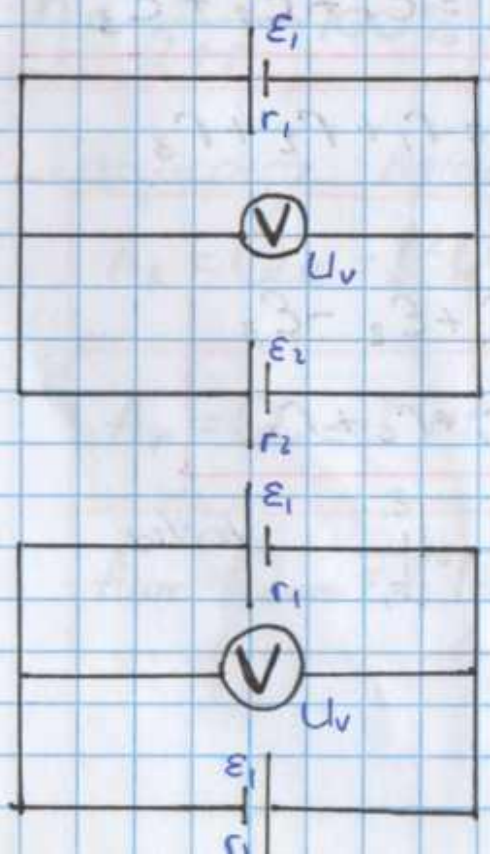


$$I_{ar} = \frac{n\mathcal{E}}{R + \frac{n}{m} r}$$

n = 3 m = 2.

n — ketma-ketlar soni

m — parallellar soni.



$$I_1 = I_2$$

$$\frac{\mathcal{E}_1 - U_v}{r_1} = \frac{U_v - \mathcal{E}_2}{r_2}$$

$$\frac{\mathcal{E}_1 - U_v}{r_1} = \frac{U_v - \mathcal{E}_2}{r_2}$$

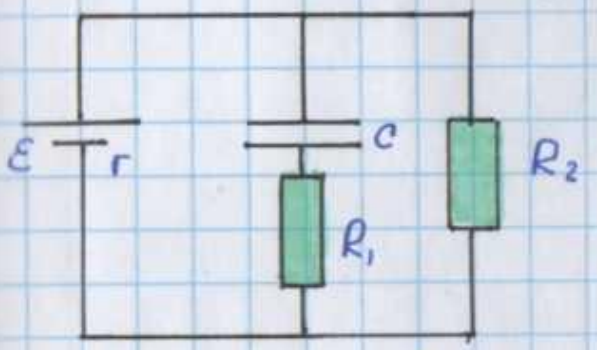
I_1 — zaryad toki
U_1 — zaryaddagi kuchlanish.

$$I_1 = \frac{U_1 - \mathcal{E}}{r} \qquad U_1 > \mathcal{E}.$$

I_2 — zaryad toki
U_2 — zaryadga tushadigan kuchlanish

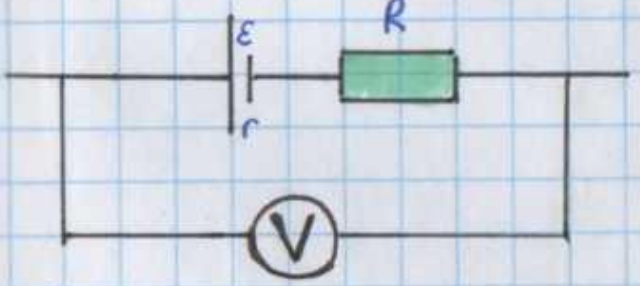
$$I_2 = \frac{\mathcal{E} - U_2}{r} \qquad U_2 < \mathcal{E}.$$

- Kondensator o'zgarmas tokni o'tkazmaydi.

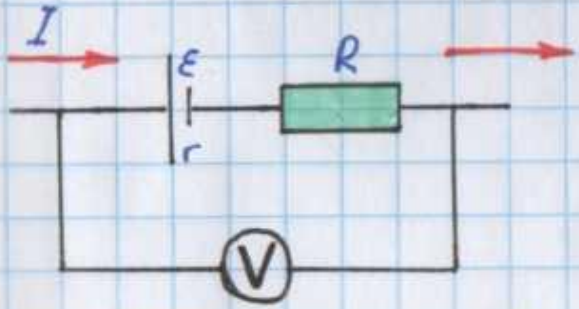


$$U_c = I \cdot R_2$$

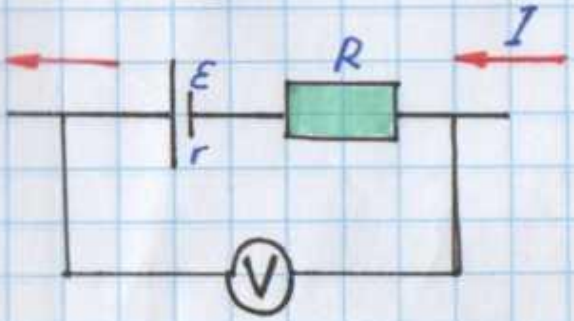
$$I = \frac{\mathcal{E}}{R_2 + r}$$



$$U_v = \mathcal{E} + U = \mathcal{E} + IR$$



$$U_v = \mathcal{E} - U = \mathcal{E} - IR$$



$$U_v = \mathcal{E} + U = \mathcal{E} + IR$$

Toklarning o'zaro ta'siri. Magnit maydon.

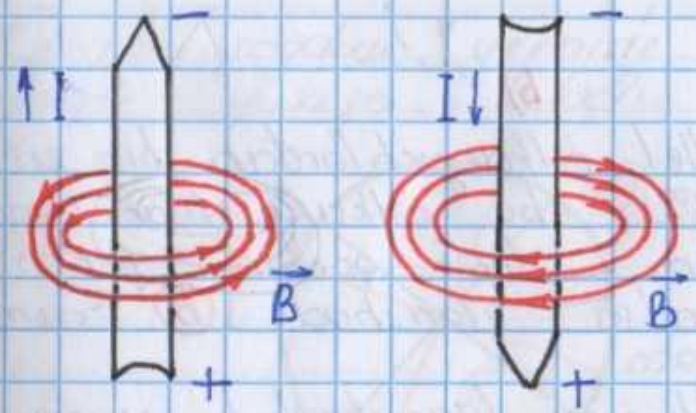
Tok o'tayotgan o'tkazgich atrofida **magnit maydoni** hosil bo'ladi. Bu hodisani Ersted aniqlagan.

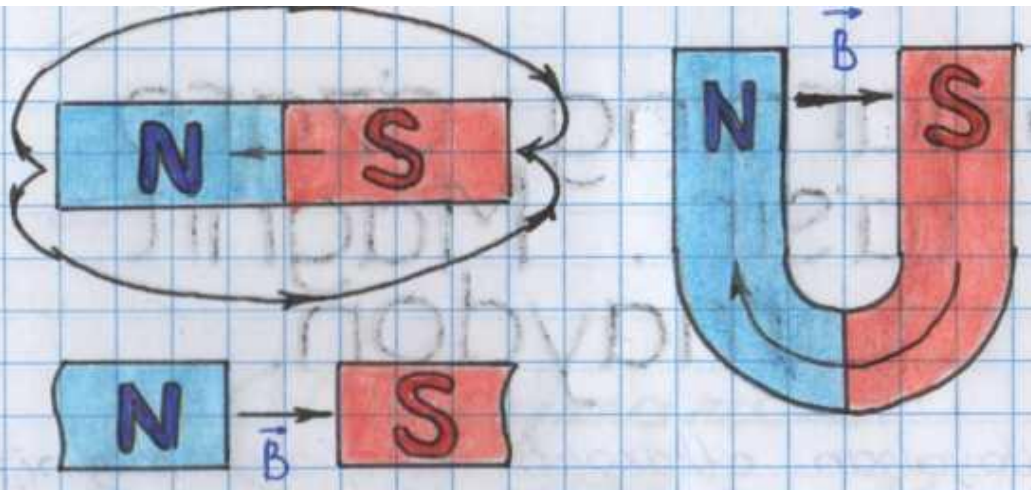
- O'zgarmas tok o'tayotgan o'tkazgich atrofida elektr maydon hamda magnit maydoni hosil bo'ladi.
- O'zgaruvchan tok o'tayotgan o'tkazgich atrofida magnit maydoni hamda uyurmali elektr maydoni hosil bo'ladi.

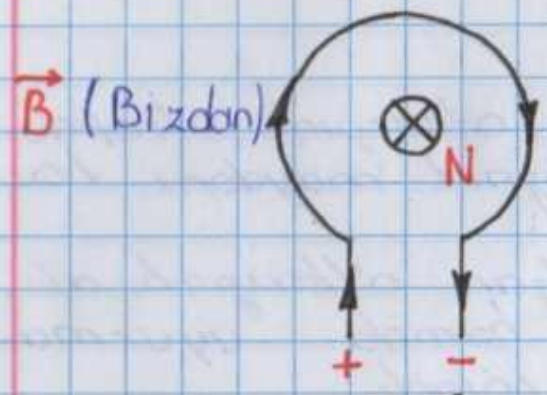
Magnit maydoni **magnit induksiya vektori** yordamida aniqlanadi.

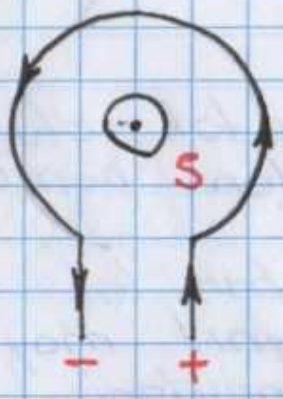
$\vec{B}$ – magnit induksiya vektori [T] (Tesla).

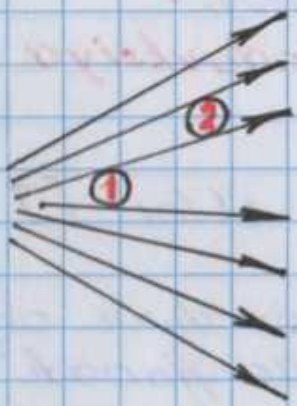
- Magnit induksiya vektori yo'nalishi o'ng parma (burg'u, vint) yordamida aniqlanadi.
- Agar parmaning dastasi $\vec{B}$ vektori yo'nalishida aniqlansa parmaning uchi tokning yo'nalishini ko'rsatadi.











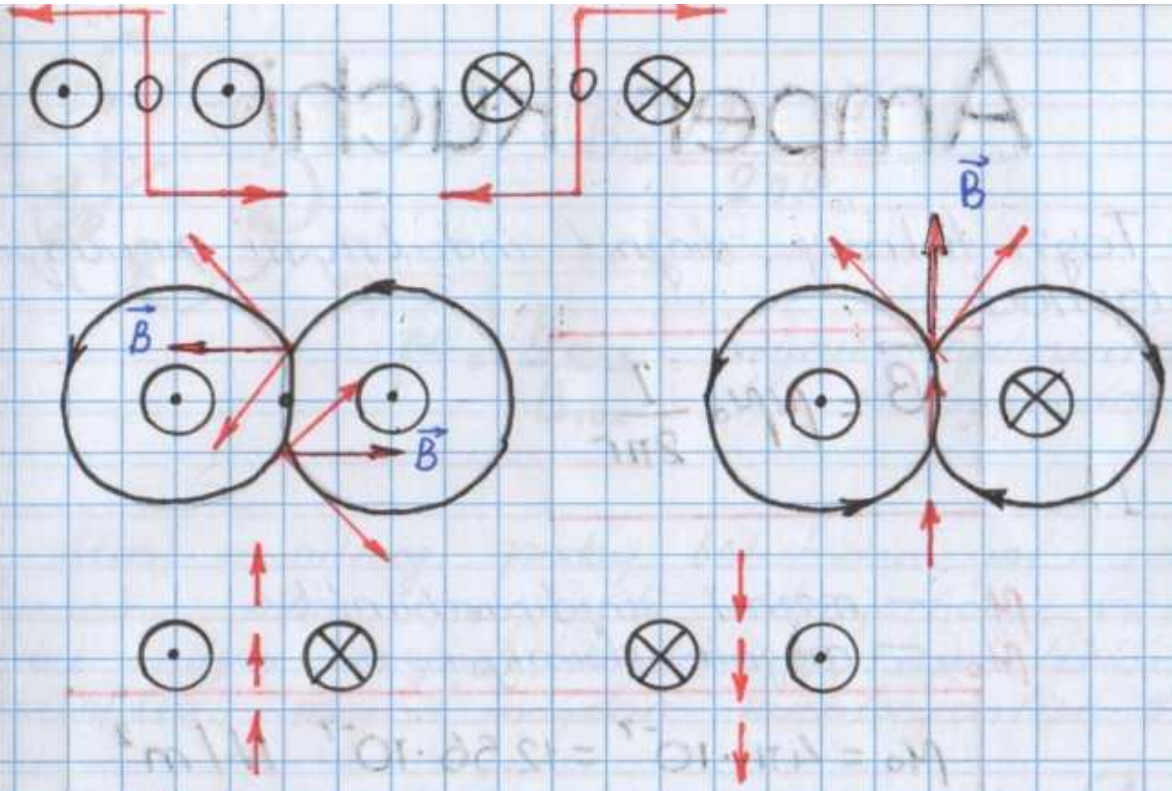
$B_2 < B_1$

Induksiya chiziqlari zich joyda magnit induksiya vektori katta, aksi bolsa kichik boladi.

a) b)

Ikkita toʻgʻri parallel oʻtkazgichlardan bir xil yoʻnalishda tok oʻtsa bu oʻtkazgichlar oʻzaro tortilishadi ⓐ rasm. Agar qarama-qarshi yoʻnalishda tok oʻtsa itarishadi ⓑ rasm.

Bunga Trolleybus liniyasi (itarishadi), uyga kirgan liniya simlari (itarishadi) misol boladi.

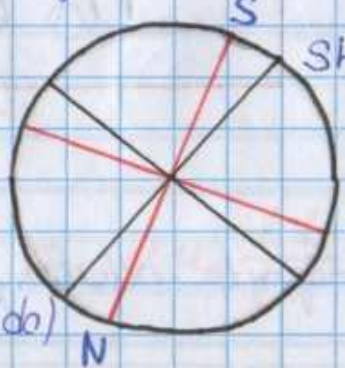


- Yer sharining magnit maydoni mavjud. Shimoliy geografiy qutb yaqinida magnit maydonining S qutbi joylashgan. Janubiy geografik qutb yaqinida magnitning N qutbi joylashgan.

- Kompas strelkasi (mili) po'latdan yasaladi. Magnit qutblarida kompas strelkasi vertikal (tik) holatda joylashadi. Magnit ekvatorda gorizontal (ufqiy) holatda joylashadi.

- Geografik ekvator bilan magnit ekvator ustma-ust tushmaydi.

- Qutb yog'dusi yerning magnit maydoni tufayli yuzaga keladi.



Shimol (arktika)

magnit ekvatori.

Janub (antarktida)

Amper kuchi

To'g'ri tokning magnit induksiyasi quyidagicha topiladi.

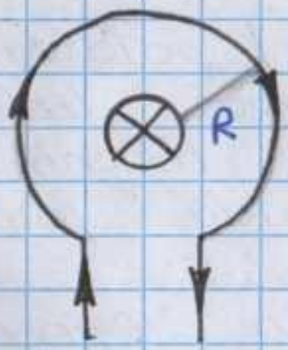
$$\vec{B} = \mu\mu_0 \frac{I}{2\pi r}$$

μ — magnit singdiruvchanlik.
μ_0 — magnit doimiysi

$$\mu_0 = 4\pi \cdot 10^{-7} = 12.56 \cdot 10^{-7} \ N/m^2$$

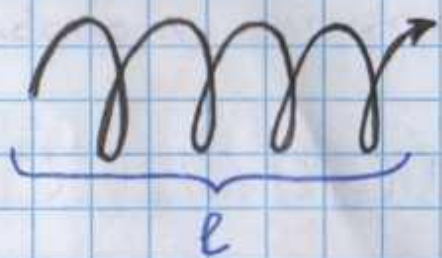
r — qaralayotgan nuqtagacha masofa.

- Vakum, havo uchun $\mu = 1$.
- Doiraviy magnit induksiyasi quyidagicha topiladi.



$$\vec{B} = \mu\mu_0 \frac{I}{2R}$$

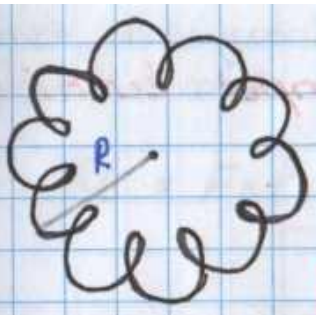
- Solinoid uchun magnit induksiyasi



$$\vec{B} = \mu\mu_0 \frac{NI}{\ell}$$

N — o'ramlar soni

- Toroid uchun magnit induksiyasi



$$\vec{B} = \frac{\mu\mu_0 NI}{2\pi R}$$

$$\mu = \frac{B_{muh}}{B_{vak}}$$ magnit singdiruvchanlik (har qanday modda uchun)

- Atrof muhitning qanday bo'lishidan qat'i nazar fazoning biror nuqtasida o'tkazgichdagi tok ta'sir hosil qilgan magnit maydonini xarakterlovchi kattalikka **magnit maydon kuchlanganligi** deyiladi.

$\vec{H}$ – magnit maydon kuchlanganligi $\left[\frac{A}{m}\right]$

- Yo'nalishi $\vec{B}$ ning yo'nalishidek bo'ladi

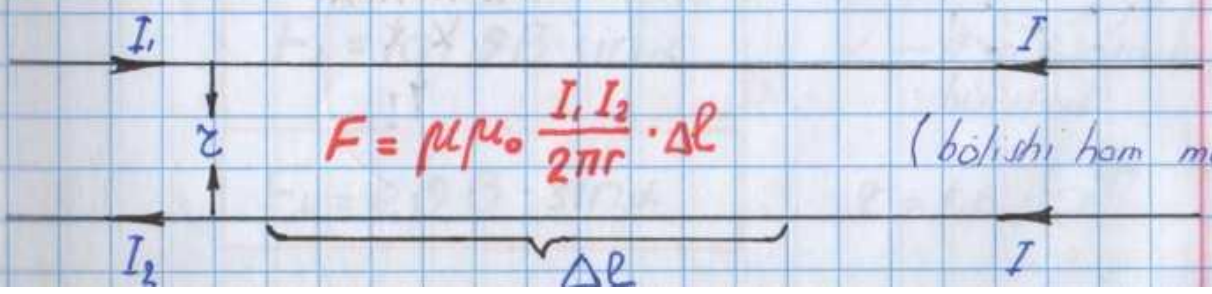
$$\vec{B} = \mu\mu_0 \vec{H}$$

$$H = \frac{I}{2\pi r}$$ To'g'ri tokning magnit maydon kuchlanganligi

$$H = \frac{N \cdot I}{\ell}$$ Solenoid magnit maydon kuchlanganligi

$$H = \frac{N \cdot I}{2\pi R}$$ Toroid magnit maydon kuchlanganligi

$$H = \frac{I}{2R}$$ Doiraviy magnit maydon kuchlanganligi



$$F = \mu\mu_0 \frac{I_1 I_2}{2\pi r} \cdot \Delta\ell$$ (bo'lishi ham mumkin)

Tok o'tayotgan o'tkazgichda magnit maydon tomonidan ta'sir qiladigan kuchga **amper kuchi** deyiladi.

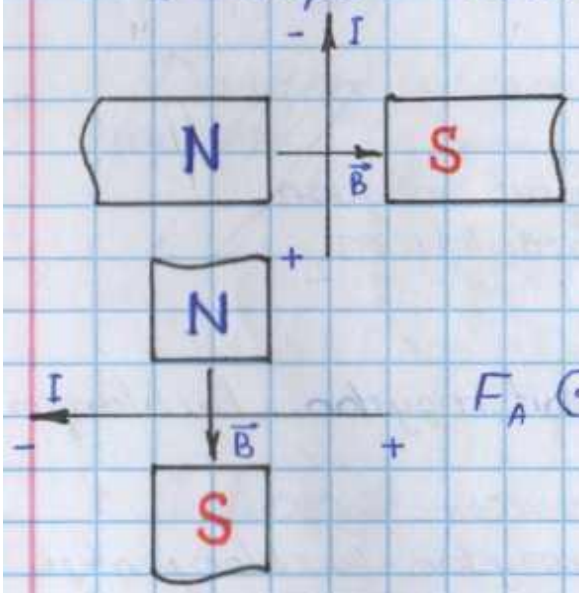
$$F_A = BIl\sin\alpha$$

α – magnit induksiya va tok orasidagi

• Amper kuchining yo'nalishi **chap qo'l qoidasi** yordamida aniqlanadi.

Chap qo'l qoidasi

Agar tok chap qo'limizdagi 4 ta barmog'i o'tkazgichdagi tokning yo'nalishini ko'rsatsa, B vektor kaftimizga kirsa yani kaftimiz magnitning N ga qarasa, 90° ga ochilgan bosh barmog'imiz amper kuchini yo'nalishini ko'rsatadi.



$F_A \otimes$ bixdan.

$F_A \odot$ bixga.

$F_A \downarrow$

$F_A \rightarrow$

Agar tokli kontur magnit maydoniga kiritilsa aylantiruvchi kuch momenti yuzaga keladi:

$$\mathcal{M} = F_A \ell = BI\ell \cdot \ell \cdot \sin\alpha = B \cdot IS \sin\alpha$$

$$\boxed{\mathcal{M} = BIS \sin\alpha}$$

$\mathcal{M}$ – kuch momenti $[N/m]$

$$\boxed{P_M = IS}$$

P_M – magnit momenti $[A \cdot m^2]$

$$\boxed{\mathcal{M} = B P_M \sin\alpha}$$

- Magnit momenti yo'nalishi parma qoidasi yordamida aniqlanadi.

Parma qoidasi.

Agar parmaning dastasi konturdagi tokning yo'nalishi bo'ylab aylantirilsa parma uchi P_{Mog} yo'nalishini ko'rsatadi.

Lorens kuchi.

Tinch turgan zaryadli zarraga magnit maydoni ta'sir qilmaydi. Harakatlanayotgan zaryadli zarraga magnit maydon tomonidan ta'sir qiladigan kuchga **Lorens kuchi** deyiladi.

$$\boxed{F_L = |q| \vartheta B \cdot \sin\alpha}$$

α – ϑ va B orasidagi burchak

$$\boxed{F_L = e \vartheta B \cdot \sin\alpha}$$

$e = 1{,}6 \cdot 10^{-19}$

• Lorens kuchi ish bajarmaydi. U zarraching tezligi yo'nalishini o'zgartiradi. Tezlik modulini o'zgartirmaydi. Shuning uchun ish bajarmaydi.

• Lorens kuchining yo'nalishini musbat zaryadlar uchun chap qo'l, manfiy zaryadlar uchun o'ng qo'l qoidasi yordamida aniqlanadi.

Musbat zarra — alfa, proton (chap qo'l q)
Manfiy zarra — elektron (o'ng qo'l qoidasi)

X_Z^A — A — massa soni, Z — zaryadi

alfa — $\alpha_2^4 = He_2^4$ (geliy)

proton — p_1^1

elektron — e_{-1}^0 $\quad m = 9.1 \cdot 10^{-31}$ kg

$Z = 1 = 1e = 1{,}6 \cdot 10^{-19} C$
$Z = 2 = 2e = 3{,}2 \cdot 10^{-19} C$.

$m = A \cdot 1{,}66 \cdot 10^{-27}$ kg $\quad A - [m.a.b] = [u]$.

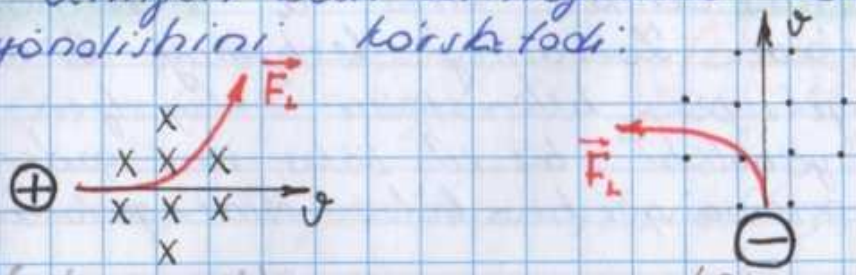
O'ng qo'l qoidasi

Agar o'ng qo'limizning 4 ta barmog'i manfiy zaryadlarning tezlik yo'nalishini ko'rsatsa B vektor kaftimizga kirsa yani magnitning N igo qarasa, 90° ga ochilgan bosh barmog'imiz Lorens kuchini yo'nalishini ko'rsatadi.

Chap qo'l qoidasi.

Agar chap qo'limizning 4 ta barmog'i musbat zaryadning tezlik yo'nalishini

körsatsa, B vektor kaftimizga kirsa, 90° ga ochilgan bosh barmog'imiz Lorens kuchini yönalishini körsatadi:



(chap qo'l) (O'ng qo'l)

- Agar zaryadli zarra magnit maydoniga B vektor yönalishida yoki B vektorga qarama-qarshi yönalishda uchib kirsa, tögri chiziqli trayektoriya bo'ylab harakat qiladi. Lorens kuchi ta'sir etmaydi.

- Agar zaryadli zarra B ga perpendikulyar uchib kirsa aylana bo'ylab harakat qiladi. Zarra chizadigan aylana radiusi quyidagicha

$$q\vartheta B = \frac{m\vartheta^2}{R}$$

$$R = \frac{m\vartheta}{qB} \qquad R_e = \frac{m_e\vartheta}{e \cdot B}$$

$e = 1{,}6 \cdot 10^{-19}$
$m_e = 9{,}1 \cdot 10^{-31}$

Kinetik energiyasi: $W = \frac{m\vartheta^2}{2}$ $W_K = q \cdot U$

Radiusi: $R_e = \frac{m_e\vartheta}{eB}$ $W_e = \frac{m\vartheta^2}{2}$ $W_e = eU$

$$R = \frac{m}{qB} \cdot \sqrt{\frac{2W}{m}} = \frac{\sqrt{2Wm}}{qB}$$

Davri: $\vartheta = \frac{RqB}{m}$ $\vartheta = \frac{2\pi R}{T}$

$$\frac{2\pi}{T} = \frac{qB}{m} \qquad T = \frac{2\pi m}{qB}$$

2 marta ionlashsa — $q = 2e$.

• Agar zaryadli zarra magnit maydoniga biror burchak ostida uchib kirsa u vintsimon harakat qiladi. Zarraning tezligining B vektorga proyeksiyasi bilan to'g'ri e'tiborga kuchning yo'nalishi bir xil bo'lsa vint qadami ortadi, qarama qarshi bo'lsa vint qadami kamayadi.

Moddaning magnit xossalari.

Magnit maydonida magnitlanadigan moddalarga **magnitiklar** deyiladi.

$$B = \mu B_0$$

B — muhitda
B_0 — vakuumda
μ — magnit singdiruvchanlik.

• $\mu < 1$ bo'lsa, ular **diamagnitlar** deyiladi. ular tashqi maydonni susaytiradi.

Diamagnitlarga: oltin, kumush, mis, vismut, suv va boshqalar kiradi.

• $\mu > 1$ bo'lsa, ular **paramagnitlar** deyiladi. ular tashqi maydonni juda kam kuchaytiradi.

Paramagnitiklarga: alyuminiy, platina, volfram, gazlar va boshqalar kiradi.

- Ular $\mu \gg 1$ bo'lsa, ular feromagnitlar deyiladi. Ular tashqi maydonni juda kop kuchaytiradi.

Feromagnitlarga: temir, kobalt, nikel va polat kiradi.

- Ferromagnitlarning magnit xususiyatini yo'qotadigan temperaturaga Kyuri temperaturasi deyiladi.

Ferromagnitlar paramagnitlarga yoki diamagnitlarga aylanadigan temperaturaga Kyuri temperaturasi deyiladi.

Metallarning elektron o'tkazuvchanligi.

Metallarda elektr tokini erkin elektronlar tashishini birinchi bo'lib tajribada
1913-yil Mandelshtam va Papoleksi;
1916-yil Styuart va Tolmen lar aniqlagan.

- Metallarda elektr tokini erkin elektronlar tashiydi.

Metallarda temperatura ortishi bilan ularning qarshiligi chiziqli ravishda ortadi, ya'ni

$$R = R_0(1 + \alpha t)$$

R_0 — 0°C dagi qarshilik
R — t°C dagi qarshilik [Ω]
t — temperatura
α — qarshilikning temperatura koeffitsiyenti, termik koeffitsiyent

1911-yil Kamerling Onnes **o'ta o'tkazuvchanlik** hodisasini kashf qildi.

O'ta o'tkazuvchanlik deb, ma'lum temperaturada qarshiligini yo'qotadigan moddalarga aytiladi.

O'ta o'tkazgichlar
ba'zi metallar

metallar

Suyuqlik

yarim o'tkazgichlar

dielektriklar.

Yarim o'tkazgichlarda elektr toki.

Temperatura ortishi bilan qarshiligi kamaya-digan moddalarga **yarim o'tkazgichlar** deyiladi.

$$\rho_{met} < \rho_{y.o't} < \rho_{dielektriklar}$$

- Mendeleyev davriy jadvalidagi 4 valentli elementlar **yarim o'tkazgichlar** hisoblanadi. Eng ko'p tarqalgani Kremniy va Germaniy dir.

  Si — Kremniy
  Ge — Germaniy

- To'rt valentli elementlar **kovalent bog'lanish** hosil qiladi. Kovalent bog'lanish deb, juft-juft elektronlar vositasida bog'lanishga aytiladi.

- Sof (aralashmasiz) yarim o'tkazgichlarda elektr tokini elektronlar va teshiklar (kovaklar) ta-shiydi.

  Teshik bu elektron egallashi mumkin bo'lgan bosh joydir.
  Agar elektron va kovak uchrashsa **neytral atom** hosil boladi va **energiya** ajraladi.

- Sof yarim o'tkazgichlarda elektronlar qancha tok tashisa, kovaklar ham shuncha tok tashiydi.

$$I_e = I_k$$

$$\boxed{I_{um} = I_e + I_k = 2I_e = 2I_k}$$

- Yarim o'tkazgichlarning o'tkazuvchanligini oshirish uchun yarim o'tkazgichlarga **aralashma** kiritiladi.

• Agar 4 valentli elementga 5 valentli element kiritilsa 4 ta elektron kovalent bog'lanib bittasi ortib qoladi. Bunday aralashmaga donor aralashma deyiladi.

Bunday turdagi yarim o'tkazgichlarga n-tip-dagi yarim o'tkazgichlar deyiladi. Bularga asosan elektron tashiydi, teshiklar hisobga olinmaydi.

$$Si\ (IV) + As\ (V) \longrightarrow$$ donor aralashma
n-tip
negativ (manfiy).

• Agar 4 valentli elementga 3 valentli element kiritilsa 3 tasi kovalent bog'lanib, 1 ta yetmay qoladi. Bunday aralashmaga akseptor aralashma deyiladi.

Bunday tipdagi yarim o'tkazgichlarga p-tip dagi yarim o'tkazgichlar deyiladi. Bularda tok asosan kovaklar tashiydi, elektronlar hisobga olinmaydi.

$$Si\ (IV) + In\ (III) \longrightarrow$$ akseptor aralashma
p-tip
positiv (musbat)

n-tipdagi va p-tipdagi yarim o'tkazgichlarni kontaktlashtirsak yarim o'tkazgichli diod hosil bo'ladi.

• Har qanday diodni vazifasi o'zgaruvchan tokni o'zgarmas tokka aylantirishdir.

Yarim o'tkazgichning VAX (Volt amper xarakteristikasi) quyidagicha.

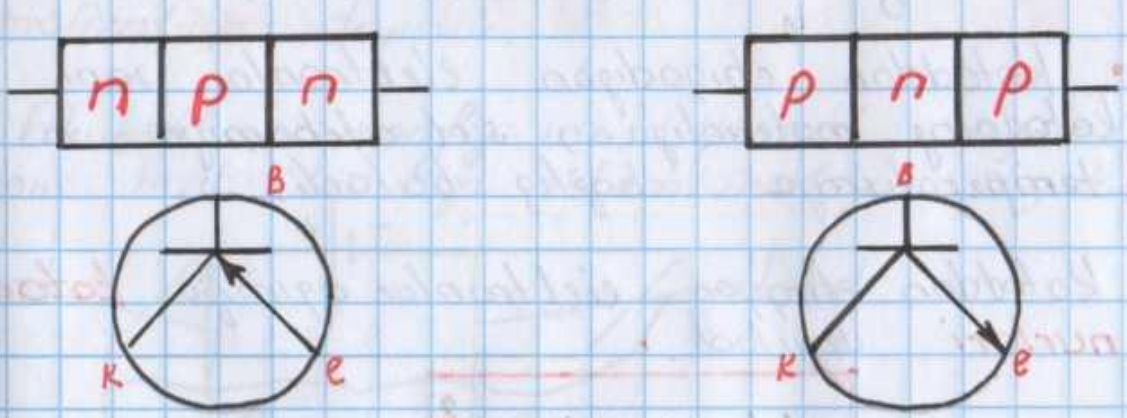
• Yarim o'tkazgichlarning qarshiligi modda turiga, shakliga, o'lchamlariga, temperaturaga va yorug'likka bog'liq bo'ladi.

Yorug'lik ta'sirida qarshiligi o'zgaradigan yarim o'tkazgichlarga **foto rezistor** deyiladi.

Temperatura ta'sirida qarshiligi o'zgaradigan qurilmalarga **termo rezistor** deyiladi.

O'ta darajada past va o'ta darajada yuqori temperaturani **termistor** (termorezistor) o'lchaydi.

Tranzistor



K — kollektor
e — emetter
B — baza

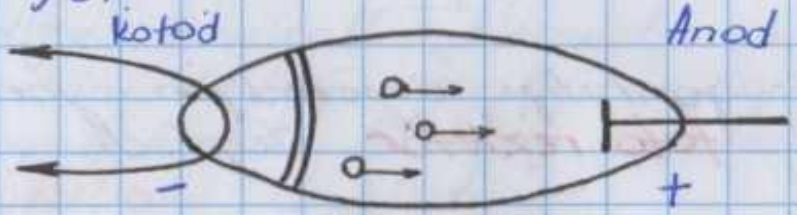
• Tranzistorning vazifasi elektr signallarini kuchaytirishdan iborat.

Vakumda elektr toki. Diod.

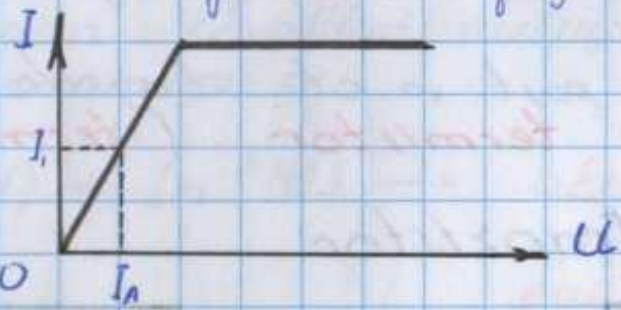
Vakumda elektr toki termo elektron emissiya hodisasi tufayli yuzaga keladi.

Termo elektron emissiya deb issiqlik ta'sirida metal sirtidan elektronlarning uchib chiqishiga aytiladi.

- Vakumda elektr tokini elektronlar tashiydi.



- Vakumli diodning VAX i quyidagicha bo'ladi



$$R = \frac{U_A}{I}$$

- Katoddan chiqadigan elektronlar soni katodning materialiga, sirt o'lchamiga va temperaturaga bog'liq bo'ladi.

Katoddan chiqqan elektronlar oqimiga **katod nurlari** deyiladi.

$$eU_T = \frac{m_e v^2}{2}$$

U_T — termoxlorchi kuchlanish, to'xtatuvchi potensial, tezlatuvchi potensial.

$$U_T = \frac{m_e v^2}{2e}$$

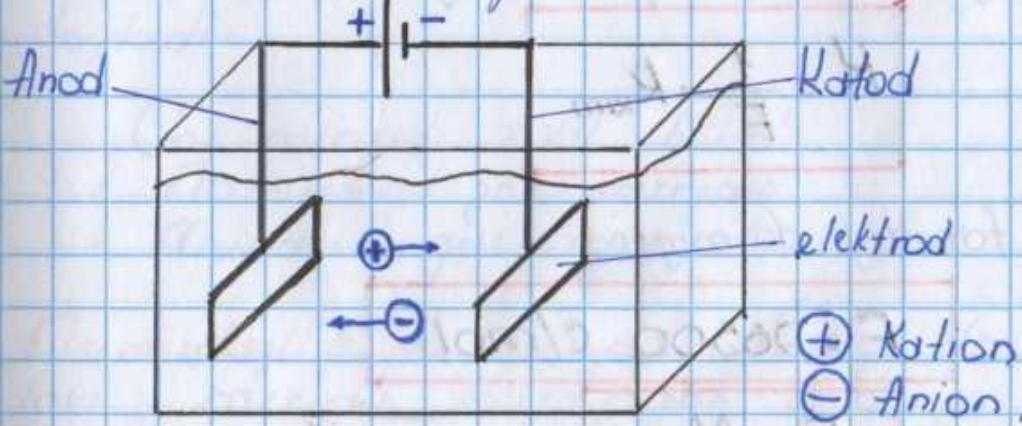
Suyuqliklarda elektr. toki. Elektroliz. Gazlarda elektr tok

Elektr tokini o'tkazadigan eritmalarga (suyuqliklarga) **elektrolit** deyiladi.

- Distirlangan toza suv elektrolit emas.
- Elektrolitlarda elektr tokini musbat va manfiy ionlar tashiydi.

Musbat va manfiy ion hosil bo'lish jarayoniga **ionlashish**, **ionizatsiya**, **elektrolitik dissotsiatsiya**, **molizatsiya** deyiladi.

- Musbat va manfiy ion qo'shilib neytral atom hosil bo'lishiga **rekombinatsiya** deyiladi.



Musbat elektronga **anod**, manfiy elektronga **katod** deyiladi.

Elektrolitdan tok o'tganda modda ajralib chiqishiga **elektroliz** deyiladi.

Elektroliz vaqtida ajralib chiqqan modda massasi faradey qonunlari yordamida aniqlanadi.

Faradeyning birinchi qonuni:

Elektrodda ajralayotgan modda massasi elektrolitdan o'tgan zaryadga to'g'ri proporsional.

$$m = kq$$

k — moddaning elektro kimyoviy ekvivalenti $[kg/c]$

$$I = \frac{q}{t} \qquad q = It.$$

$$m = kIt$$

Faradeyning ikkinchi qonuni

Moddaning elektro-kimyoviy ekvivalenti uning kimyoviy ekvivalentiga to'g'ri proporsional.

$$K = \frac{1}{F} \cdot K_{kim}$$

F — faradey doimiysi.

$$F = 96500 \ C/mol$$

$$F = N_A \cdot e$$

$$K_{kim} = \frac{M}{n} = \frac{A}{z}$$

M — molyar massa
A — massa soni
n, z — valentlik

$$F = 9{,}65 \cdot 10^7 \ C/ekv \ kg$$

• Kislorod uchun $n=2$, Boshqa moddalar uchun $n=1$.

$$m = \frac{1}{F} \cdot k_{kim} \cdot q \qquad m = kq$$

$$k = \frac{1}{F} k_{kim.}$$

$$F = \frac{k_{kim}}{m} \cdot q$$

Faradey doimiysi elektrodda massasi moddaning kimyoviy ekvivolentiga son jihatdan teng bolgan miqdorda modda ajratib chiqarish uchun elektrolitdan o'tkazish zarur bolgan zaryadga teng.

Faradeyning umumlashgan qonuni.

$$m = \frac{1}{F} \cdot \frac{M}{n} \cdot It$$

$$\vartheta = \frac{m}{M} \qquad \vartheta = \frac{It}{Fn} \qquad N = \frac{m}{M} \cdot N_A$$

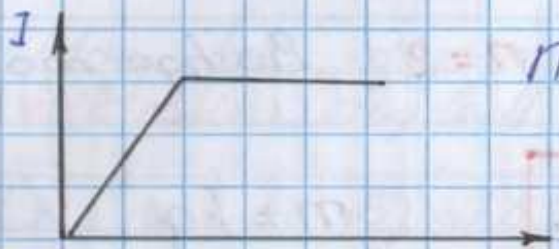
• Oddiy sharoitda gazlarda tok o'tmaydi. Gazlardan tok o'tish hodisasiga **gaz razryadi** deyiladi.

Gaz razryadi 2 xil boladi
• Nomustaqil gaz razryadi
• Mustaqil gaz razryadi.

Nomustaqil gaz razryadi – tashqi ta'sir to'xtasa, razryad to'xtaydigan hodisaga aytiladi.

Mustaqil gaz razryadi — tashqi ta'sir to'xtasa, razryad to'xtaydigan hodisaga aytiladi.

• Gazlarda elektr tokini musbat va manfiy ionlar hamda elektronlar tashiydi.



Nomustaqil gaz razryadi VAXi.

Mustaqil gaz razryadi VAXi.

Nomustaqil gaz razryadi turlari:

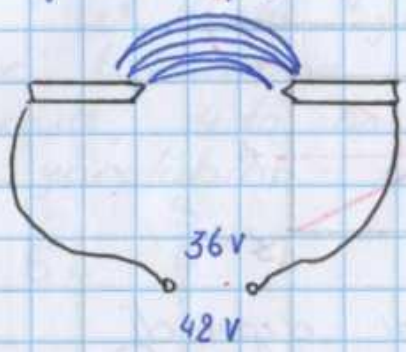
- Zarbdan ionlashish
- Foto elektron imissiya
- Termo elektron imissiya
- Afto ionlashish
- Ikkilamchi elektron imissiya.

Mustaqil gaz razryadi turlari:

- Miltillama (Bixsimo) razryad – past bosimli shisha naylarda kuzatiladi. Kunduzgi yoritgich lampalari va reklama yozuvlari misol boladi.
- Uchqunli razryad – Bulut bilan bulut, yer bilan bulut orasida katta kuchlanish yuzaga kelib yashin hosil bolishidir. Yashin vaqtida tok kuchi 10^7 A ga yetadi.
- Tojli razryad – Yuqori kuchlanish liniyalarida simlardan biri uzilganda kuzatiladigan yoritgichdir.

• Yoy razryadi, (elektr yoyi), Petrov yoyi.

1852-yil rus fizigi Petrof chöglangan elektrodlar orasida kuchlanish yuqori bölganda yuzaga keladigan yorug'lanishni kuzatdi. Yoy yongan davrida kuchlanish kamayadi.



Magnit oqim. Lens qoidasi

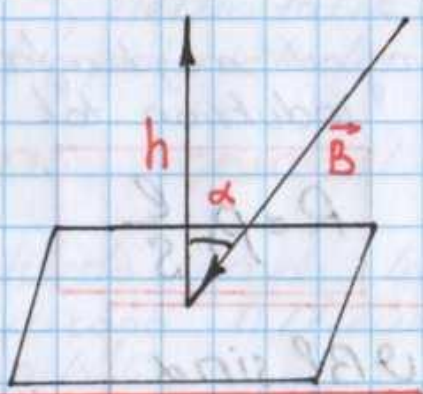
Berk konturdan o'tuvchi magnit oqimi quyidagicha topiladi.

φ – magnit oqimi [Wb] (Veber)

$$\varphi = B \cdot S \cdot \cos\alpha$$

$$\varphi_{max} = B_m \cdot S$$

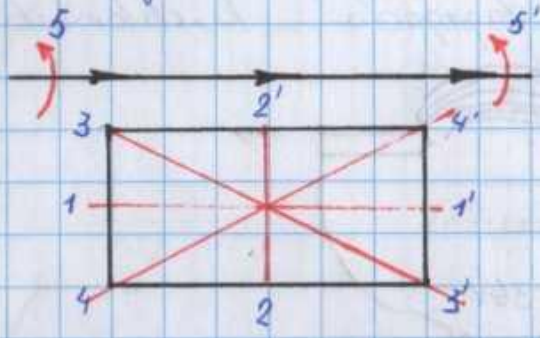
$$\varphi = \varphi_m \cdot \cos\alpha \qquad \alpha = \omega t$$



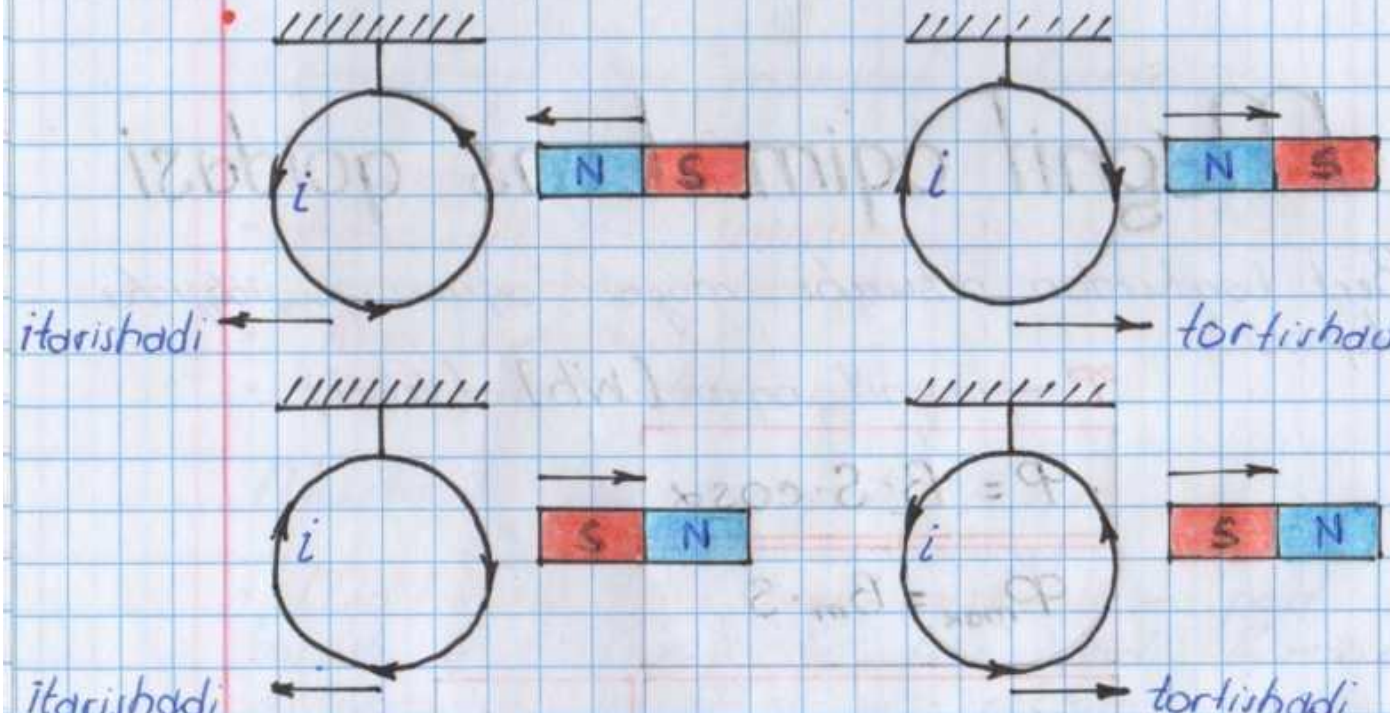
$$\varphi = NBS\cos\alpha$$

N – o'ramlar soni.

• Agar magnit maydonida kontur harakatlantirilsa magnit oqimi o'zgaradi. Agar $\vec{B}$ yo'nalishida harakatlantirilsa oqim o'zgarmaydi. Agar jism o'zining massa markazidan o'tuvchi o'q atrofida aylansa ham magnit oqimi o'zgarmaydi.



55' – magnit oqimi o'zgaradi.



i – induksion tok

• Agar o'tkazgich magnit maydonida harakatlanso bu o'tkazgichda induksion tok yuzaga keladi.

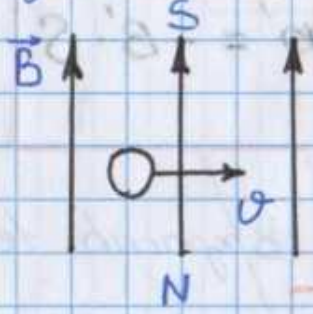
$$i = \frac{\mathcal{E}_i}{R} \qquad R = \rho_s \frac{l}{S}$$

$$\mathcal{E}_i = \vartheta B l \sin\alpha$$

• Induksion tokning yo'nalishi o'ng qo'l qoidasi yordamida aniqlanadi.

O'ng qo'l qoidasi:

Agar o'ng qo'limizning 90° ga ochilgan bosh barmog'i v tezlik yo'nalishini ko'rsatsa, B vektor kaftimizga kirsa yani kaftimiz N ga qarasa, 4 ta barmog'imiz induksion tokning yo'nalishini ko'rsatadi.



i bizga yo'nalgan ⊙

• Agar magnit oqimi o'zgarsa ish bajariladi.

$$A = I\,\Delta\varphi = I\cdot(\varphi_2 - \varphi_1)$$

• Har qanday massali jismning atrofida gravitatsion maydon mavjud bo'ladi.

• Zaryadli zarra atrofida gravitatsion maydon hamda elektrostatik (elektr) maydon mavjud bo'ladi.

• Harakatlanayotgan zaryadli zarra atrofida gravitatsion, elektrostatik hamda magnit maydon mavjud bo'ladi.

Lens qoidasi quyidagicha

Berk konturda paydo bo'ladigan induksion tok uni yuzaga keltiruvchi sababga qarshilik qiladi.

Elektro magnit induksiya qonuni.

Elektro magnit induksiya qonuni:

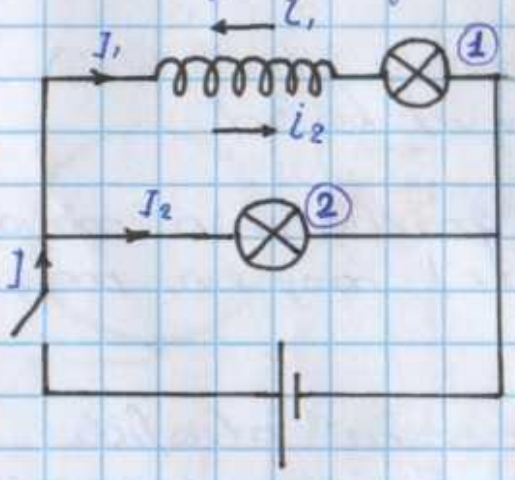
Berk konturda hosil bo'ladigan induksiya EYK shu konturdan o'tuvchi magnit oqimining o'zgarish tezligiga to'g'ri proporsional.

$$\mathcal{E}_i = -\frac{\Delta\Phi}{\Delta t} = -\Phi' = -B' \cdot S$$

$\frac{\Delta\Phi}{\Delta t}$ – magnit oqimining o'zgarish tezligi $\left[\frac{Wb}{s}\right]$

$$\mathcal{E}_i = -N \cdot \frac{\Delta\Phi}{\Delta t}$$

N – g'altakdagi o'ramlar soni.

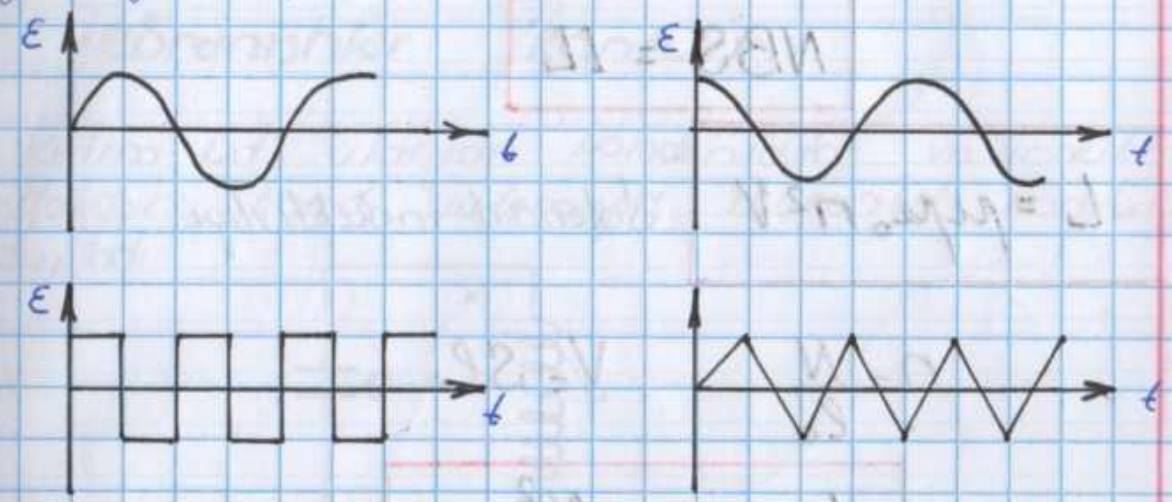


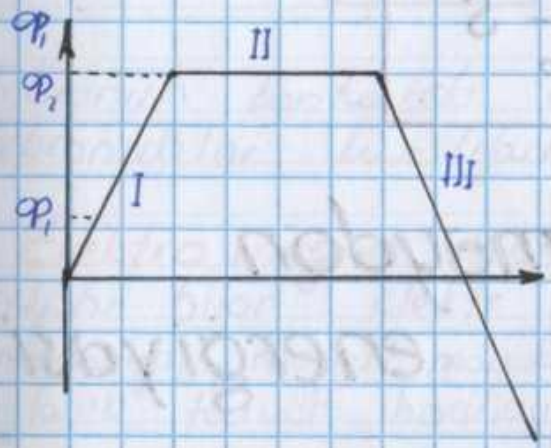
• Agar kalit ulansa ikkinchi lampa darhol yonadi, birinchi lampa asta-sekin yonadi, chunki asosiy I_1 tokka qarama-qarshi yo'nalishda i_1 induksion tok yuzaga keladi. Shuning uchun asta-sekin yonadi.

• Agar kalit uzilsa ikkinchi lampa darhol o'chadi. Birinchisi esa asta-sekin o'chadi chunki asosiy I_1 tok yo'nalishida i_2 tok yuzaga keladi va uni darhol o'chishiga yo'l qo'ymadi.

• Kalit uzilsa ikkinchi lampada tok yo'nalishi o'zgaradi.

• Induksiya EYK vaqtga bog'lanish grafigi quyidagi yo'nalishlarda bo'ladi:





$\mathcal{E}_1 < 0$

$\mathcal{E}_2 = 0$

$\mathcal{E}_3 > 0$

$$\mathcal{E} = -\frac{\Phi_2 - \Phi_1}{t_2 - t_1}$$

O'zinduksiya. Induktivlik.

G'altakdan tok o'tganda shu g'altakni o'zida induksion tok hosil bo'lish odisasiga **o'zinduksiya** deyiladi. O'zinduksiya EYK ni quyidagicha topiladi.

$$\mathcal{E}_{i.oz} = -L \cdot \frac{\Delta I}{\Delta t} = -L \cdot I'$$

$\frac{\Delta I}{\Delta t}$ – toknig o'zgarish tezligi.

L – induktivlik [H] (genri)

$$\mathcal{E}_i = -\frac{\Delta \Phi}{\Delta t} \qquad \mathcal{E}_i = -L\frac{\Delta I}{\Delta t}$$

$$\Delta \Phi = L \Delta I$$

$\Phi = LI \qquad \Phi = NBS$

$$NBS = IL$$

$$L = \mu\mu_0 n^2 V$$ Solenoid induktivligi.

$$n = \frac{N}{\ell_0} \qquad V = S\ell_0$$

$$L = \mu\mu_0 \frac{N^2}{\ell_0} S$$

Tok magnit maydon energiyasi.

Tok magnit maydon energiyasi quyidagicha topiladi.

$$W_{mag} = \frac{L \cdot I^2}{2}$$

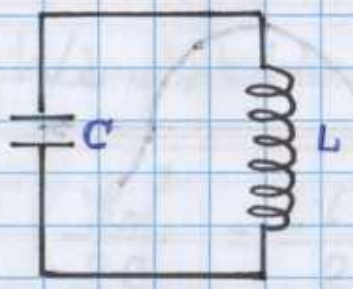
$$\Phi = L \cdot I$$

$$W_{mag} = \frac{\Phi \cdot I}{2}.$$

Elektromagnit tebranishlar.

Tebranishlar konturi.

Ketma-ket ulangan kondensator va induktiv g'altakdan iborat sistemaga **tebranish konturi** deyiladi.



- Tebranish konturida erkin elektromagnit tebranishlar kuzatiladi.

Elektromagnit tebranishlar deb vaqt o'tishi bilan elektr maydonning magnit maydoniga, magnit maydonining elektr maydoniga aylanib turush hodisasiga aylanadi.

- Tebranish konturidan kondensator zaryadi tebranadi. O'zgaruvchan magnit maydoni **uyurmali elektr maydonini** vujudga keltiradi.

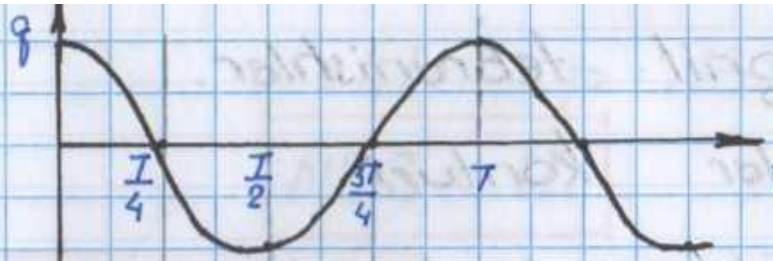
$$W_T = W_{el} + W_{mag}$$

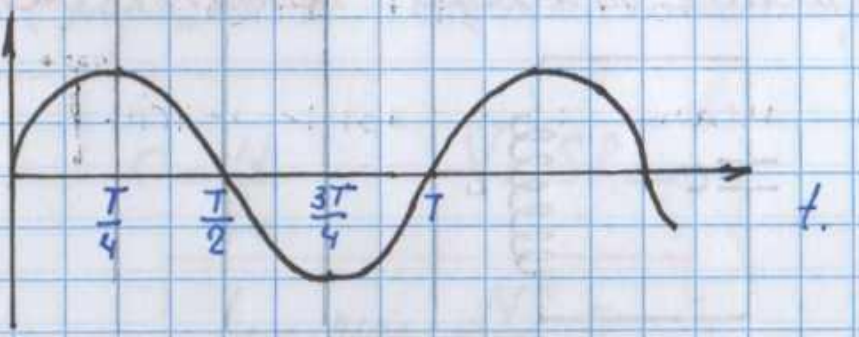
$$W_{el} + W_{mag} = const.$$

$W_{el} = \frac{q^2}{2C}$ — magnit maydon elektr energiyasi

$W_m = \frac{LI^2}{2}$ — magnit energiya.

$W_{el} = \frac{q^2}{2C}$





$W_m = \frac{LI^2}{2}$

$t_1 = 0 \quad W_T = W_{el} = \frac{q^2}{2C} \quad W_{mag} = 0$

$t_2 = \frac{T}{4} \quad W_T = W_{mag} = \frac{LI^2}{2} \quad W_{el} = 0$

$t_3 = \frac{T}{2} \quad W_T = W_{el} = \frac{q^2}{2C} \quad W_{mag} = 0$

$t_4 = \frac{3T}{4} \quad W_T = W_{mag} = \frac{LI^2}{2} \quad W_{el} = 0$

$t_5 = T \quad W_T = W_{el} = \frac{q^2}{2C} \quad W_{mag} = 0.$

- $T/8$ bo'lganda $W_{el} = W_{mag}$. bo'ladi
- Har chorak ($T/4$) davrda elektr maydon energiyasi magnit maydon energiyasiga, magnit maydon energiyasi elektr maydon energiyasiga aylanib turadi.
- Har yarim ($T/2$) davrda elektr maydon energiyasi elektr maydon energiyasiga, magnit maydon energiyasi magnit maydon energiyasiga aylanib turadi.

- Har bir ($t = T$) davr mobaynida elektr maydon energiyasi ikki marta magnit maydon energiyasiga magnit maydon energiyasi esa 2 marta elektr maydon energiyasiga aylanadi.

- Davrning 1/8 qismida $W_{el} = W_{mag}$ bo'ladi.

$$W_{el.max} = W_{mag.max}$$

$$\frac{q_m^2}{2C} = \frac{LI_m^2}{2}$$

$$q_m^2 = CLI_m^2 \Rightarrow q_m = CU_m$$

$$C^2U_m^2 = CLI_m^2$$

$$I_m = \sqrt{\frac{C}{L}} \cdot U_m$$

$$U_m = \sqrt{\frac{L}{C}} \cdot I_m$$

$$I_m = q_m \cdot \omega \qquad I_m = CU_m \cdot \omega$$

$$i = q'$$

- Tebranish konturini harakterlovchi parametrlar:

Davr (T)

Induktivlik (L)

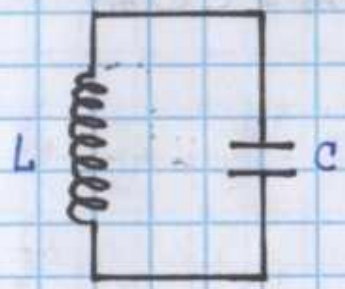
Sig'im (C)

• Agar bir xil kondensatorlar turli xil manbalardan zaryadlansa bu kondensatorlar tebranish amplitudalari bir xil bo'ladi, boshqa kattaliklar bir xil bo'ladi.

Garmonik tebranishlar.

Tebranishlar amplitudasi, davri va chastotasi.

Tebranish konturining davri Tompson formulasi yordamida aniqlanadi va u quyidagicha.



$$T = 2\pi\sqrt{L \cdot C}$$

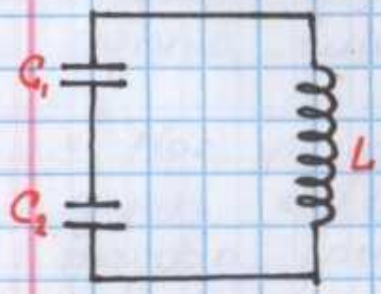
$$C = \frac{\varepsilon\varepsilon_0 S}{d}$$

$$L = \mu\mu_0 n^2 V$$

Chastotasi $$\nu = \frac{1}{\sqrt{L \cdot C} \cdot 2\pi}$$

Siklik chastotasi $$\omega = \frac{1}{\sqrt{LC}}$$

Xususiy xollar:

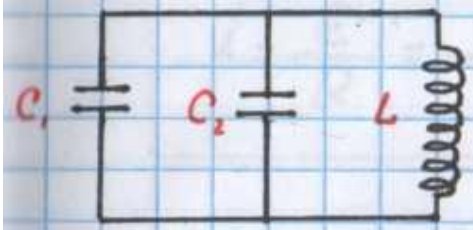


$$T = 2\pi \cdot \sqrt{L \cdot \frac{C_1 C_2}{C_1 + C_2}}$$

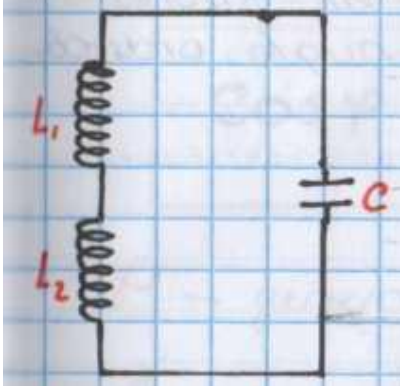
$$T = \frac{1}{\nu}$$

$$T = \frac{2\pi}{\omega}$$

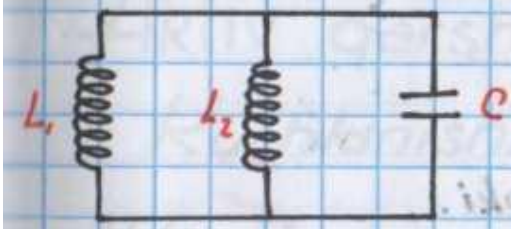
$$\omega = 2\pi\nu$$



$$T = 2\pi\sqrt{L(C_1+C_2)}$$



$$T = 2\pi\sqrt{C\cdot(L_1 \pm L_2)}$$



$$T = 2\pi\sqrt{C\cdot\frac{L_1 L_2}{L_1+L_2}}$$

Tebranishlar fazasi.

Tebranishlar fazasi deb, davriy ravishda o'zgaryotgan fizik kattalikning ixtiyoriy vaqt momentidagi qiymatini aniqlovchi fizik kattalikka aytiladi.

φ – faza [rad]

$$\varphi = \omega t$$

$$q = q_m \cos(\omega t + \varphi_0)$$

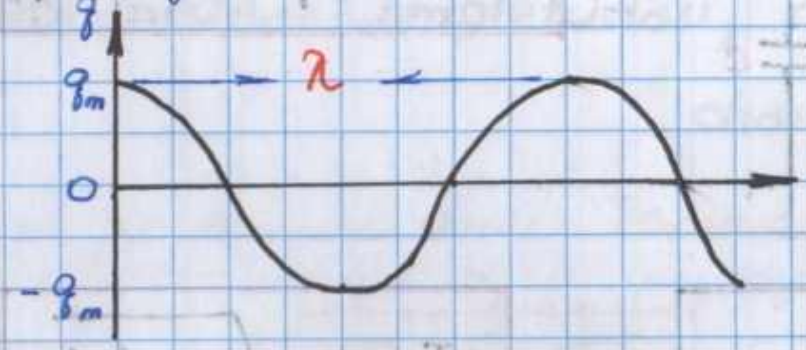
$\omega t + \varphi_0$ – faza • Sinus yoki Cosinus argumenti fazadir.

φ_0 – boshlang'ich faza

ωt – oxirgi faza

$$\Delta\varphi = \frac{2\pi\Delta\ell}{\lambda}$$

(λ) To'lqin uzunligi deb, bir xil fazada tebranuvchi eng yaqin 2 ta nuqta orasidagi masofaga aytiladi.



O'zgaruvchan elektr toki.

Vaqt o'tishi bilan ham yo'nalish jihatidan ham miqdor jihatidan o'zgaradigan tokka o'zgaruvchan tok deyiladi.

$$\mathcal{E} = \mathcal{E}_m \sin \omega t$$

$$\mathcal{E}_m = \varphi_m \omega$$

$$\varphi_m = B \cdot S$$

$$\mathcal{E}_m = B \cdot S \cdot \omega$$

$$\mathcal{E}_m = B \cdot S \cdot N \cdot \omega$$

$$\mathcal{E}_m = \vartheta B_m \ell$$

$$\mathcal{E}_m = L I \omega$$

$$I = \frac{\mathcal{E}}{R} = \frac{\varphi'}{R} = \frac{B'S}{R}$$

$\cos\varphi$ – quvvat koeffitsiyenti.

$$\cos\varphi = \frac{P_f}{P_{um}} = \frac{P}{I_1 U_1} \qquad P_{um} = I_1 U_1$$

P – generator quvvati (foydali quvvat).

Aktiv qarshilik. Tok kuchi va Kuchlanishning samaradar qiymati.

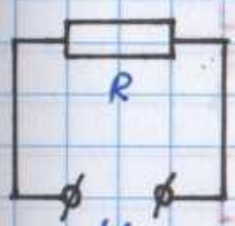
• Aktiv (faol) qarshilik o'zgarmas tokni ham, o'zgaruvchan tokni ham bir xil qarshilik bilan o'tkazadi.

$$R = \rho_s \cdot \frac{\ell}{S}$$

• O'zgaruvchan tok zanjiriga aktiv qarshilik ulasak tok kuchi tebranishlari bilan kuchlanish tebranishi bir xil fazada tebranadi. Ular orasidagi fazalar farqi nolga teng.

$I \rightarrow \quad U \rightarrow$ $\Delta\varphi$ – fazalar farqi.

$\Delta\varphi = 0$

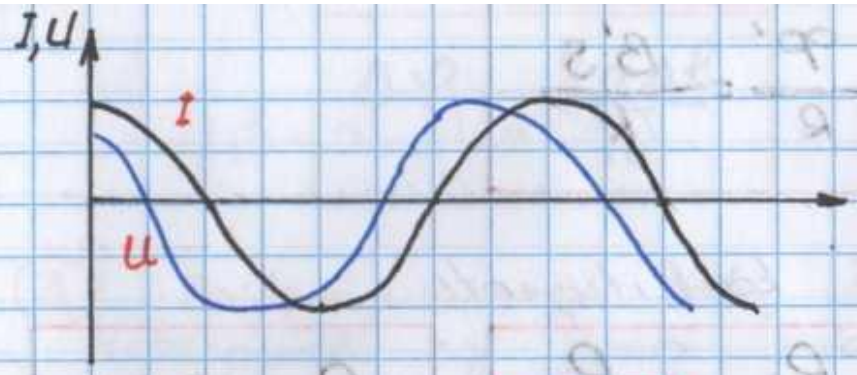


$$U = U_m \cos\omega t$$

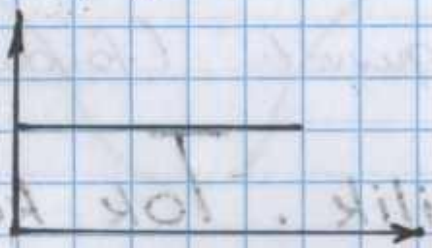
$$I = \frac{U}{R} = \frac{U_m \cos\omega t}{R}$$

$$I_m = \frac{U_m}{R}$$

$$I = I_m \cos\omega t$$



• $R = \rho_s \frac{\ell}{S}$ $\boxed{R \neq \nu}$ Qarshilik chastotaga bog'liq emas



Agar o'tkazgich magnit harakatlansa bu o'tkazgichda **induksion tok** yuzaga keladi.

Tok kuchining ta'sir etuvchi qiymati deb, o'zgaruvchan tok bir davr ichida qancha issiqlik ajratsa, o'zgarmas tok ham shu vaqt ichida shuncha issiqlik ajratadigan qiymatga aytiladi.

I_t – tok kuchining ta'sir etuvchi (effektiv, samarador) qiymati

$$\boxed{I_t = \frac{I_m}{\sqrt{2}}} \quad \boxed{U_t = \frac{U_m}{\sqrt{2}}} \quad \boxed{\mathcal{E}_t = \frac{\mathcal{E}_m}{\sqrt{2}}}$$

$$\boxed{P_{um} = P_{o'rt} = I_t U_t = \frac{I_m U_m}{2}}$$

$$\boxed{Q = I_t^2 Rt = \frac{I_m^2 Rt}{2}}$$

• Ampermetr va Voltmetr ta'sir etuvchi qiymatin

ko'rsatadi.

Kondensatorli o'zgaruvchan tok zanjiri.

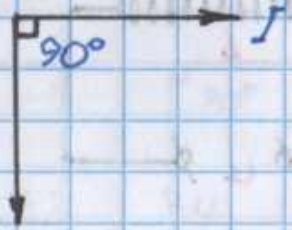
• Kondensator o'zgarmas tokni o'tkazmaydi, o'zgaruvchan tokni qarshilikday o'tkazadi.

Kondensatorning qarshiligiga sig'im qarshilik deyiladi.

R_c, X_c – sig'im qarshilik [Ω]

$$X_c = \frac{1}{\omega C} = \frac{1}{2\pi\nu C}$$

Agar kondensatorni o'zgaruvchan tok zanjiriga ulasak, tok kuchi tebranishlari kuchlanish tebranishlaridan $\pi/2$ qadar oldinda yuradi.



$$\Delta\varphi = \frac{\pi}{2}.$$

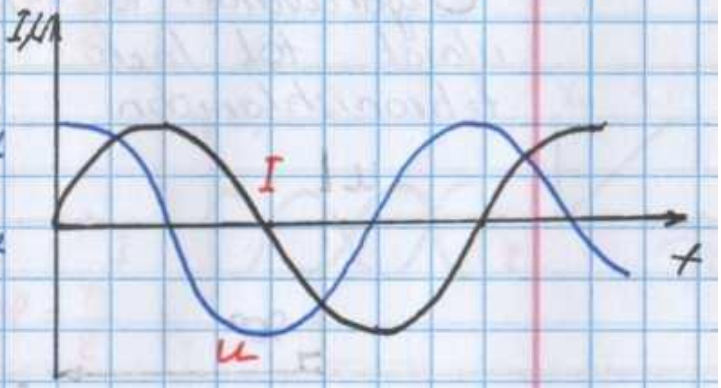
$$U = U_m \cos\omega t$$

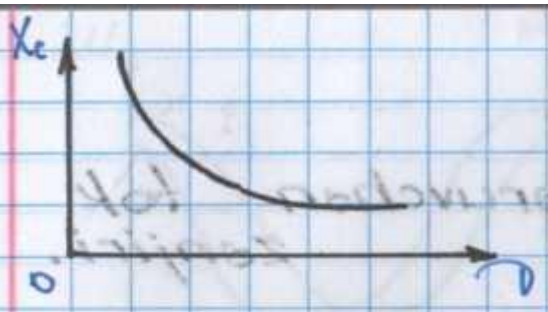
$$q = CU = CU_m \cos\omega t$$

$$I = q' = -CU_m \sin\omega t$$

$$I_m = CU_m\omega$$

$$I = -I_m \sin\omega t$$





$I = CU\omega = CU2\pi\nu$

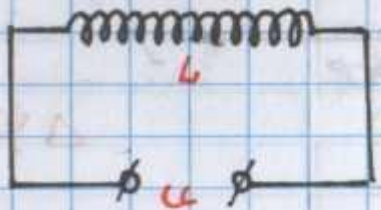
$I \sim C\nu$

Induktivlik g'altagili o'zgaruvchan tok zanjiri.

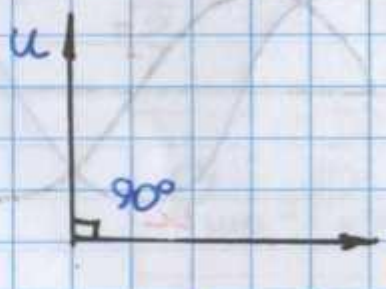
- Induktiv g'altak o'zgarmas tokni shunday, o'zgaruvchan tokni qarshilikday o'tkazadi.
- G'altakning qarshiligiga induktiv qarshilik deyiladi.

R_L, X_L – induktiv qarshilik $[\Omega]$

$$X_L = \omega L = 2\pi\nu L$$



O'zgaruvchan tok manbaiga induktiv g'altak ulasak tok kuchi tebranishlari, kuchlanish tebranishlaridan $\pi/2$ qadar ortda qoladi.



$$\Delta\varphi = \frac{\pi}{2}$$

$$I = I_m \sin\omega t$$

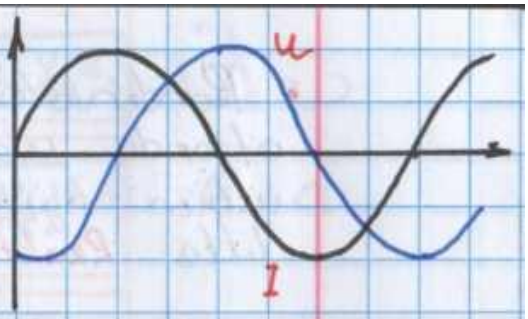
$$U = \mathcal{E} = L \cdot I' = L \cdot I_m \cos\omega t \cdot \omega$$

$$U = U_m \cos\omega t$$

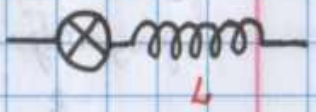
$U_m = \omega \cdot L \cdot I_m$

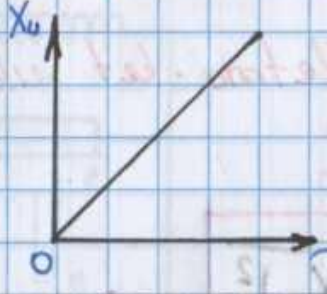
$I_m = \frac{U_m}{L\omega}$ $\quad \omega = 2\pi\nu$

$I_m = \frac{U_m}{L \cdot 2\pi\nu}$



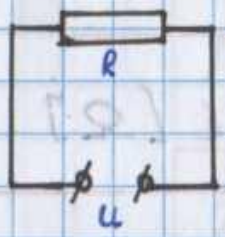
$I \sim \frac{1}{L\nu}$





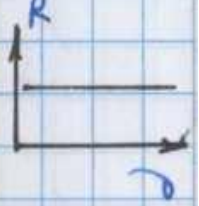
Rezistor

$R = \rho_s \frac{l}{S}$



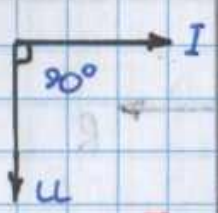
$\vec{I}$ $\vec{u}$

$\Delta\varphi = 0$

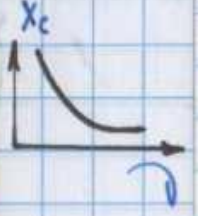


Kondenzátor

$X_c = \frac{1}{\omega C}$

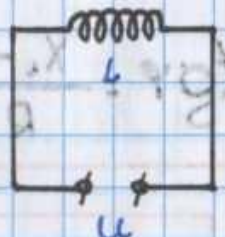


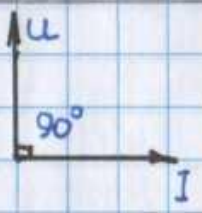
$\Delta\varphi = \frac{\pi}{2}$



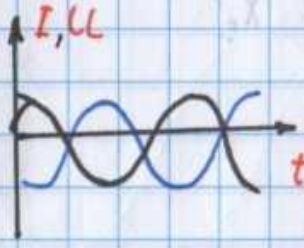
Induktivita

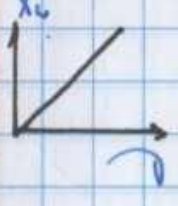
$X_L = \omega L$





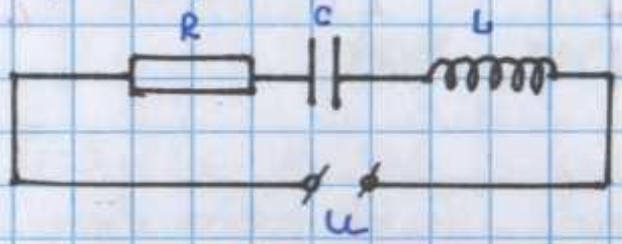
$\Delta\varphi = \frac{\pi}{2}$





• Kondensator va galtaldan o'zgaruvchan tok o'tganda ulardan issiqlik ajralmaydi. Shuning uchun sigim garshilik va induktiv garshilikka **Reaktiv garshilik** deyiladi.

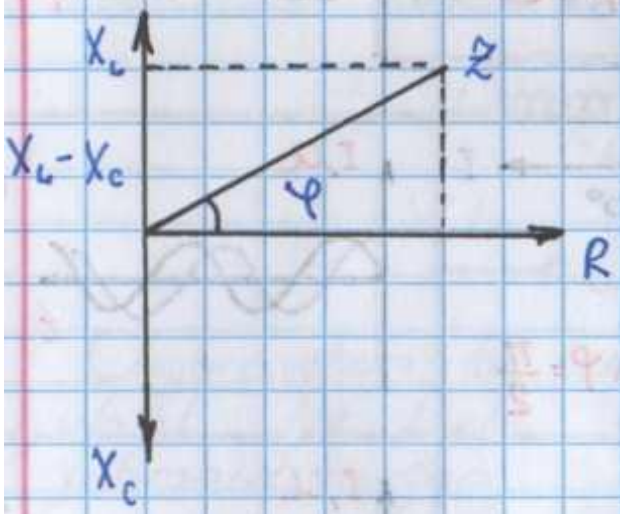
• O'zgaruvchan tok zanjiriga aktiv va reaktiv garshilik ketma-ket ulansa to'liq garshilik quyidagicha topiladi:



Ketma-ket ulash.

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

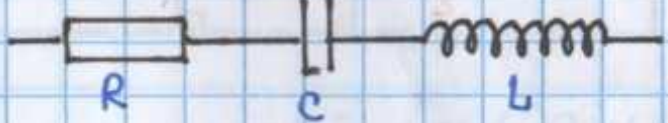
Z — asbob (to'liq) garshilik [Ω]



$$\cos\varphi = \frac{R}{Z}$$

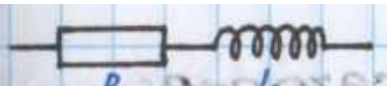
$$\sin\varphi = \frac{X_L - X_C}{Z}$$

$$tg\varphi = \frac{X_L - X_C}{R}$$

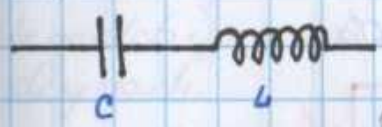


$$I_{um} = I_R = I_C = I_L$$

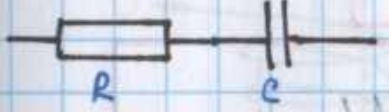
$$U = \sqrt{U_R^2 + (U_L - U_C)^2}$$



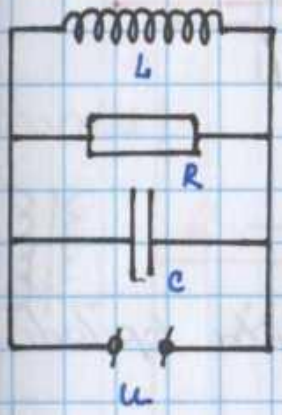
$$Z = \sqrt{R^2 + X_L^2} \qquad X_C = 0$$



$$Z = \sqrt{(X_L - X_C)^2} \qquad R = 0$$



$$Z = \sqrt{R^2 + X_C^2} \qquad X_L = 0.$$

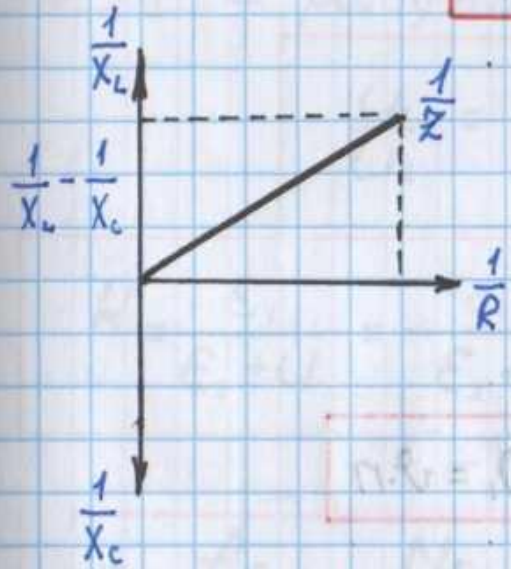


Parallel ulash

$$U_{um} = U_R = U_C = U_L$$ Kuchlanish

$$I = \sqrt{I_R^2 + (I_L - I_C)^2}$$ Tok kuchi

$$\frac{1}{Z} = \sqrt{\frac{1}{R^2} + \left(\frac{1}{X_L} - \frac{1}{X_C}\right)^2}$$ To'liq qarshilik



Elektr zanjiridagi rezonans

Elektr zanjiridagi rezonansda

$$X_L = X_C \qquad Z = R$$

$$P = I_T U_T \cos\varphi = \frac{I_m U_m}{2} \cos\varphi$$

P — aktiv quvvat [W]

Transformatorlar.

• Generator juft qutblar soni quyidagicha topiladi:

$$n = \frac{\vartheta_1}{\vartheta_2}$$

ϑ_1 — tokning chastotasi
ϑ_2 — aylanishlar chastotasi.

$$\vartheta_2 = \frac{\vartheta}{2\pi R}$$

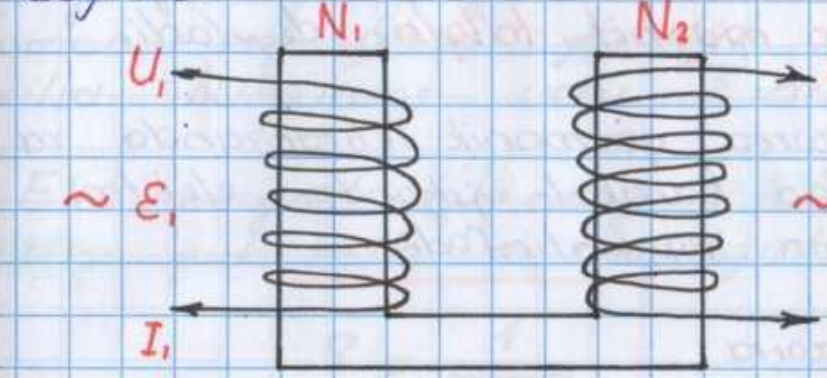
$$n = \frac{\vartheta_1}{\vartheta_2} = \frac{\vartheta_1 \cdot 2\pi R}{\vartheta}$$

$$\vartheta_1 = \frac{\vartheta n}{2\pi R} \qquad \vartheta_1 = \vartheta \cdot n$$

Transformatorlar — elektro magnit induksiya qonuniga asoslanishlaydi.

Transformatorning vazifasi o'zgaruvchan tok kuchini yoki kuchlanishni o'zgartirishdan iborat. Transformator **po'lat**dan yoki **ferrit**dan tayyorlangan ikkita berk o'zak va unga kiritilgan bir-biriga izolyatsiyalangan oramlar soni turlicha

bo'lgan g'altakdan tuziladi. Transformatorning tok manbaiga ulanadigan qismi birlamchi chulg'am, iste'molchiga ulangan qismi ikkilamchi chulg'am deyiladi.



K – transformatsiya koeffitsiyenti.

$$K = \frac{U_1}{U_2} \qquad K = \frac{N_1}{N_2} \qquad K = \frac{I_2}{I_1}$$

$K < 1$ – kuchaytiruvchi $S_1 > S_2$

$K > 1$ – pasaytiruvchi $S_1 < S_2$

$$\frac{U_1}{U_2} = \frac{N_1}{N_2}$$

$$K = \frac{\mathcal{E}_1}{\mathcal{E}_2 + U} = \frac{\mathcal{E}_1}{\mathcal{E}_2 + IR}$$

Simlarga tushadigan kuchlanish e'tiborga olinsa, unda K (transformatsiya koeffitsiyenti) quyidagicha bo'ladi.

$$\eta = \frac{A_f}{A_{um}} = \frac{N_f}{N_{um}} = \frac{I_2 U_2}{I_1 U_1}$$

foydali ish koeffisiyenti.

$$P_1 \approx P_2$$

$$I_1 U_1 \approx I_2 U_2$$

$$\frac{U_1}{U_2} = \frac{I_2}{I_1}$$

Elektromagnit tolqinlar.

Elektromagnit tebranishlarning fazodagi tarqalishiga **elektromagnit to'lqin** deyiladi.

- Zaryadli zarra garmonik tebranganda va tezlanish bilan harakat qilganda elektromagnit to'lqin nurlantiriladi.

- Zaryadli zarra
  a) tekis
  b) tezlanuvchan
  c) sekinlanuvchan
  d) aylana bo'ylab tekis harakat
  e) aylana bo'ylab tezlanuvchan
  f) garmoni harakat

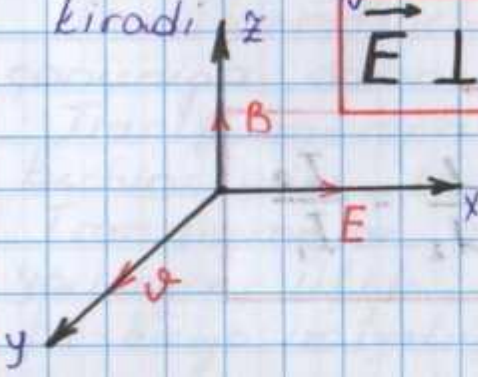
Shulardan ⓐ holda nurlantirmaydi qolgan holatlarda nurlanadi, ⓓ holat bo'lishiga sabab aylana bo'ylab tekis harakatda markazga intilma tezlanish mavjuddir.

- Ochiq tebranish konturiga **gers vibratori** deyiladi.
- Gers vibratori elektromagnit to'lqinni tarqatadi.
- Tarqalayotgan to'lqinning energiyasi va quvvati chastotaning to'rtinchi darajasiga teng.

$$W \sim \nu^4 \qquad P \sim \nu^4$$

- Elektromagnit to'lqin **ko'ndalang to'lqin** turiga kiradi.

$$\vec{E} \perp \vec{B} \perp \vec{\vartheta}$$



E – elektr maydon kuchlanganligi

B – induksiya

ϑ – tezlik

• Tezlikning yo'nalishi **o'ng burgu** (parma, vint) qoidasi yordamida topiladi.

Agar burgining dastasi $\vec{E}$ dan $\vec{B}$ ga tomon eng qisqa yo'nalish bilan aylantirilsa burgining uchi ϑ ni ko'rsatadi.

• Elektromagnit to'lqinning vakuumda tarqalish tezligi juda katta va quyidagicha topiladi.

$$C = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$$

C – yorug'likning vakuumdagi tezligi

$$C = 3 \cdot 10^8 \ m/s$$

$$C = \frac{E}{B}$$

$F = q\vartheta B$

$F = qE$

$q\vartheta B = qE$

$$\vartheta = \frac{E}{B}$$

$$\vartheta = \lambda \nu \qquad \lambda = CT$$

$$C = \lambda \nu \qquad \lambda = C \cdot 2\pi\sqrt{LC}$$

• Elektromagnit to'lqinning muhitdagi tezligi quyidagicha topiladi.

$$\vartheta = \frac{1}{\sqrt{\varepsilon \mu \varepsilon_0 \mu_0}}$$

$$n = \sqrt{\varepsilon\mu}$$

n – muhitning sindirish ko'rsatkichi yoki muhitning optik zichligi.

$$\vartheta = \frac{c}{\sqrt{\varepsilon\mu}} \qquad \vartheta = \frac{c}{n} \qquad n = \frac{c}{\vartheta}$$

$$c > \vartheta$$
$$n > 1$$

- Vakum, havo uchun $n = 1$

Muhitning sindirish ko'rsatkichi fizik ma'nosi quyidagicha elektromagnit to'lqinning biror muhitda tarqalish tezligi vakuumda tarqalish tezligidan necha marta kichikligini ko'rsatuvchi kattalikdir.

- Elektromagnit to'lqinning nurlanish oqim zichligi quyidagicha topiladi.

$$I = \frac{W}{St}$$

I – nurlanish oqim zichligi (intensivlik) $\left[\frac{J}{m^2 s}\right]$

$$S = 4\pi r^2$$

$$I = \frac{W}{4\pi r^2 t} \qquad I \sim \frac{1}{r^2}$$

$$\underline{\omega} = \frac{W}{V} \qquad W = \underline{\omega} V$$

$\underline{\omega}$ – energiya zichligi.

$$I = \frac{\underline{\omega} V}{St} = \frac{\underline{\omega} S \cdot l}{S \cdot t} = \underline{\omega} \cdot \vartheta \qquad I = \underline{\omega}\vartheta$$

• Radio to'lqinlar yordamida obyekni topish va uning turgan joyini aniqlashga **radiolokatsiya** deyiladi.

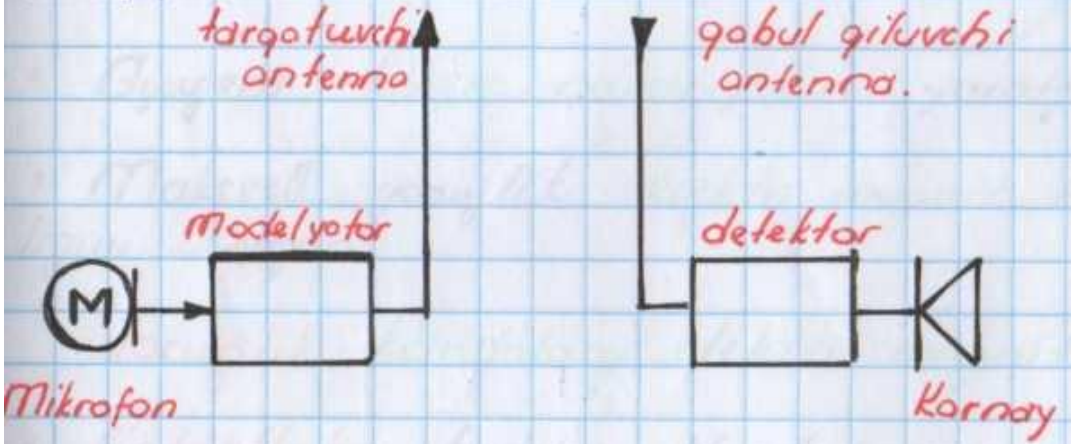
• Radiolokatsiya **radiolokatr** yoki **radar** yordamida amalga oshiriladi. va Obyektgacha bolgan masofa quyidagicha topiladi

$$R = \frac{ct}{2N}$$ yoki, N bolmasa $$R = \frac{ct}{2}$$

N – impulslar soni
$c = 3 \cdot 10^8$ m/s
t – umumiy vaqt

$t_1 > t_2$ bolsa,
$t = t_1$ deb olamiz.

• Radiolokatsiyaning blok sxemasi quyidagicha boladi.



Modelyator past chastotali tovush tolqinlarini yuqori chastotali tolqinga aylantiradi. ya'ni modelyatsiyalaydi.

Detektor yuqori chastotali elektromagnit tolqinni past chastotali tolqinga aylantiradi.

• Elektro magnit tolqinlar shkalasi quyidagiga tartibda

1. Past chastotali tolqinlar $\lambda > 10^4$ m
2. Radio tolqinlar $\lambda = 10^4 \div 10^{-4}$ m

3. Infra qizil nurlar $\lambda = 10^{-4} \div 8 \cdot 10^{-7}$ m

4. Ko'rinadigan nurlar $\lambda = 8 \cdot 10^{-7} \div 4 \cdot 10^{-7}$ m

5. Ultra binafsha nurlar $\lambda = 4 \cdot 10^{-7} \div 10^{-9}$ m

6. Rentgent nurlari $\lambda = 10^{-8} \div 10^{-11}$ m

7. Gamma nurlari $\lambda < 10^{-11}$ m.

OPTIKA

Fizikaning yorug'lik hodisalarini o'rganadigan bo'limiga **optika** deyiladi.

Optika 2 qismdan iborat.

- Geometrik optika (nurlar optikasi)
- Fizik optika (to'lqinlar optikasi)

Yorug'lik nuri yorug'lik energiyasi tarqatadigan chiziqdir.

- **Isaak Nyuton** korpuskulyar nazariyasini yaratgan. Nyuton fikriga ko'ra yorug'lik zarralardan iborat

- **Gyugens** to'lqin nazariyasini yaratgan

- **Maksvell** yorug'lik elektromagnit to'lqinligini aytgan.

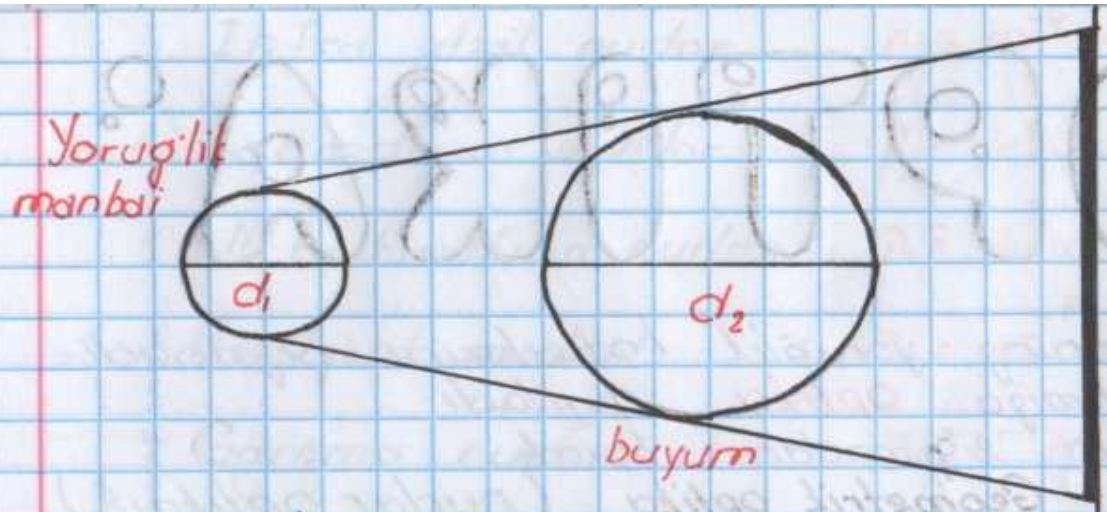
Yorug'lik ko'ndalang elektromagnit to'lqin.

- **Fotoeffekt** hodisasi Nyuton nazariyasi asosida tushuntiriladi.

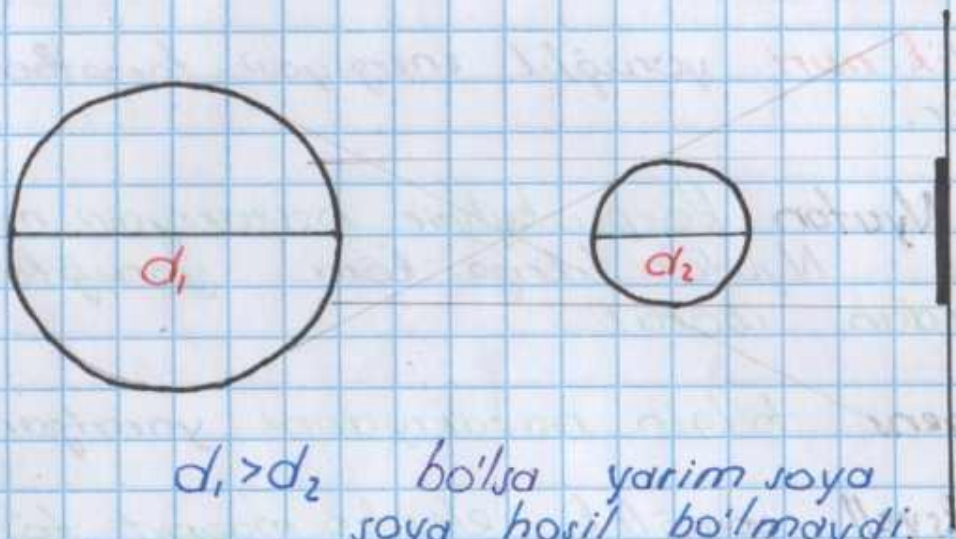
- **Difraksiya**, **Interferensiya**, **Qutblanish**, **dispersiya** hodisalari Gyugens nazariyasi ya'ni to'lqin nazariyasi asosida tushuntiriladi.

Yorug'likning tarqalish qonuni.

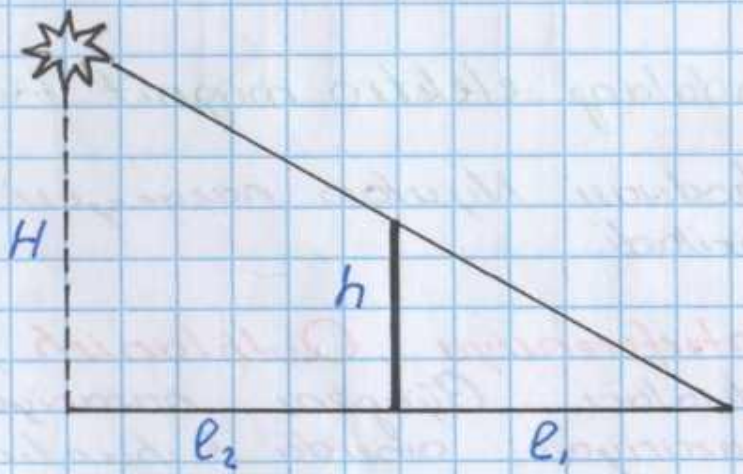
Yorug'lik nuri bir jinsli muhitda to'g'ri chiziq bo'ylab tekis tarqaladi.



$d_1 < d_2$ bo'lsa soya hosil boladi.



$d_1 > d_2$ bo'lsa yarim soya yoki soya hosil bo'lmaydi.



$$\frac{h}{\ell_1} = \frac{H}{\ell_2 + \ell_1}$$

- Yerdan quyoshgacha masofa $S = 150 \cdot 10^9$ m
  Yorug'likning vakumdagi tezligi $c = 3 \cdot 10^8$ m/s

$$c = \frac{S}{t} \qquad t = \frac{S}{t} = \frac{150 \cdot 10^9}{3 \cdot 10^8} = 500 \text{ sek} \approx 8{,}4 \text{ min}$$

Quyosh nuri yerga $t = 8{,}4$ min

• Yorug'lik tezligini birinchi bo'lib Riomer astronomik usulda aniqlagan.
Keyinchalik Fizo tajribada aniqlagan

$$\vartheta = 4N\nu s$$

Yorug'lik tezligini Maykelson va Andersonlar ham tajriba usulida aniqlashgan.

• Quyidagi hollarda yorug'likning to'g'ri chiziq bo'ylab tarqalish qonuni bajarilmaydi:

1. Yorug'lik bir jinsli bo'lmagan muhitdan o'tganda
2. O'lchami yorug'likning to'lqin uzunligi bilan yaqin bo'lgan tirqish yoki teshikdan o'tganda

$$d \approx \lambda$$

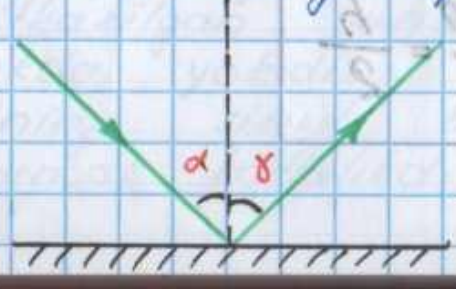
3. Yorug'lik o'lchami to'lqin uzunligiga yaqin bo'lgan to'siqqa uchraganda
4. Sindirish ko'rsatkichi nuqtadan-nuqtaga o'zgaradigan muhitda tarqalganda
5. Yorug'lik kuchli gravitatsion maydonda tarqalganda

$$n = \frac{c}{\vartheta} \qquad n = \sqrt{\varepsilon\mu}$$

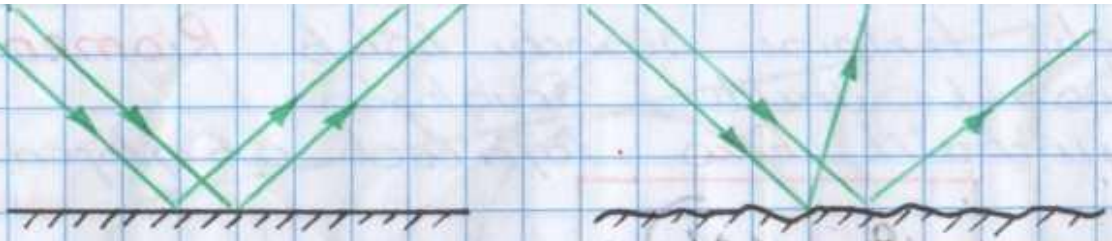
n – sindirish ko'rsatkichi.

Yorug'likning qaytish qonuni

Tushuvchi nur, qaytgan nur va tushish nuqtasiga tiklangan perpendikulyar bitta tekislikda yotadi. Tushish burchagi qaytish burchagiga teng.



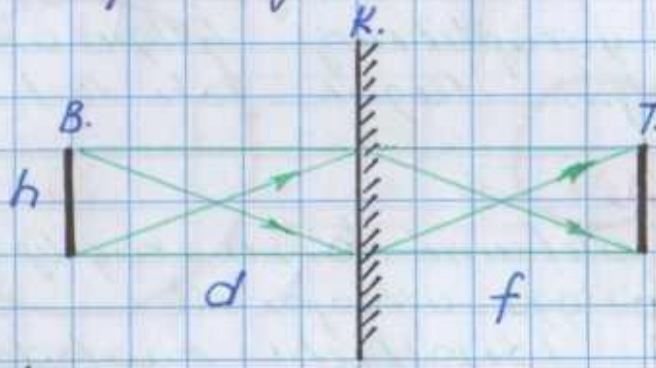
$$\alpha = \gamma$$



Ko'zgu qaytish diffuz qaytish.

• Parallel nurlar dastasi parallel qaytsa **ko'zgu qaytish**, parallel qaytmasa **diffuz qaytish** deyiladi.

• Yassi ko'zgudo tasvir yasash yorug'likning qaytish qonuniga asoslanadi.



$h = H$
$d = f$

h – buyumning balandligi
H – tasvirning balandligi
d – buyumdan ko'zgugacha masofa
f – ko'zgudan tasvirgacha masofa.

• Ko'zgudo tasvir **mavhum** holda hosil bo'ladi. Agar tasvir

Agar tasvir qaytgan nur davomining kesishganidan hosil bo'lsa **mavhum tasvir** deyiladi.

• Buyum to'liq ko'rinishi uchun ko'zgu buyumning yorim o'lchamiga teng bo'lishi kerak

$$\ell = \frac{h}{2}$$

• Agar ko'zgu α burchakka burilsa ko'zgudan qaytgan nur 2α burchakka buriladi.

$$N = \frac{360}{\alpha}$$

$$N = \frac{2\pi}{\alpha}$$

N – tasvirlar umumiy soni. (Ko'zgular orasidagi buyum tasviri)
α – ko'zgular orasidagi burchak.

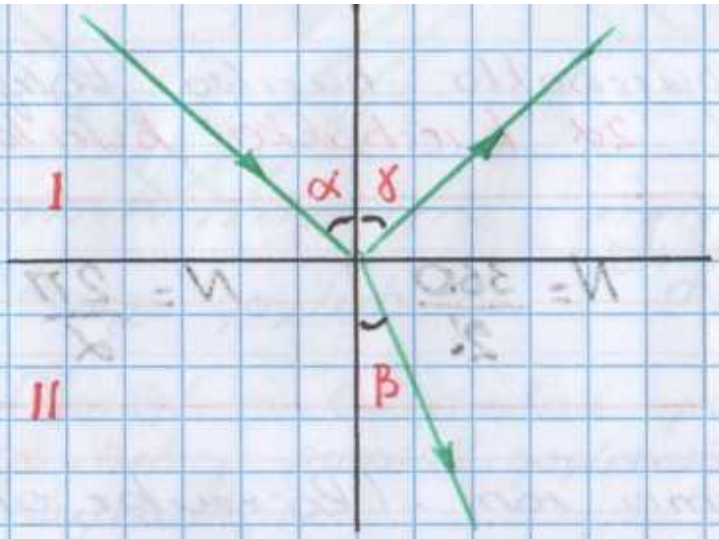
• Maxraj nolga intilsa qiymat cheksizga intiladi.

• 3 ta ko'zgu perpendikulyar tursa parallel nurlar dastasi parallel chiqib ketadi.

• Agar ko'zgu yorug'lik manbai tomon v tezlik bilan harakat qilayotgan bo'lsa, ko'zgudagi tasvir qo'zg'almay turishi uchun yorug'lik manbai ko'zgudan $2v$ tezlik bilan uzoqlashishi kerak.

Yorug'likning sinish qonuni.

Tushuvchi nur, singan nur, tushish nuqtasiga o'tkazilgan perpendikulyar bir tekislikda yotadi. Tushish burchagi sinusining sinish burchagi sinusiga nisbati o'zgarmas kattalikdir.

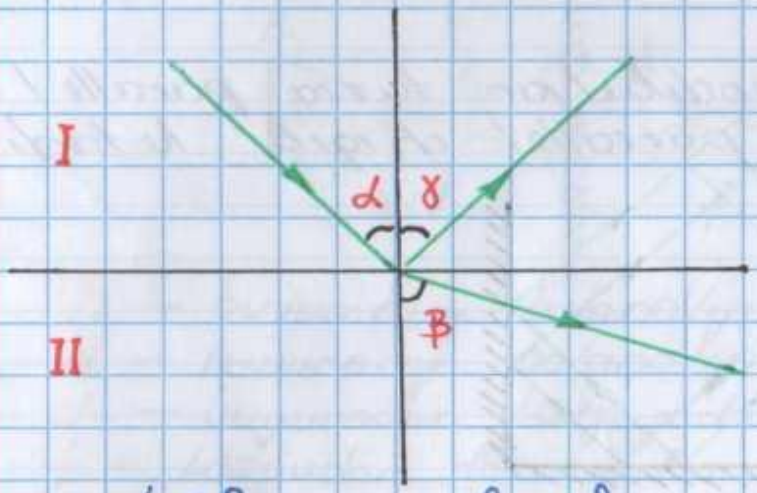


$$\frac{\sin\alpha}{\sin\beta} = \frac{n_2}{n_1}$$

$\alpha \neq n$
$\beta \neq n$

$\vartheta_2 < \vartheta_1$ $\quad \alpha > \beta$ $\quad \nu_1 = \nu_2$

$n_1 < n_2$ $\quad \lambda_1 > \lambda_2$ $\quad \nu = const$



$$\frac{\sin\alpha}{\sin\beta} = \frac{1}{n}$$

$\alpha < \beta$ $\quad \vartheta_1 < \vartheta_2$ $\quad \nu_1 = \nu_2$

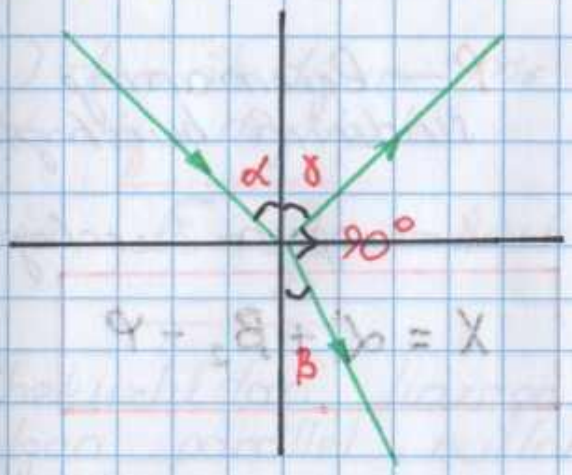
$n_1 > n_2$ $\quad \lambda_1 < \lambda_2$ $\quad \nu = const$

$$\frac{n_2}{n_1} = \frac{\vartheta_1}{\vartheta_2} = \frac{\lambda_1}{\lambda_2}$$

Suv — $n = 1{,}33 = \frac{4}{3}$

Shisha — $n = 1{,}5$

havo — $n = 1$.
vakuum



$$\alpha + 90 + \beta = 180$$

$$\beta = 90 - \alpha$$

$$\frac{\sin\alpha}{\sin\beta} = \frac{n_2}{n_1}$$

$$\frac{\sin\alpha}{\sin(90-\alpha)} = \frac{n_2}{n_1}$$

$$\boxed{tg\alpha = \frac{n_2}{n_1}}$$

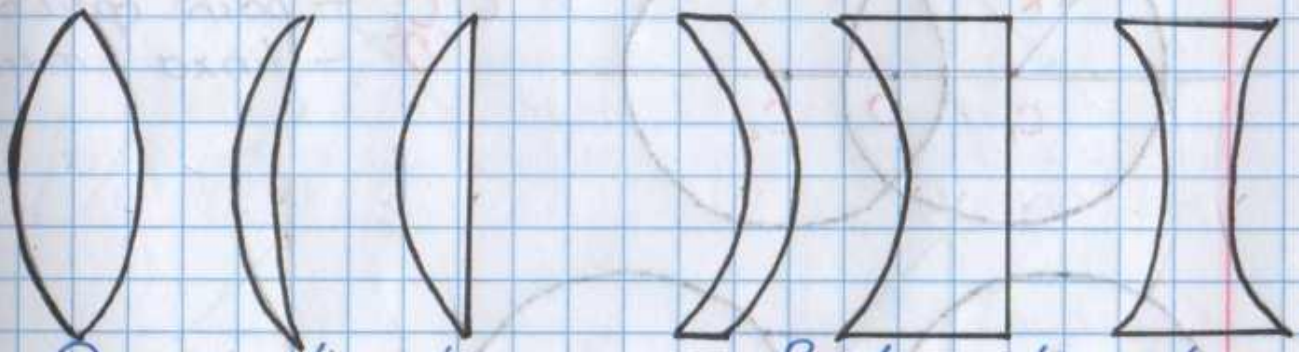
• Yorug'likning sinish qonunidan linzalardan tasvir yasashda foydalaniladi.

Linza deb, 2ta sferik sirt bilan chegaralangan shaffof jismga aytiladi.

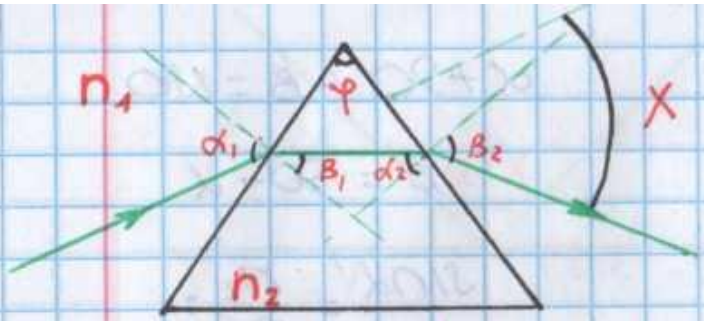
Sirtlardan biri yassi bo'lishi ham mumkin. Linzalar 2 xil bo'ladi:

- Qavariq linza
- Botiq linza

Qavariq linza yig'uvchi, botiq linza sochuvchi linza hisoblanadi.



Qavariq linzalar Botiq linzalar.

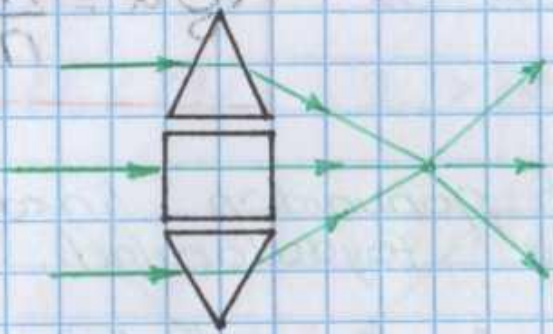


φ — Prizmaning sindirish burchagi

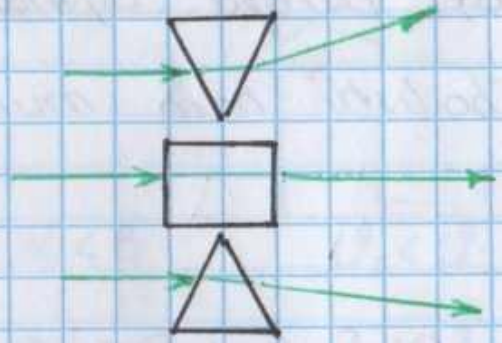
X — og'ish burchagi.

$$X = \alpha_1 + \beta_2 - \varphi$$

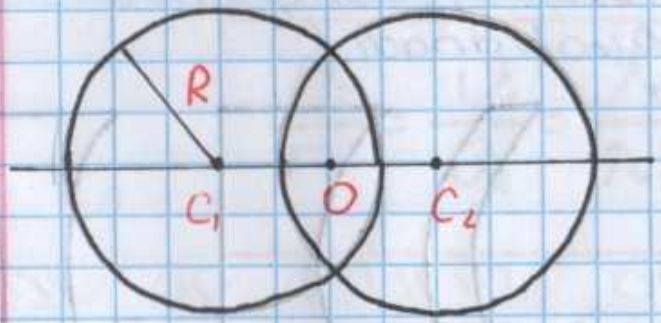
• Uchburchakli prizma nurni asosiga qarab sindiradi.



Yig'uvchi linza

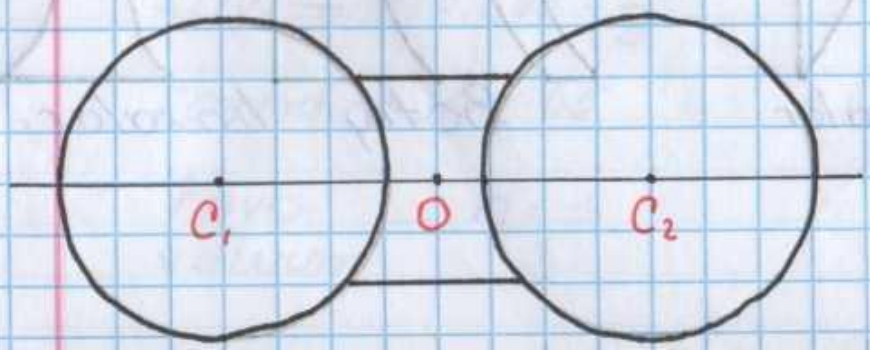


Sochuvchi linza.



C_1, C_2 — bosh optik o'q

D — linza markazi



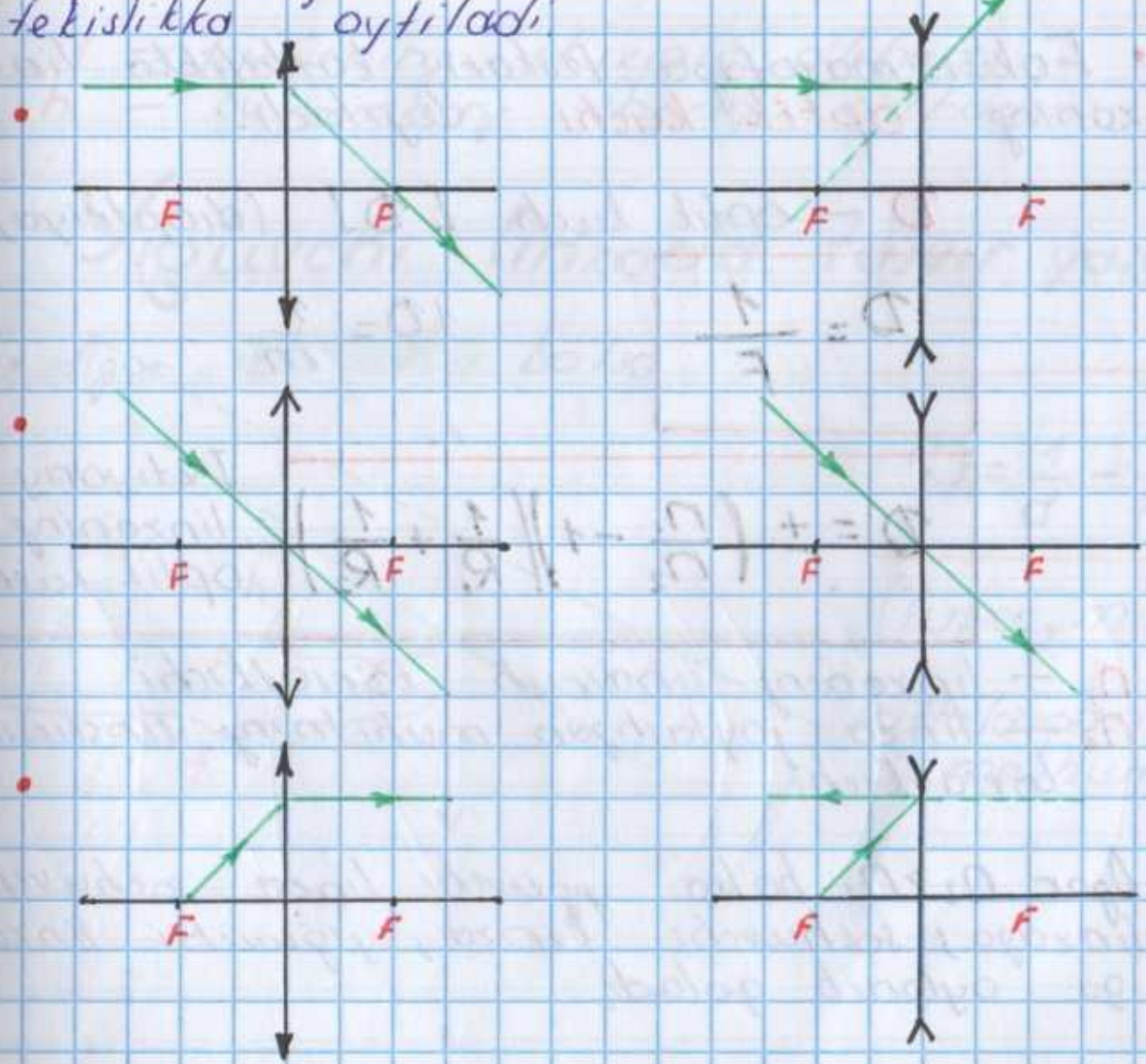
O dan ötadigan har qanday öggo yordamchi öq deyiladi.

$$F = \frac{R}{2}$$ bosh fokus yoki fokus masofa.

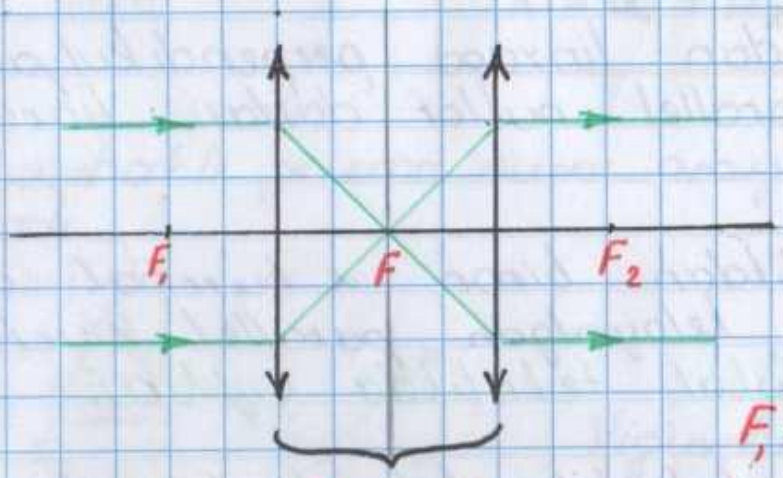
- Cheksizlikdan linzaga perpendikulyar kelayotgan parallel nurlar dastasi linza fokusida yig'iladi.

- Cheksizlikdan biror α burchak ostida linzagan keloyotgan parallel nurlar dastasi fokal tekislikda yig'iladi.

Fokal tekislik deb, bosh optik öggo perpendikulyar va linza fokusidan o'taoljan tekislikka aytiladi.



• Agar parallel nurlar dastasi ikkita yig'uvchi linzadan o'tgach ham parallelligini saqlashi uchun 1-linzaning orqa fokal tekisligi ikkinchi linzaning oldingi fokal tekisligi bilan ustma-ust tushishi kerak.



$F_1 = F_2$

$\ell = F_1 + F_2$ $\quad$ $\ell = 2F$

• Fokus masofaga teskari kattalikka linzaning optik kuchi deyiladi.

D — optik kuch $[D]$ (dioptriya)

$$D = \frac{1}{F}$$

$$1D = \frac{1}{m}$$

$$D = \pm\left(\frac{n_1}{n_2} - 1\right)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

Ixtiyoriy linzaning optik kuchi

n_1 — linzaning sindirish ko'rsatkichi
n_2 — linza joylashgan muhitning sindirish ko'rsatkichi

• Agar $n_2 > n_1$ bo'lsa yig'uvchi linza, sochuvchi linzaga; sochuvchi linza, yig'uvchi linzaga aylanib qoladi

$$\pm D = \frac{1}{d} \pm \frac{1}{f}$$

⊕ – yig'uvchi
⊖ – sochuvchi

⊕ haqiqiy
⊖ mavhum

k, Γ — kattalashtirish.

$$k = \frac{f}{d}$$

$$f = kd$$

$$k = \frac{H}{h}$$

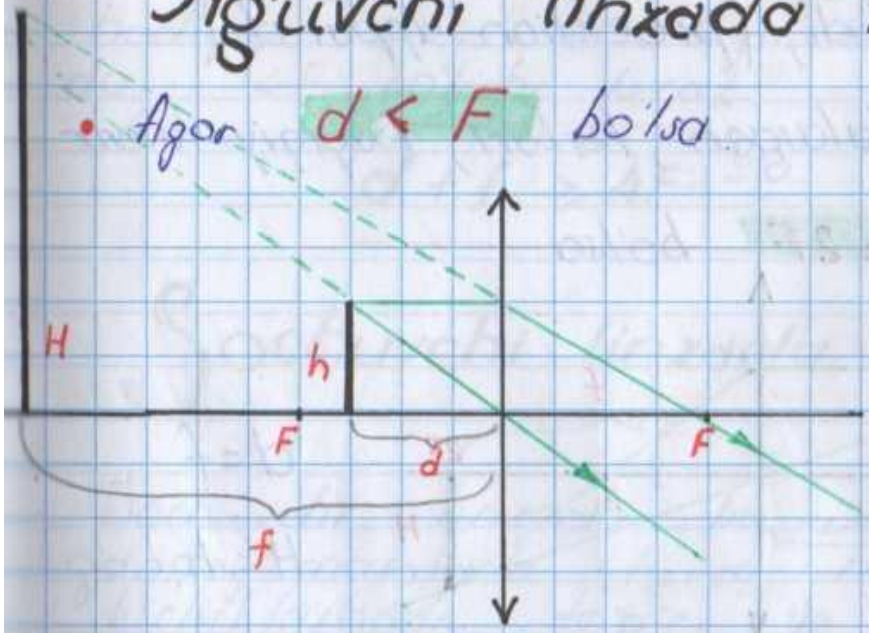
Masshtab = k
$m = 1 : 1000$

$$k = \frac{1}{1000}$$

H — tasvirning chiziqli o'lchami
h — buyumning chiziqli o'lchami.

Yig'uvchi linzada tasvir yasash.

• Agar $d < F$ bo'lsa

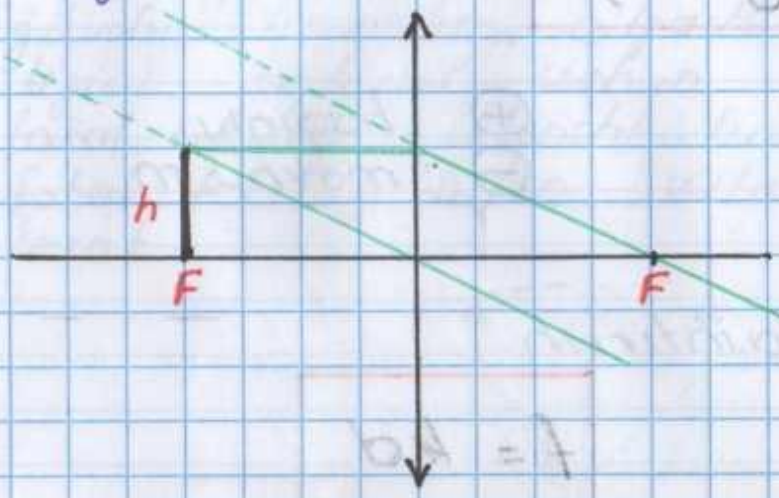


$$D = \frac{1}{d} - \frac{1}{f}$$

(lupa, mikroskop)

kattalashgan, to'g'ri mavhum tasvir

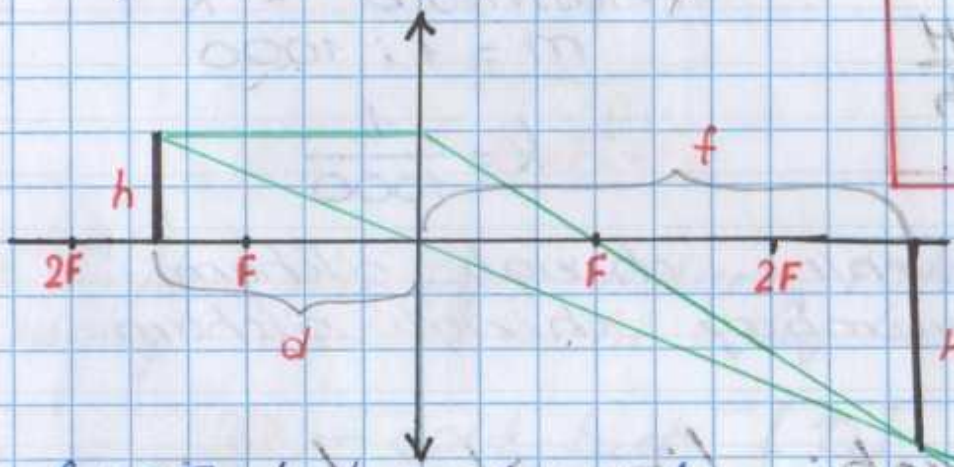
• Agar $d = F$ bo'lsa



tasvir hosil bo'lmaydi.

• Agar $F < d < 2F$ bo'lsa

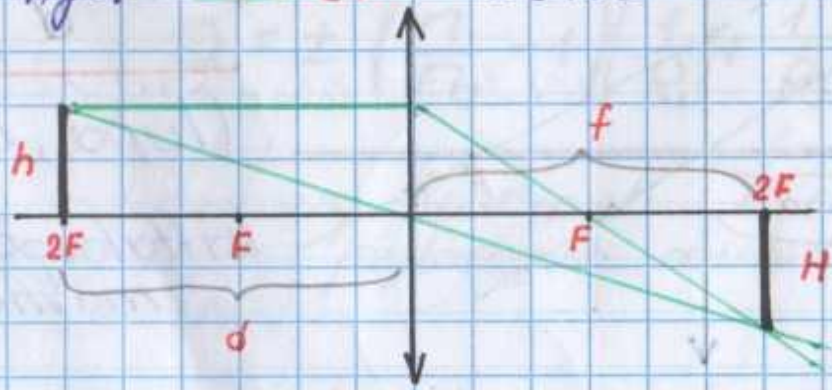
$$\frac{1}{F} = \frac{1}{d} + \frac{1}{f}$$



$f > 2F$ bo'ladi; (proektsion apparat)

Kattalashgan, teskari, haqiqiy tasvir

• Agar $d = 2F$ bo'lsa

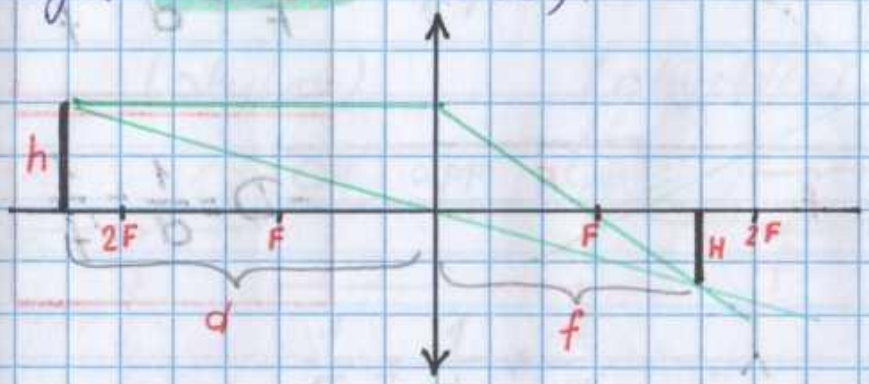


$d = f$

$H = h$.

teng, teskari, haqiqiy tasvir

• Agar $d > 2F$ bo'lsa,



(Fotoapparat)

$F < f < 2F$

$$\frac{1}{F} = \frac{1}{d} + \frac{1}{f}$$

kichiklashgan, haqiqiy, teskari tasvir

• Agar $d \to \infty$ bo'lsa $f \to F$

$\frac{1}{F} = \frac{1}{d} + \frac{1}{f}$. $d=0$. $\frac{1}{F} = \frac{1}{f}$ bo'ladi;

Agar linzaning biror qismi to'silsa tasvir hosil bo'ladi, ammo ravshanlik kamayadi ya'ni kiralashadi.

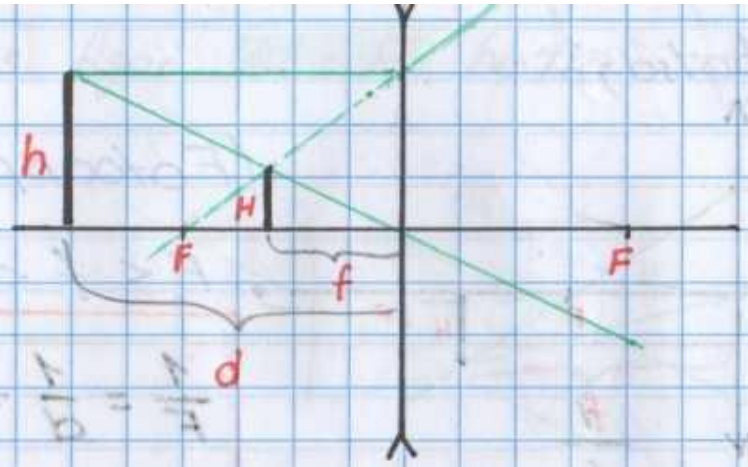
• Yig'uvchi linzada buyum bilan uning haqiqiy tasviri orasidagi masofa kamida $4F$ bo'lishi kerak

$$d + f \geq 4F$$

Sochuvchi linzada tasvir yasash

Sochuvchi linzada buyum linzadan qanday masofada tursa ham tasvir kichiklashgan, to'g'ri va mavhum holda hosil bo'ladi.

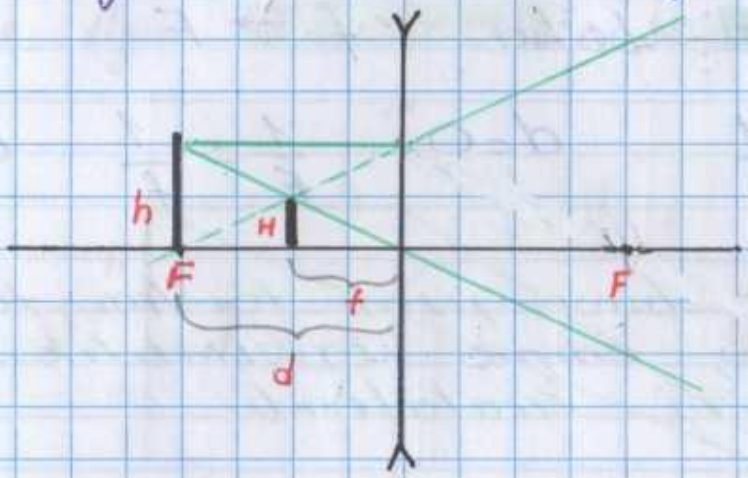
• $d > f$, $h > H$ bo'lsa



$$-\frac{1}{F}=\frac{1}{d}-\frac{1}{f}$$

$$-D=\frac{1}{d}-\frac{1}{f}$$

• Agar $d=F$ bo'lsa $f=\frac{F}{2}$, $K=\frac{1}{2}$ bo'ladi.



Fokus masofasi katta bo'lgan yig'uvchi linzaga **lupa** deyiladi.

$$k_L=\frac{L_0}{F}=L_0D$$

$L_0=25$ sm eng yaxshi (asosmat) ko'rish masofasi.

$$k_{opt}=\frac{L_0}{F}+1$$

Optimal kattalash-tirish.

$$k_{opt}=L_0D+1$$

Fotoapparat

(okulyar) (obyektiv)

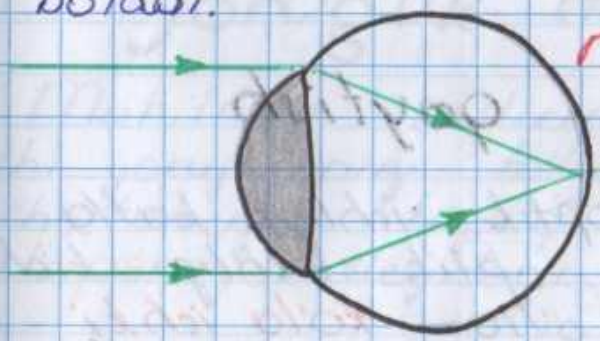
$$\frac{1}{F} = \frac{1}{d} + \frac{1}{f}$$

$f = 0$.

Fotoapparatda $\frac{1}{F} = \frac{1}{dk}$ $k = \frac{H}{h}$ $\frac{1}{F} = \frac{h}{Hd}$

Ko'z

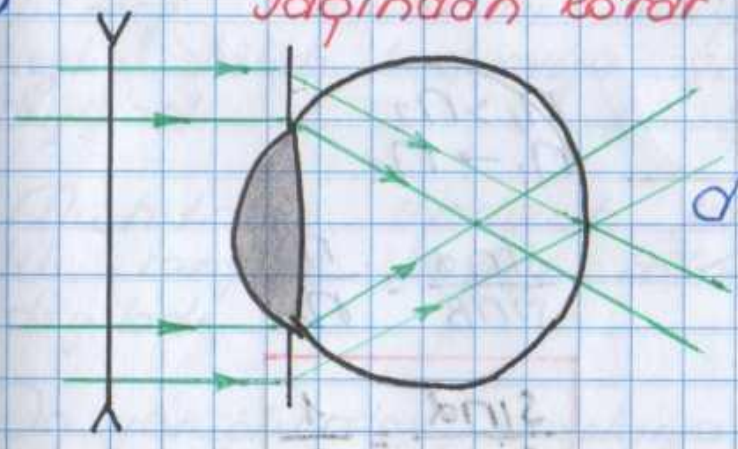
Inson ko'zi ham yig'uvchi linzadir. Ko'zning to'r pardasida tasvir kichiklashgan, teskari, haqiqiy holda hosil bo'ladi.



Normal ko'z. $D = 0$

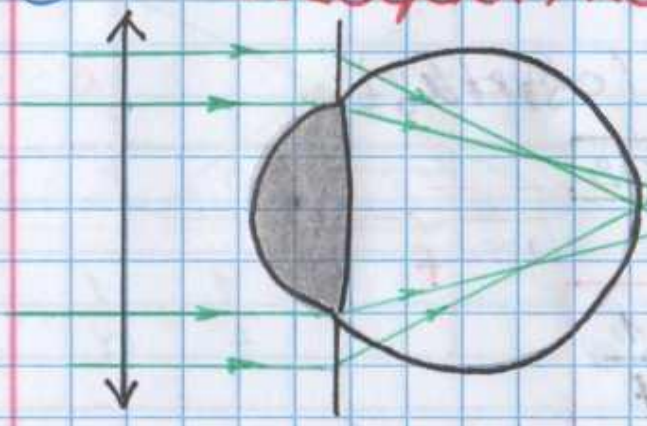
to'r parda $d = L_0$

⊖ Yaqindan ko'rar ko'zlar.



$d < L_0$ $D = \frac{1}{L_0} - \frac{1}{d}$

Uzoqdan ko'rar ko'zlar.



$$D = \frac{1}{L_0} - \frac{1}{d}$$

Ko'zoynak formulasi

Mikroskop

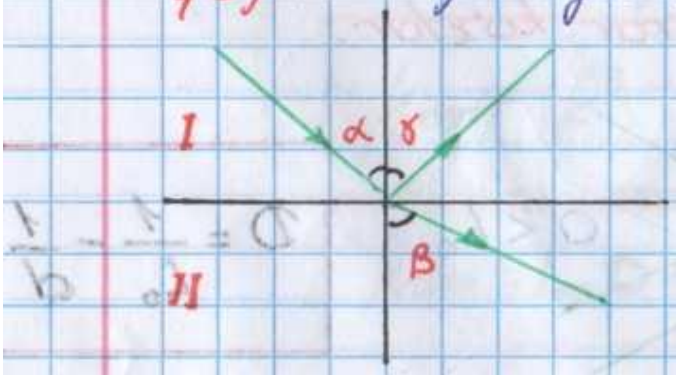
$$k_{mik} = k_{ok} \cdot k_{ob}$$

$$k_o = \frac{L_o}{F_{ok}} \qquad k_{ob} = \frac{\ell_{tubus}}{F_{ok}}$$

Mikrakop formulasi

To'la ichki qaytish

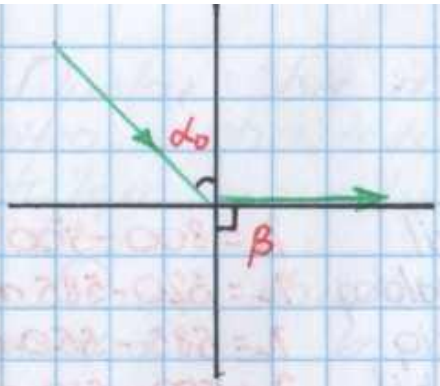
Yorug'lik nuri optik zichligi katta bo'lgan muhitdan optik zichligi kichik bo'lgan muhitga o'tsa **to'la ichki qaytish** yuzaga keladi.



$n_1 > n_2$
$n_1 \to n_2$

$$\frac{\sin\alpha}{\sin\beta} = \frac{n_2}{n_1}$$

$$\frac{\sin\alpha}{\sin\beta} = \frac{1}{n}$$

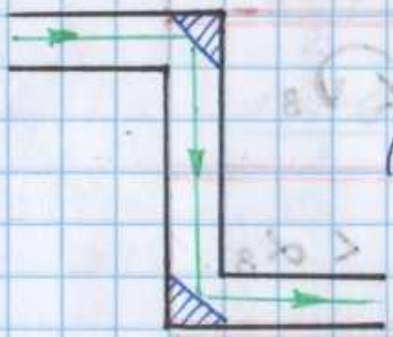


$$\sin\alpha_0 = \frac{1}{n}$$

α_0 – chegaraviy burchak

• Svetovod (nurtola)ning ishlashi to'la ichki qaytishga misol bo'ladi.

Fereskop ning ishlashi to'la ichki qaytish hodisasiga asoslanadi.



(Pereskop)

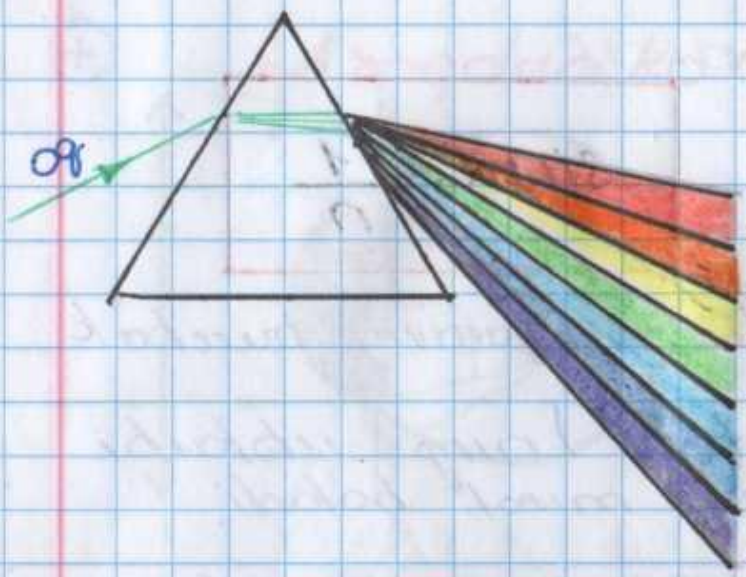
Yorug'lik dispersiyasi.

Muhitning sindirish ko'rsatkichi tushuvchi yorug'likning to'lqin uzunligiga yoki chastotasiga bog'liq bo'lish hodisasiga **dispersiya** deyiladi.

Muhitning sindirish ko'rsatkichi yorug'likning muhitda tarqalish tezligiga bog'liq bo'lish hodisasiga **yorug'lik dispersiyasi** deyiladi.

Muhitning sindirish ko'rsatkichi yorug'lik rangiga bog'liq bo'lishi **dispersiya** deyiladi.

Oq yorug'likning ranglarga ajralishi **dispersiya** deyiladi.



Qizil $\lambda = 800-620$ nm
Zarg'aldoq $\lambda = 620-585$ nm
Sariq $\lambda = 585-550$ nm
Yashil $\lambda = 550-510$ nm
Havorang $\lambda = 510-480$ nm
Ko'k $\lambda = 480-450$ nm
Binafsha $\lambda = 450-320$ nm

$\lambda_q > \ldots > \lambda_B$

$\vartheta_q < \ldots < \vartheta_B$

$\alpha_q < \ldots < \alpha_B$

$v_q > \ldots > v_B$

$n_q < \ldots < n_B$

$F_q > \ldots > F_B$

- Vakumda har qanday rangdagi nur bir xil tarqaladi
- Bitta rangga (chastotaga) ega bo'lgan nurga monokromatik nur deyiladi
- Oq nur monokromatik emas

- Nurlar bir muhitdan ikkinchi muhitga o'tsa chastotasi va rangi o'zgarmaydi, to'lqin uzunligi va tezligi o'zgaradi.

- Qizil shisha bilan qizil buyumga qaralsa u ko'rinmaydi, oq buyumga qaralsa u qizil rangda ko'rinadi, qolgan har qanday rangga qaralsa qora ko'rinadi.

ranglarni qo'shish.

1 - qizil
2 - zarg'aldoq
3 - sariq
4 - yashil
5 - havorang
6 - ko'k
7 - binafsha

$\frac{1+7}{2} = 4$ (yashil)

$\frac{1+4+6}{3} \approx 3,6 = 4$ (yashil).

Interferensiya.

To'lqinlar interferensiyasi deb, to'lqinning fazoviy muayyan nuqtasida natijaviy tebranishlar amplitudolarining vaqt o'tishi bilan o'zgarmaydigan taqsimlanishini yuzaga keltirib, qo'shish hodisasiga aytiladi.

To'lqinlar interferensiyasi deb, ikkita kogerent to'lqinning qo'shilib bir-birini kuchaytirish yoki susaytirish hodisasiga aytiladi.

Kogerent to'lqinlar deb, to'lqin uzunligi va chastotalari bir xil fazalar farqi o'zgarmas bo'lgan to'lqinlarga aytiladi.

• To'lqin uzunligi turlicha bo'lgan nurlar interferensiyalanmaydi.

$\lambda_1 = \lambda_2$ bo'lsa  bo'lsa

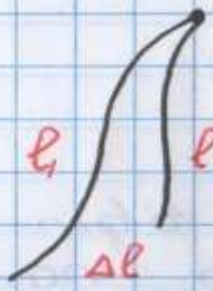
$\nu_1 = \nu_2$

interferensiyalanadi.

• Interferensiyaga quyidagilar misol bo'ladi: Nyuton halqalari, sinadigan panjara, yupqa moy qatlamlarining rangli bo'lanishi.

Interferensiyaning maksimumlar (kuchayish) sharti

Optik yo'llar farqi juft son marta yarim to'lqin uzunligiga teng bo'lsa interferensiya kuchayadi.

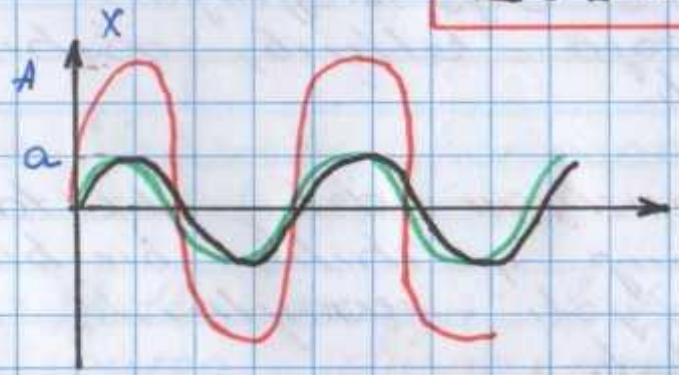


$\Delta l = l_1 - l_2$

Δl — optik yo'llar farqi.

$\Delta l = 2k \cdot \frac{\lambda}{2}$ $\quad k = 0, 1, 2, \ldots$

$$\Delta l = k \cdot \lambda$$



a — qo'shiluvchi to'lqinlar amplitudasi

A — hosil bo'lgan to'lqin amplitudasi

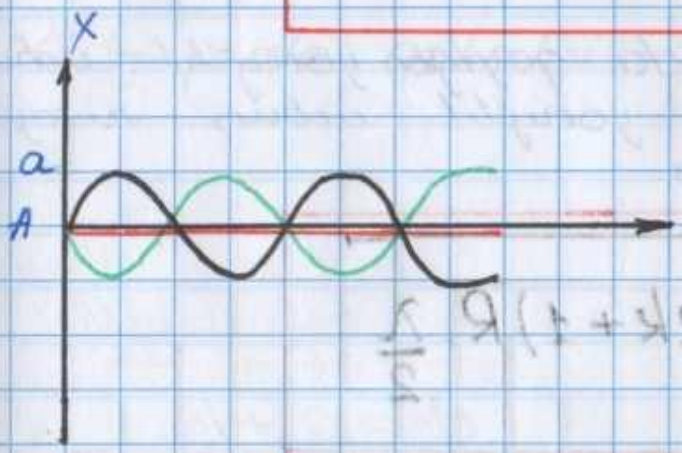
$$A = 2a$$

• Bir xil fazali, juft to'lqinlar bo'lsa maksimum.

Interferensiyaning minumlar (susayish) sharti.

Optik yo'llar farqi toq son marta yarim to'lqin uzunligiga teng bo'lsa interferensiya susayadi.

$$\Delta \ell = (2k+1)\cdot\frac{\lambda}{2}$$



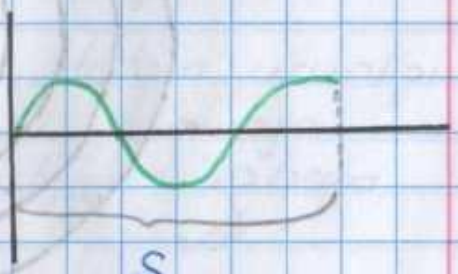
$$A = 0$$

• qorama-qarshi fazali toq to'lqinlar bo'lsa minumum.

• Misollarda k – butun songa teng bo'lsa maksimum, k – kasr son bo'lsa minumum shart boladi.

$$\Delta\varphi = \frac{2\pi\cdot\Delta\ell}{\lambda}$$

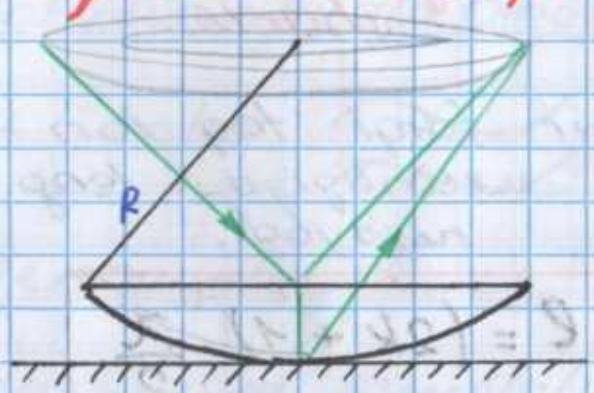
$$\ell = n\cdot s$$



n – to'lqinlar soni
ℓ – optik yo'l
S – geometrik yo'l

$$\lambda = \frac{2\pi\Delta\ell}{\Delta\varphi}$$

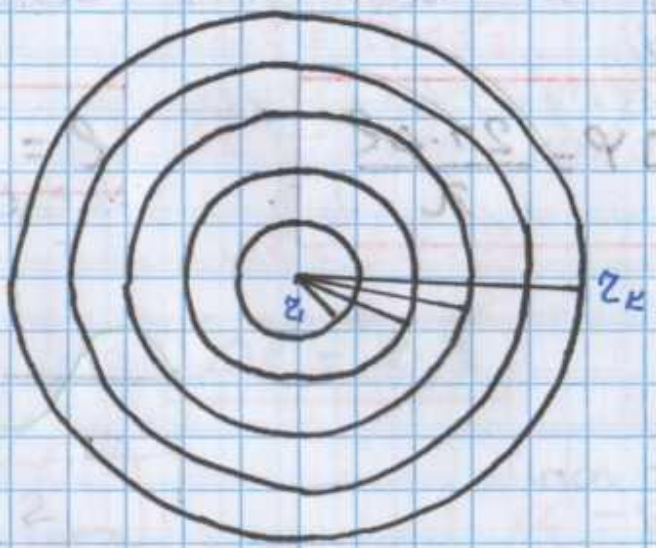
Nyuton xalqalari



• Nyuton xalqalarida qaytgan yorug'lik uchun kuchayish o'tgan yorug'lik uchun susayish sharti quyidagicha

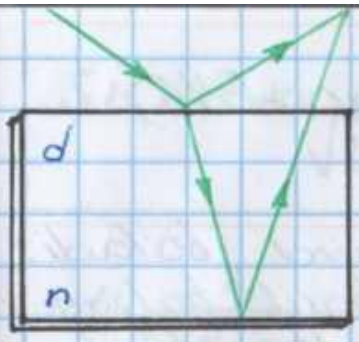
$$r_k = \sqrt{(2k+1)R \cdot \frac{\lambda}{2}}$$

R — linzaning egrilik radiusi



• Nyuton xalqalarida qaytgan yorug'lik uchun susayish, o'tgan yorug'lik kuchayish sharti quyidagicha.

$$r_k = \sqrt{kR\lambda}$$

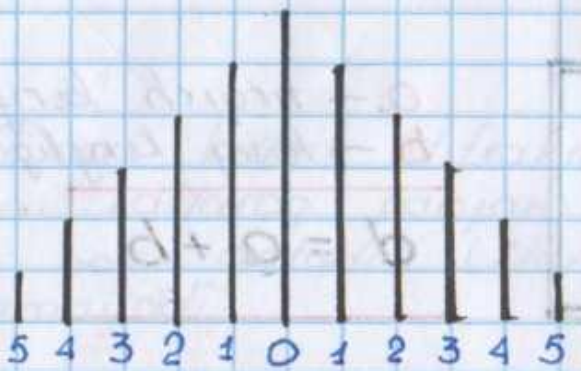


• Yupqa pardada hosil bo'ladigan interferensiyaning maksimumlar sharti quyidagicha

$2nd = k\lambda$ o'tgan

$nd = k\lambda$ qaytgan

d – parda qalinligi. $\lambda = \frac{c}{\nu}$



m – maksimumlar soni

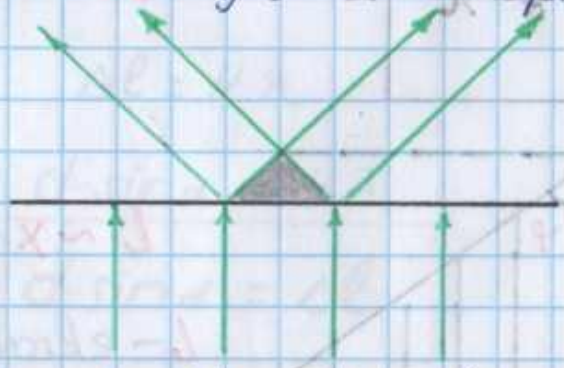
$m = 2k + 1$

$k = 2,99 \approx 2.$

Difraksiya. Difraksion panjara.

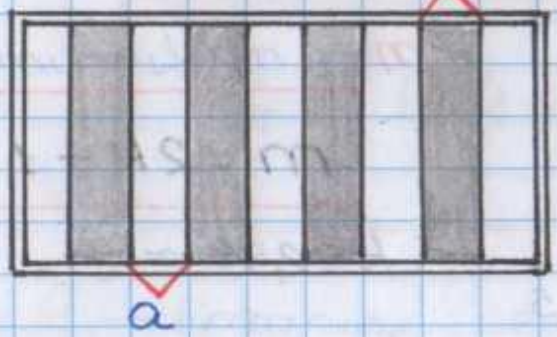
Difraksiya deb, o'lchamlari to'lqin uzunligi tartibida bo'lgan to'siq yoki tirqishga tushgan to'lqinlarning to'siqlar sohasiga egib tarqalish hodisasiga aytiladi.

$d \approx \lambda$ geometrik optikaning chegarasi



d – to'siq yoki tirqishning chiziqli o'lchami

- Barcha to'lqinlar difraksiyalanadi, hamda interferensiyalanadi.
- Difraksiyaga quyidagilar misol bo'ladi: kichik to'siqlar atrofidan hosil bo'lgan soyaning chetlarida yorug' dog' hosil bo'lishi, yorug'lik tarqalishining geometrik soya hosil bo'lishi, to'siqqa o'ziq tarqalishi.
- Difraksiya difraksion panjarada kuzatiladi.



a – tirqich kengligi
b – to'siq kengligi

$$d = a + b$$

d – difraksion panjara davri, difraksion panjara doimiysi [m]

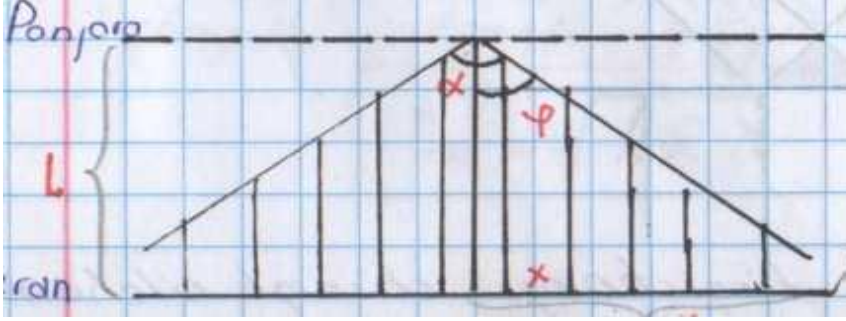
$$d \cdot \sin\varphi = k \cdot \lambda$$

φ – og'ish burchak. $k = 0, 1, 2, 3 \ldots$

$$d = \frac{\ell}{N}$$

ℓ – uzunlik
N – shtrixlar soni.

$$\frac{\ell}{N} \cdot \sin\varphi = k \cdot \lambda$$



$L \sim x$

L – ekrandan panjaragacha masofa

$$\sin\varphi = \frac{x}{\sqrt{L^2+x^2}}$$

$$d\cdot\frac{x}{\sqrt{L^2+x^2}} = k\lambda$$

$$\sin\alpha \approx tg\alpha$$

Kichik burchaklarda

$$tg\alpha = \frac{x}{L}$$

$$d\cdot\frac{x}{L} = k\cdot\lambda$$

$$L = \frac{dx}{k\cdot\lambda}$$

$L \sim x$

• Davri kichik difraksion panjara olinsa, davri kattaroq panjara olinsa maksimumlar soni ortadi. Ular orasidagi masofa kamayadi.

$d_1 > d_2$

$x_2 > x_1$

$N_1 > N_2$

• Davri kichik bo'lgan panjaradda yanada ko'proq spektr olish mumkin.

$$\Delta\ell = k\lambda$$

$$d\cdot\sin\alpha = k\lambda$$

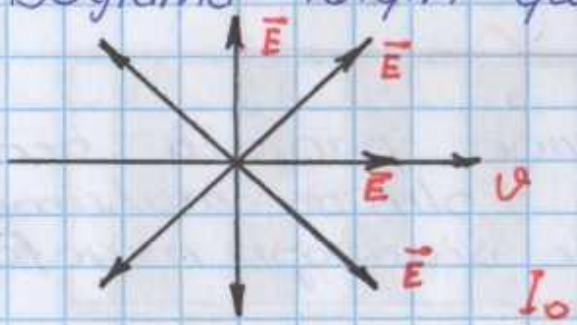
$$d\cdot\sin\alpha = \Delta\ell$$

• Yorug'lik uchburchakli shaffof prizmadan va difraksion panjaradan o'tsa tarkibiy qismlarga (rangga) ajraladi.

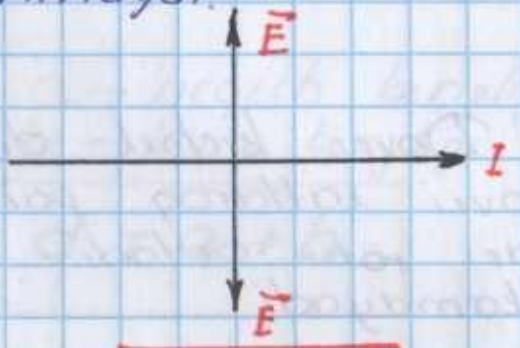
Yorug'likning qutblanishi.

• Yorug'lik ko'ndalang to'lqinligi uchun qutblanadi.

• Bo'ylama to'lqin qutblanmaydi.



oddiy (qutblanmagan)



$$I = \frac{I_0}{2}$$

qutblangan

I – intensivlik $\left[J/m^2 s \right]$

$$I = I_0 \cos^2 \alpha$$

Nisbiylik nazariyasi elementlari

Maxsus nisbiylik nazariyasi fizikaning faza va vaqtning asosiy xususiyatlarini o'rganuvchi bo'limdir. Nisbiylik nazariyasi 1905-yilda Albert Enshteyn tomonidan yaratilgan. Nisbiylik nazariyasi 2 ta postulatga asoslanadi.

1-postulot (nisbiylik prinsipi): tabiatdagi barcha jarayonlar har qanday inersial sanoq sistemasida bir xilda yuz beradi.

2-postulot (yorug'lik tezligining doimiyligi): Yorug'likning vakuumda tarqalish tezligi barcha inersial sanoq sistemalari uchun bir xilda, u yorug'lik manbaining tezligiga ham, yorug'lik signalini qabul qiluvchining tezligiga ham bog'liq emas.

$$c = 3 \cdot 10^8 \text{ m/s} = 300.000 \text{ km/s}.$$

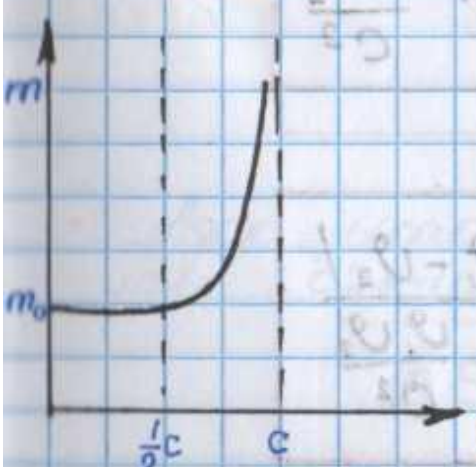
Nisbiylik nazariyasi postulotlaridan kelib chiqadigan natijalar:

1. Massa nisbiyligi

Agar $\vartheta \to c$, $m > m_0$ bo'ladi

m — harakatdagi massa
m_0 — tinch holatdagi massa

$$m = \frac{m_0}{\sqrt{1 - \frac{\vartheta^2}{c^2}}}$$



$\vartheta \to c$
$m \to \infty$

2. Uzinlik nisbiyligi.

agar $v \to c$, $l < l_0$ boladi.

$$l = l_0\sqrt{1 - \frac{v^2}{c^2}}$$

$S = const$ $\rho = \frac{m}{V} = \frac{m}{Sl}$

$$\rho = \frac{\rho_0}{1 - \frac{v^2}{c^2}}$$

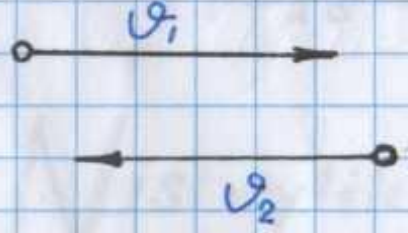
$\rho > \rho_0$

$V \sim l$.

3. Vaqtning nisbiyligi.

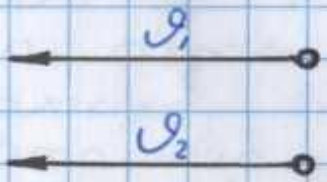
$$t = t_0\sqrt{1 - \frac{v^2}{c^2}}$$

Tezliklarning qoshishning relativistik qonuni quyidagicha



$$v = \frac{v_1 + v_2}{1 + \frac{v_1 v_2}{c^2}}$$

qarama-qarshi yo'nalish.



$$v = \frac{|v_1 - v_2|}{1 - \frac{v_1 v_2}{c^2}}$$

bir xil yo'nalish

Massa va energiya orasidagi bog'lanish.

• Jismning to'liq energiyasi quyidagicha topiladi.

$$E_T = mc^2$$

E_T – energiya [J]

enshteyn formulasi

$$c^2 = 9 \cdot 10^{16}$$

$$E_T = E_K + E_0$$

E_0 – tinch holatdagi energiya $E_0 = m_0 c^2$

E_K – kinetik energiya.

$$E_K = E_T - E_0 = mc^2 - m_0 c^2 = \frac{m_0 c^2}{\sqrt{1 - \frac{\vartheta^2}{c^2}}} - m_0 c^2 =$$

$$= m_0 c^2 \left(\frac{1}{\sqrt{1 - \frac{\vartheta^2}{c^2}}} - 1 \right)$$

$$E_K = E_0 \left(\frac{1}{\sqrt{1 - \frac{\vartheta^2}{c^2}}} - 1 \right)$$

• Agar jismning massasi o'zgarsa energiyasi o'zgaradi

$$\Delta E = \Delta m c^2$$

$$\frac{mv^2}{2} = \Delta mc^2$$

$$mgh = \Delta mc^2$$

$$\frac{k\Delta x^2}{2} = \Delta mc^2$$

$$Cm\Delta T = \Delta mc^2$$

Nurlanish va spektrlar

- To'lqin uzunligi qizil nurlarning to'lqin uzunligidan katta nurlarga **infraqizil nurlar** deyiladi.

Infra qizil nurlarga **issiqlik nurlari** deyiladi.

Har qanday 0 K (harorat) dan yuqori haroratdagi jism o'zidan infraqizil nurlarni yani elektro magnit to'lqinlarni chiqaradi.

Ko'rinadigan har qanday jismlar o'zidan elektro magnit to'lqinni chiqaradi.

- To'lqin uzunligi binafsha nurlarning to'lqin uzunligidan kichik nurlarga **ultra-binafsha nurlar** deyiladi.

Ultra binafsha nurlar ko'z pardasini yemiradi. Meditsinada keng qo'llaniladi.

Oddiy shishadan ultrabinafsha nurlar o'tmaydi. Kvars shishadan o'tadi.

- Elektronlarning keskin to'xtashi natijasida yuzaga keladigan nurlarga **rentgen nurlar** deyiladi.

Rentgen nurlari spektrlarining qisqa to'lqinlari tomonidan keskin tugashi, anod va katod orasidagi kuchlanishga bog'liq.

Atom va molekulalar orasidagi masofa rentgen nurlari uchun difraksion panjara vazifasini o'taydi.

Yorug'lik energiyasi **plank formulasi** orqali topiladi:

$$E = h \cdot \nu$$

h — plank doimiysi $h = 6.62 \cdot 10^{-34}$ J·s
$h = 4.14 \cdot 10^{-15}$ eV·s

$$\nu = \frac{c}{\lambda} \qquad E = \frac{h \cdot c}{\lambda}$$

$$h\nu = eU_T$$

U_T — tormozlovchi, tezlatuvchi kuchlanish [V]

$$\frac{hc}{\lambda} = eU_T$$

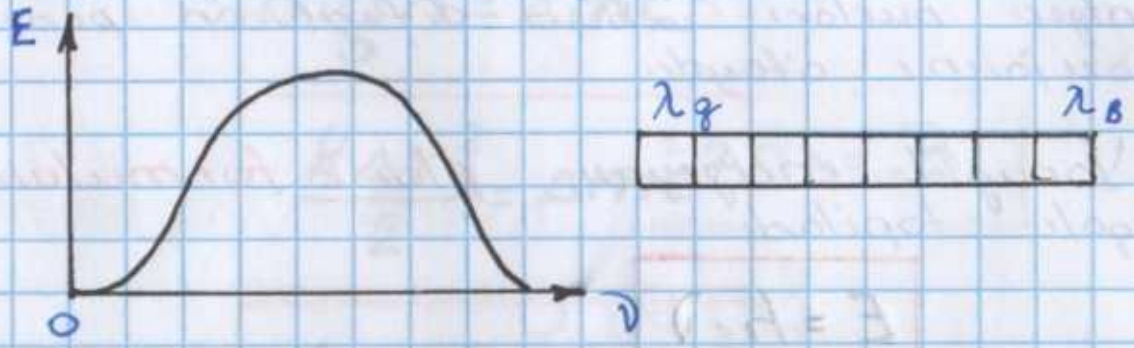
$$eU = \frac{m_e v^2}{2}$$

Yuqori temperaturagacha qizdirilgan qattiq jism va suyuqliklar **nurlanish spektri**ni beradi.

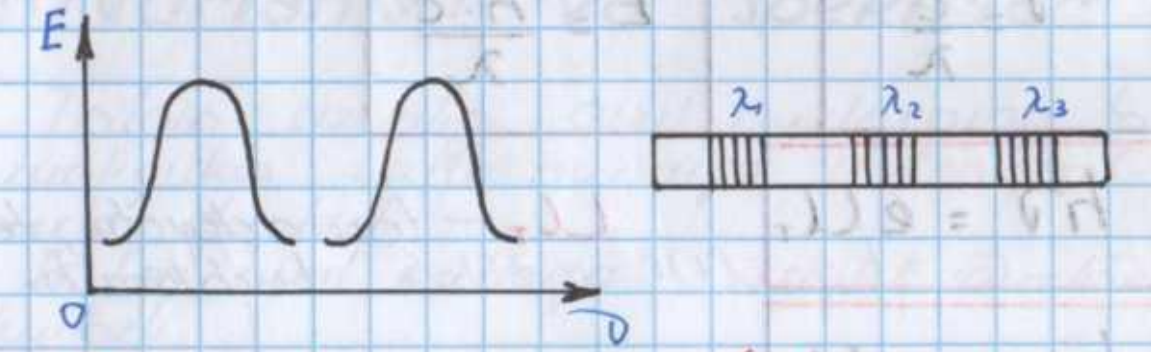
Spektr deb, energiyaning chastotalar bo'yicha taqsimlanishiga aytiladi.

Spektrlar 3 turga bolinadi:

1. Uzluksiz (tutash, yalpi) spektr
quyosh spektri, olangan spektri bunga misol boladi.



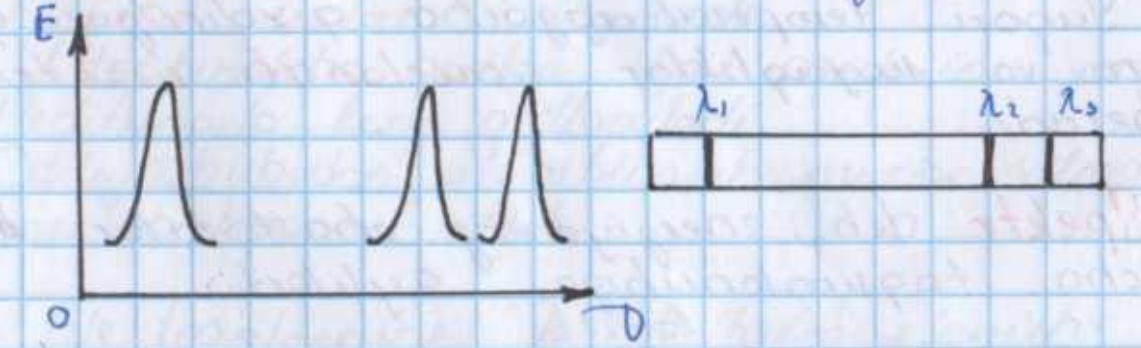
2. Yol-yol spektr (gaz, molekula)
Molekulyar holatdagi gazlar yol-yol spektrga misol boladi



3. Chiziq-chiziq spektr (atom, inert gazlar)

He – geliy
Ne – neon
Xe – ksenon
Ar – argon
Kr – kripton
Rn – radon
} inert gazlar va

O, H, Fe, Cu, Al, ...
lar bunga misol boladi



• Mendeleyev davriy jadvalidagi har bir elementi o'zining spektriga ega va ular bir-biriga o'xshamaydi.

• Qutblanish analizator yordamida kuzatiladi.

Spektr spektroskop yordamida kuzatiladi.

Spektrometr yordamida spektrdagi to'lqin uzunliklari o'lchanadi.

• Moddaning spektriga qarab uning kimyoviy tarkibini aniqlash usuliga spektral-analiz deyiladi.

• Modda sovitilganda yutilish spektrini beradi. Nurlanish va yutilish spektrlari aynan o'xshash chastotalari teng bo'ladi.

Quyidagi nurlanish turlari mavjud:

Issiqlikdan nurlanish — quyosh nurlari, cho'g'lama lampa, alanga

Elektrolyuminestensiya — gazlardan elektr toki o'tishi natijasida yorug'likning chiqishi; qutb yog'dusi, reklama yozuvi misol bo'ladi.

Lyuministensiya — sovuq nurlanish

Katodolyuminestensiya — qattiq jismlar elektronlar yordamida bombardimon qilinishi natijasida yorug'likning chiqishi. Elektron nurli trubka (ekran) buning misol bo'ladi.

Televizorni vatani Toshkent.

Kimilyuminestensiya — kimyoviy reaksiya natijasida yorug'likning chiqishi. Tillo qo'ng'iz, fosfor misol bo'ladi.

Fotolyuminestsensiya. — yorug'lik ta'sirida natijasida moddaning o'zidan boshqa to'lqin uzunlikdagi yorug'lik chiqishi.

• Sergey Ivanovich Vavelov fotolyuminestsensiya sohasida ishlagan. (Vavelov lyuminestsensiya sohasi otasi).

• Yorug'lik ta'sirida boradigan kimyoviy o'zgarishlarga **foto kimyoviy reaksiyalar** deyiladi. Bunga fotosintez, fotografiya misol bo'ladi.

• Yorug'lik ta'sirida jismning qizishi **yorug'likning issiqlik ta'siridir**. Bunda yorug'likning energiyasi ichki energiyaga aylanadi.

Yorug'lik kvantlari. Fotoeffekt.

Yorug'lik ta'sirida moddadan elektronlar ajralib chiqish hodisasiga **fotoeffekt** deyiladi.

• Fotoeffekt yorug'likning kvant nazariyasi asosida tushuntiriladi, yorug'likning zarracha ekanligini isbotlaydi.

• Fotoeffekt natijasida modda musbat zaryadlanadi.

Fotoeffekt yorug'lik ta'sirida ondalyog yuzaga kelad yani inersiyasiz hodisadir.

Fotoeffekt natijasida uchib chiqqan elektronlarga **fotoelektronlar** deyiladi. Elektronlar oqimiga **fototok** ham deyiladi

- Fotoeffek sobasida Stoletov ishlagan.

Fotoeffektning birinchi qonuni

Moddadan uchib chiqayotgan fotoelektronlar soni tushayotgan yorug'lik intensivligiga va yorug'lik oqimiga bog'liq, chastotaga bog'liq emas.

$N \sim I$ $[J/m^2 s]$ intensivlik

$N \sim \varphi$ $[lm]$ (lyumen)

$N \sim I$ $[A]$ tok kuchi

$N \not\sim \nu$ $[Hz]$ chastota

N – uchib chiqayotgan elektronlar soni.

Fotoeffektning ikkinchi qonuni

Fotoelektronlarning kinetik energiyasi tushayotgan yorug'likning chastotasiga bog'liq bo'ladi, intensivlikka bog'liq bo'lmaydi.

$$E_k \sim \nu$$

$$E_k = h\nu$$

$$\frac{mv^2}{2} = h\nu \qquad \nu \sim v^2$$

$$E_K = eU \qquad \frac{m_e v^2}{2} = eU$$

$$eU = h\nu$$

- Fotoeffekt uchun Eynshteyn tenglamasi quyidagicha

$$E = A_{CH} + E_K$$

E – tushayotgan energiya
A_{CH} – chiqish ishi

$$h\nu = A_{CH} + \frac{m_e v^2}{2}$$

$$A_{CH} = h\nu_0 = \frac{hc}{\lambda_0}$$

$$A_{CH} = h\nu_0 \qquad \nu_0 \geq \frac{A_{CH}}{h}$$

$$\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + \frac{m_e v^2}{2}$$

$$h\nu = A_{CH} + E_K$$

Agar chastota n marta ortsa, kinetik energiya n martadan ko'p ortadi.
Agar chastota n marta kamaysa, kinetik energiya n martadan ko'p kamayadi.

$h\nu = A_{CH} + E_K$ $\quad 2 = 1 + 1$
$\nu \sim 2\nu$ bo'lsa $\quad 2 \cdot 2 = 1 + 1 \cdot 3$
$\quad 4 = 1 + 3$

Yorug'lik energiyasini elektr energiyaga aylantiruvchi qurilmaga **fotoelement** deyiladi.

- Yorug'lik bosimi mavjudligini rus fizigi Lebedev tajribada aniqlagan. Havo ochiq kunda $1\ m^2$ yuzaga yorug'lik $4 \cdot 10^{-8}\ N$ kuch bilan bosadi.

Fotonlar.

Yorug'lik zarrasiga **yorug'lik kvanti** yoki **foton** deyiladi.

- Tinch holatda foton massaga ega emas. Foton harakatlanganda massaga ega bo'ladi.

$$m = \frac{E}{c^2} \qquad m = \frac{h\nu}{c^2} \qquad m = \frac{h}{\lambda c}$$

- Fotonning impulsi quyidagicha topiladi.

p – impuls $[\ kg \cdot m/s\ ]$

$$p = mc \qquad p = \frac{E}{c} \qquad p = \frac{h\nu}{c} \qquad p = \frac{h}{\lambda}$$

$$p \sim \frac{1}{\lambda} \qquad p_9 < \dots < p_6$$

$$p = m\vartheta \qquad \vartheta = \frac{c}{n}$$ biror muhitdagi impuls.

$$p = \frac{h\nu}{c} \qquad E = h\nu \qquad p = \frac{E}{c} \qquad E = p \cdot c$$

$A = Nh\nu$

$A = Pt$

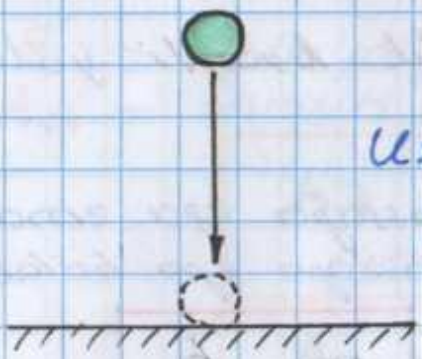
N – fotonlar soni
P – quvvat.

$mc^2 = Nh\nu$

$Pt = Nh\nu$

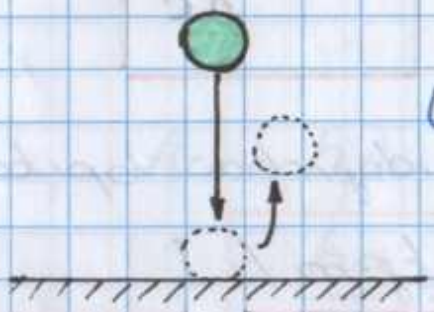
$Pt = \frac{Nhc}{\lambda}$

$\lambda = \frac{\lambda\nu}{n}$



Uzilib to'xtadi, yutildi, qorasirt

$\Delta p = \frac{h}{\lambda}$



Urilib qaytdi oq sirt

$\Delta p = 2 \cdot \frac{h}{\lambda}$

- Fotoplyonkaning qorayish darajasi yorug'lik kvantlari energiyasiga bog'liq bo'lmaydi.

$I = \frac{W}{St}$ Intensivlik

$P = \frac{F}{S}$ $A = W = F \cdot e$ $\frac{W}{e} = F$ $P = \frac{W}{Se}$ $W = PSe$

$$I = \frac{\rho S \ell}{S t} = \frac{\rho \ell}{t}$$

$$\boxed{I = \rho \cdot c}$$

$$I \sim \frac{1}{S} = \frac{1}{4\pi R^2} \qquad I \sim \frac{1}{R^2} \qquad R - \text{masofa}$$

$$\boxed{\underline{\omega} = \frac{W}{V}}$$ energiya zichligi.

$$W = \underline{\omega} V$$

$$I = \frac{\underline{\omega} V}{St} = \frac{\underline{\omega} S \cdot \ell}{S t} = \underline{\omega} \cdot \frac{\ell}{t}$$

$$\boxed{I = \underline{\omega} c}$$

• Har qanday zarrachaning anti zarrachasi mavjud.

Elektronning anti zarrasi pozitrondir

e_{-1}^{0} anti e_{1}^{0} pozitron.

Protonning anti zarrasi antiprotondir.

p_{1}^{1} anti $\overline{p}_{1}^{1}$ antiproton.

Neytronning anti zarrasi antineytrondir

n_{0}^{1} anti $\tilde{n}_{0}^{1}$ antineytron.

ν_{0}^{0} – $\tilde{\nu}_{0}^{0}$ anti neytrino.

He_2^4 anti $\widetilde{He}_2^4$ antigeliy.

- Agar zarracha o'zining anti zarrasi bilan to'qnashsa zarralar yo'qolib qoladi, faqat energiya qoladi. yo'ni

annigilyatsiya

$e_{-1}^0 + e_1^0 = 2\gamma$ $\quad 2mc^2 = h\nu$

$mc^2 + mc^2 = h\nu$ $\quad 2mc = \frac{h}{\lambda}$

Agar $E_k = 0$ bo'lsa $\quad mc = \frac{h}{\lambda}$

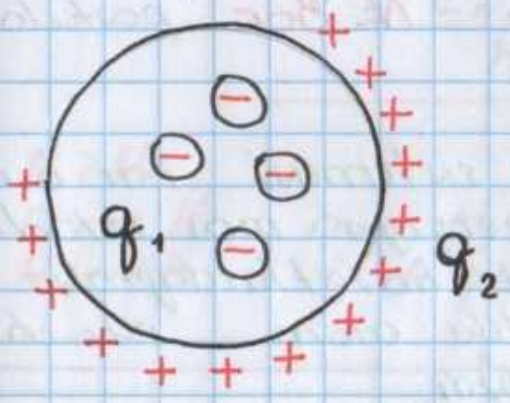
To'lqin soni $- k \left[\frac{1}{m}\right]$

$1\ eV = 1{,}6 \cdot 10^{-19} \cdot J$

ATOM VA YADRO FIZIK
S

Atom fizikasi.

Atom tuzilishini birinchi modelini Tomson yaratgan. Tomson modeliga ko'ra, atom musbat zaryadlangan shar bo'lib, uning ichida manfiy zaryadlangan elektronlar suzib yuradi. Lekin bu model noto'g'ri.

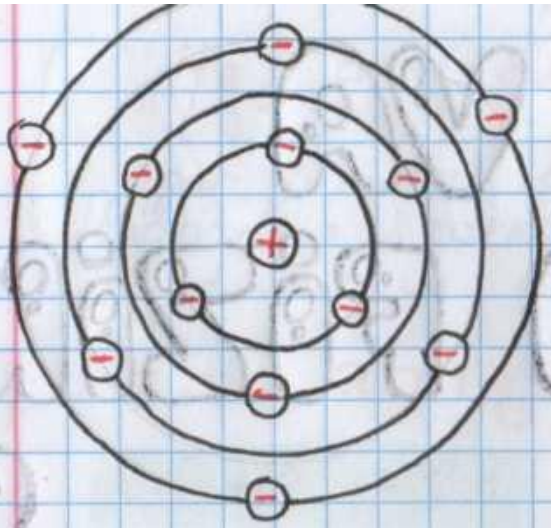


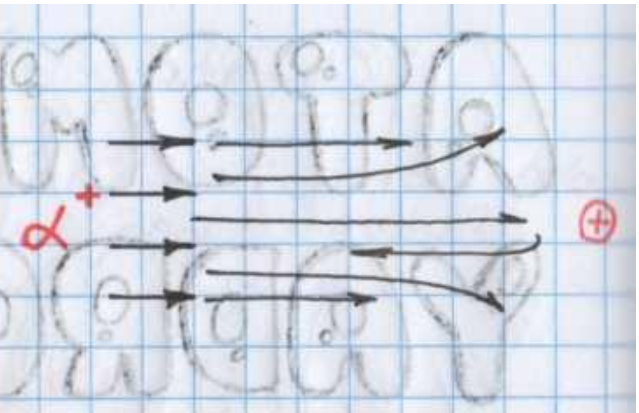
$$|q_1| = |q_2|$$

Rezerford atomning planetar modelini yaratdi. Rezerford fikriga ko'ra atom o'rtasida musbat zaryadlangan yadro, uning atrofida manfiy zaryadlangan elektronlar aylanma harakat qiladi. Atomning butun massasi yadroda yig'ilgan bo'ladi.

Xuddi quyosh atrofida planetalarning harakati singari, shunga uchun bu modelga planetar model deyiladi.

Rezerford tajribada α zarrachalarning sochilishini kuzatdi.





• α zərrələr atomun (yadrosunun) elektrostatik maydanı təsirilə sovrulur; atomun ölçüləri

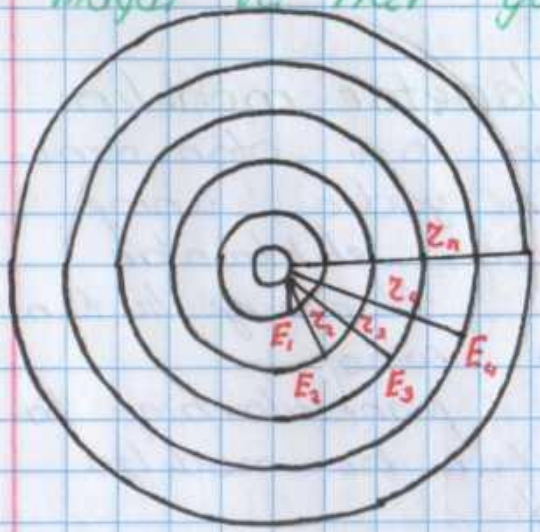
$$d_{at} = (1 \sim 5) \cdot 10^{-10}\ m$$

$$d_{yad} = 10^{-14}\ m$$

$$\frac{r_{at}}{r_{yad}} = 10^4$$

Atom quruluşu üçün N. Bor postulatları:

1-ci postulat: Atom sistemi hər biri müəyyən E_n enerjiyə malik olduğu stasionar yəni kvant halatlarından birində ola bilər. Bu halatda atom nur şüalandırmır və nur yutmaz.



$$r_1 < r_2 < r_3 < \dots < r_n$$

$$\vartheta_1 > \vartheta_2 > \vartheta_3 > \dots > \vartheta_n$$

$$E_{K1} > E_{K2} > E_{K3} > \dots > E_{KN}$$

$$E_{P1} < E_{P2} < E_{P3} < \dots < E_{PN}$$

$$E_1 < E_2 < E_3 < \dots < E_n$$

Enerjiya:

$$\frac{m_e v_n^2}{r} = -\frac{k e^2}{r^2}$$

$$r_n = -\frac{k e^2}{m_e v_n^2}$$

$$F_1 = F_2$$

$$ma = k\frac{e^2}{r^2}$$

$$a = \frac{v^2}{r}$$

2 - postulot : Atom (elektron) bir statsionar holatdan ikkinchi statsionar holatga sakrab o'tganida elektromagnit energiyali kvant chiqaradi yoki yutadi.

Chiqarilgan yoki yutilgan kvant chastotasi quyidagicha topiladi.

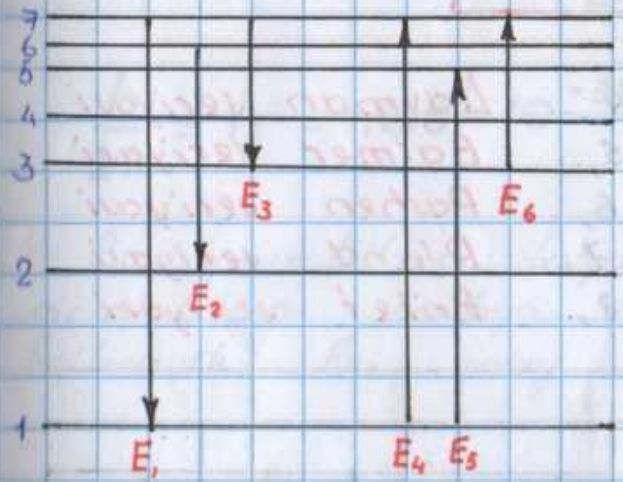
$$h\nu = E_n - E_k$$

$$\nu = \frac{E_n - E_k}{h}$$

$n > k$

$n \to k$ nur chiqaradi $n = 1, 2, 3, \ldots$

$k \to n$ yutiladi $k = 1, 2, 3, \ldots$



E_1, E_2, E_3 – nur chiqaradi

$E_1 > E_2 > E_3$

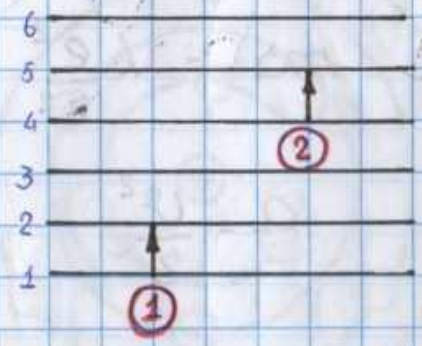
$\nu_1 > \nu_2 > \nu_3$

$\lambda_1 < \lambda_2 < \lambda_3$

E_4, E_5, E_6 – yutiladi

$E_4 > E_5 > E_6$

$\nu_4 > \nu_5 > \nu_6$ $\lambda_4 < \lambda_5 < \lambda_6$



$E_1 > E_2$

- Vodorod atomida atom (elektron) yuqori energetik holatdan pastki energetik holatga o'tganda aniq chastotali nur chiqaradi. Chiqarilgan nur chastotasi quyidagi formuladan topiladi.

$$\nu_{NK} = R \cdot c \left(\frac{1}{K^2} - \frac{1}{N^2} \right)$$

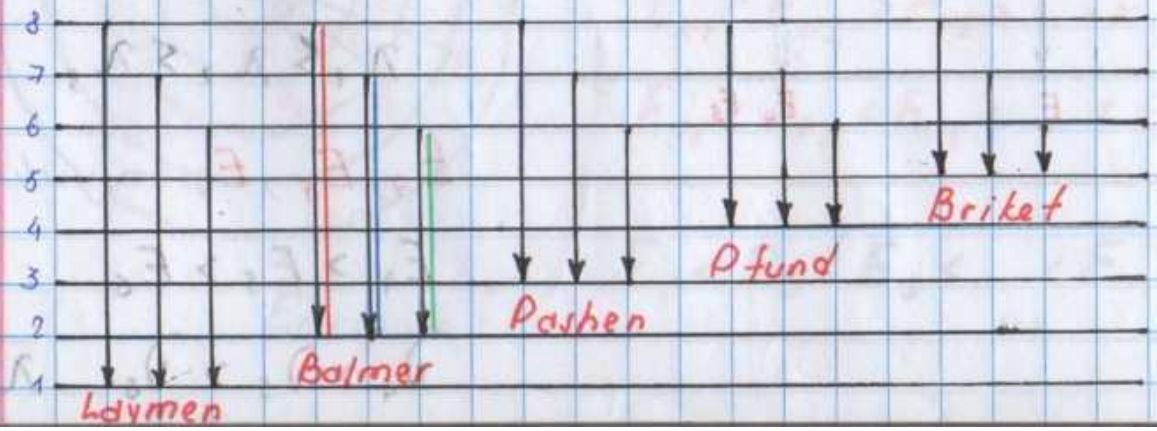
R – Ridberg doimiysi

$$R = 1{,}1 \cdot 10^7 \ \frac{1}{m}$$

$$R_c = 3{,}3 \cdot 10^{15} \ \frac{1}{s}$$

(Kerinadi)

$K = 1$ bo'lsa $n = 2, 3, 4, ..$	Layman seriyasi
$K = 2$ bo'lsa $n = 3, 4, 5, ..$	Balmer seriyasi
$K = 3$ bo'lsa $n = 4, 5, 6, ..$	Pashen seriyasi
$K = 4$ bo'lsa $n = 5, 6, 7, ..$	Pfund seriyasi
$K = 6$ bo'lsa $n = 6, 7, 8, ..$	Briket seriyasi



• Vodorod atomida birinchi orbitaning energiyasi eng kam bo'lib, $E = -13,6$ eV
Hohlagan n-orbitaning energiyasini topish uchun

$$E_n = \frac{E_1}{n^2}$$

3-postulot: Atom elektroni statsionar orbitada harakatlanganda orbital impuls momenti $\frac{h}{2\pi}$ ga karrali dir.

$$L = n \cdot \frac{h}{2\pi}$$

L – orbital impuls momenti. $[kg \cdot m^2/s]$

$$L = pr$$

$$p = mv$$

$$m_e v_n r_n = n \cdot \frac{h}{2\pi}$$

$$\frac{h}{2\pi} = \hbar = 1,05 \cdot 10^{-34}$$

• Bor postulotlari faqat vodorod atomi uchun o'rinli uni boshqa elementlarga qo'llab bo'lmaydi. Bu uning kamchiligidir.

Yadro fizikasi. Radioktiv o'zgarishlar.

Yadrodagi elementar zarralar simvolik ravishda quyidagicha belgilanadi.

$$X_Z^A$$

X — belgisi
A — massa soni
Z — zaryadi yoki tartib raqami (protonlar soni)

e_{-1}^{0} — elektron

p_1^1 — proton

n_0^1 — neytron

ν_0^0 — neytrino

e_1^0 — pozitron

He_2^4, α_2^4 — alfa

γ_0^0 — gamma kvant, foton

Elementar zarralar soni jada ko'p ular 4 ta sinfga bo'linadi.

1-sinf — Fotonlar
Bu sinfga faqat fotonlar kiradi.

2-sinf — Leptonlar
Bu sinfga yengil zarrachalar kiradi

3-sinf — Mezonlar
Bu sinfga π-onlar, k-onlar kiradi

4-sinf — Barionlar

Bu sinfga nuklonlar, giperonlar kiradi.

- Yengil zarrachalarga elektron, pozitron, neytrino kiradi.
- Nuklonlarga proton va neytronlar kiradi.
- Barcha elementar zarralar bir-biriga aylanib turadi. va bu aylanishlar ular mavjudligini isbotidir.

Masalan neytron protonga aylanadi

$$n_0^1 \longrightarrow p_1^1 + e_{-1}^0 + \nu_0^0$$

- Barcha elementar zarralarni antizarrasi mavjud. Elektronning anti zarrasi pozitrondir.

Barcha elementar zarralarni kuzatish va qayd qilish uchun quyidagi qurilmalardan foydalaniladi.

Geyger - Myuller sanagichi — gaz atomlarining ionlashish hodisasiga asosan ishlaydi. hisoblagichdan zaryadli zarra o'tganda qisqa muddatli tok paydo bo'ladi. Asosan zaryadli zarralarni sanaydi.

Velson kamerasi — gazlarda o'ta to'yingan bug'ning suv tomchilari bo'lishiga asosan ishlaydi. Kameradan zarracha o'tganda uning treki (izi) tomchi shaklida hosil bo'ladi. Trekka qarab zarracha o'rganiladi.

Pufakli kamera — zarrachа trekini paygosh uchun o'ta isitilgan suyuqlikdan foydalaniladi. Zarrachani treki pufakcha tarzida ko'rinadi.

Qalin qatlamli foto emulsiolar metodi — zarrachaning treki fotografiyadan (zo'mdan) o'rganiladi.

• Ayrim atom yadrolarining tashqi ta'sirsiz o'z-o'zidan zarrachalar chiqarib boshqa yadroga aylanish hodisasiga **radioaktivlik** deyiladi.

Bu hodisani fransuz fizigi Bekkerel kashf qilgan.

• Mendeleyev davriy jadvolidagi 83-elementdan boshlab hammasi radioaktivdir.

Bulardan tashqari bazi yengil elementlarning izotoplari ham induktivdir.

U_{92}^{238} uzan

$A = 238$ m.a.b [u]

$Z = 92$

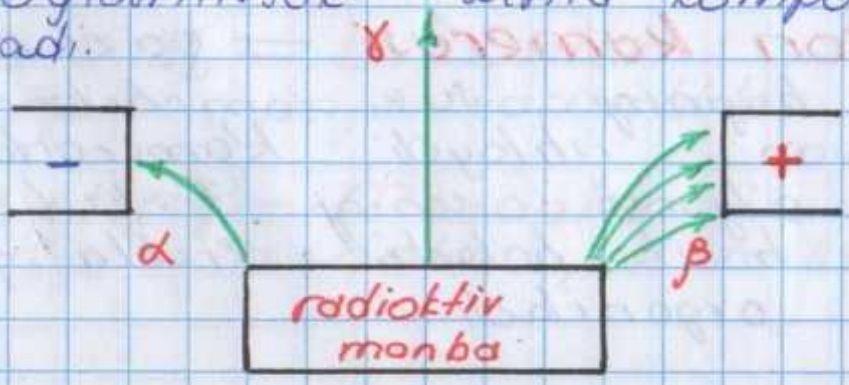
$N = A - Z = 146$

$$A = Z + N$$

Z — protonlar soni

N — neytronlar soni

• Radioaktiv nurlar ko'zga ko'rinmaydi. Agar ularni elektr yoki magnit maydoniga joylashtirsak uchta komponentga ajraladi.



α^+ — zarralarning zaryadi musbat bo'lib, o'tuvchanligi eng past zarralar oddiy qog'oz varog'idan o'tolmaydi. α bu elektronlari yo'qotilgan geliy yadrosidir

$$\alpha \rightarrow He_2^4, \quad A = 4, \quad Z = 2$$

β^- — zarralarning ishorasi manfiy bo'lib, o'tuvchanligi o'rtacha, ularni tutib qolish uchun 1sm qalinlikdagi alyuminiy zarur.

• β bu turli tezlikdagi elektronlar oqimidir.

$$\beta \rightarrow e_{-1}^0, \quad A = 0, \quad Z = -1$$

γ^0 nurlar zaryadsiz bo'lib, o'tkazuvchanligi juda yuqori, bu nurlarni tutib qolish uchun bir necha sm qalinlikdagi qo'rg'oshin zarur.

• γ^0 gamma nurlar $\lambda = 10^{-10} \div 10^{-17}$ m to'lqin uzunlikdagi qisqa elektromagnit to'lqin

• Radioktiv nurlanish natijasida bir elementning boshqa elementga aylanishi Soddiy ning siljish qonuniga (qoidasiga) bo'ysunadi.

α yemirilish (parchalanish) natijasida yadro 2 ta musbat zaryad yo'qotib massa soni 4 taga kamayadi, natijada element davriy jadvalning boshiga qarab 2 ta katakka siljiydi.

$$X_Z^A \xrightarrow{\alpha} Y_{Z-2}^{A-4} + He_2^4$$

• Agar x element n ta α yemirilishga uchrasa

$$X_Z^A \xrightarrow{n\alpha} Y_{Z-2n}^{A-4n} + n \cdot He_2^4$$

β^- yemirilish natijasida yadro 1 ta musbat zaryad qabul qilib, massa soni o'zgarmaydi. Natijada element davriy jadvalining oxiriga qarab 1 ta katakka siljiydi.

$$X_Z^A \xrightarrow{\beta^-} Y_{Z+1}^A + e_{-1}^0$$

• Agar x element n ta β^- yemirilishga uchrasa

$$X_Z^A \xrightarrow{n\beta^-} Y_{Z+n}^A + n \cdot e_{-1}^0$$

β^+ yoki pozitron yemirilish.

$$X_Z^A \xrightarrow{\beta^+} Y_{Z-1}^A + e_1^0$$

• Agar x element n ta β^+ yoki pozitron yemirilishga uchrasa

$$X_Z^A \xrightarrow{n\beta^+} X_{Z-n}^A + n \cdot e_1^0$$

γ yemilish natijasida yadroda deyarli o'zgarish bo'lmaydi, faqat gamma kvant massasicha kamayadi.

$$X_Z^A \xrightarrow{\gamma} X_Z^A + \gamma_0^0$$

Radioktiv yemirilish qonuni.

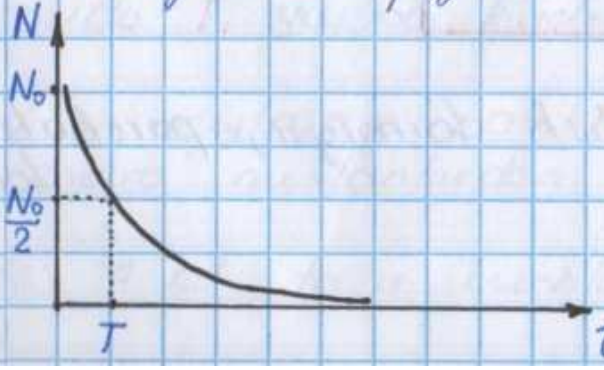
Yadroning tashqi ta'sirsiz o'z-o'zidan yemirilishiga **spontan yemirilish** deyiladi.

- Istalgan radioktiv element radioktiv yemirilish qonuniga bo'ysunadi. Bu qonun quyidagicha

$$N = N_0 \cdot 2^{-\frac{t}{T}} \cdot 100\%$$

N_0 – dastlabki atom yadro soni.
N – t vaqtdan keyin yemirilmay qolgan atom soni.
t – vaqt
T – yarim yemirilish davri.

Yarim yemirilish davri deb, yadrodagi atomlar sonining yarmi yemirilishi uchun ketadigan vaqtga aytiladi.



- Ularning yemirilish davri 4,5 mlrd yil.
- Yarim yemirilish davri massaga ham vaqtga ham bog'liq emas u kimyoviy o'zgarishga bog'liq.

$$T \not\sim m$$
$$t \not\sim T$$

$\frac{N}{N_0}$ — aktivlik

$$\Delta N = N_0 - N$$

$$\Delta N = N_0 - \frac{N_0}{2^{t/T}}$$

$$\frac{\Delta N}{N_0} = 1 - \frac{1}{2^{t/T}}$$ yemirilgan

- t vaqtda yemirilgan o'rtacha atomlar soni quyidagicha topiladi.

$$N_{o'rt} = \frac{0,693}{T} \cdot N_0 \cdot \Delta t$$

$$\ln 2 = 0,693$$

$$T = \frac{\ln 2}{\lambda}$$

λ — yemirilish doimiysi, parchalanish doimiysi.

• Radioktiv elementning o'rtacha yashash vaqti:

$$\tau = \frac{1}{\lambda}$$

Izotoplar deb, tartib raqami bir xil, massa soni turlicha bo'lgan elementlarga aytiladi.

Izotoplar deb, protonlar soni bir xil, neytronlar soni turlicha bo'lgan elementlarga aytiladi.

Ular Mendeleyev jadvolida 1 ta xonada joylashtiriladi.

H_1^1 (protiy) — proton

H_1^2 (deteriy) — deytron

H_1^3 (tritiy) — triton

Atom yadrosining tuzilishi. Yadro kuchlari. Bog'lanish energiyasi.

• Yadro proton va neytronlardan iborat. Ular orasida yadro kuchlari mavjud.

• Proton va neytronga **nuklon** deyiladi. Demak, yadro nuklonlardan iborat.

Tabiatda 4 xil ta'sir kuchlari mavjud:

1. Gravitatsion o'zaro ta'sir kuchi
Bu ta'sir har qanda massali jismlar orasida mavjud. Gravitatsion o'zaro ta'sirni gravitonlar amalga oshiradi.

2. Elektromagnit o'zaro ta'sir kuchi
Har qanday zaryadlangan jismlar orasida yuzaga keladi. Bu ta'sirni glyuonlar amalga oshiradi.

3. Kuchli o'zaro ta'sir kuchi
Bu ta'sir nuklonlar orasida yuzaga keladi.

4. Kuchsiz o'zaro ta'sir kuchi
Elementar zarralar orasida yuzaga keladi.

$$X_Z^A \qquad A = Z + N$$

U_{92}^{238} (uran) $A = 238$, $Z = 92$, $N = 146$

- Agar $q = 0$, zaryadsiz bo'lsa

$e = Z = 92$.

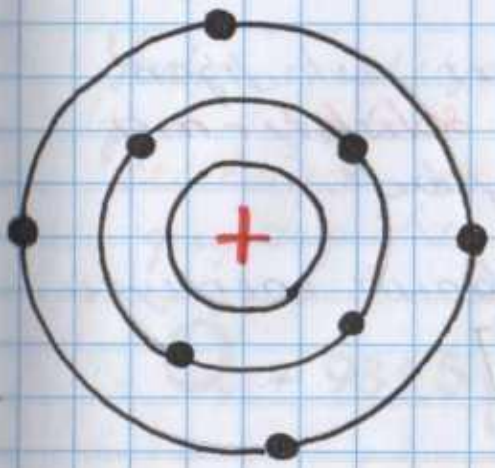
- $\boxed{e < Z}$ $q > 0$, musbat zaryad bo'lsa

$q = +1$ $e = 91$.

- $\boxed{e > Z}$ $q < 0$, manfiy zaryad bo'lsa

$q = -3$ $e = 95$

• H_1^1 va He_2^4 elementlaridan boshqa, hamma elementlarda $N \geq Z$



$q = 0$ bo'lsa $Z = 8$, $e = 8$

$q = +2$ bo'lsa $Z = 10$, $e = 8$

$q = -3$ bo'lsa $Z = 5$, $e = 8$.

Zaryadda [e] o'zgarmaydi

• Har qanda yadroning tinchlikdagi massasi, uni tashkil qilgan proton va neytronlarning massasidan kichik bo'ladi.

$$m_{yadro} < Z \cdot m_p + N \cdot m_n$$

$$\Delta m = Z \cdot m_p + N \cdot m_n - m_y$$

Δm — massa defekti

$$E_{yad} < E_p + E_n$$

• Yadroni alohida nuklonga parchalab yuborish uchun kerak bo'ladigan energiyaga yadroni bog'lanish energiyasi deyiladi.

$$E_b = \Delta m \cdot c^2$$

Δm - [kg]
E_{bog} - [J]

$$E_b = 931,5 \cdot \Delta m$$

Δm - [m.a.b]
E_{bog} - [MeV]

• Yengil yadrolar birlashtirilganda ham, og'ir yadrolar birlashtirilganda ham, energiya ajralib chiqadi.

• Alohida nuklonga to'g'ri keladigan bog'lanish energiyasiga, **solishtirma bog'lanish energiyasi** deyiladi.

$\mathcal{E}$ – solishtirma bog'lanish energiyasi

$$\left[\frac{MeV}{m.a.b}\right]$$

$$\mathcal{E} = \frac{E_{bog.}}{A} = \frac{E}{Z+N}$$

Yadro reaksiyalari.

Atom yadrolarining elementar zarralar bilan yoki bir-biri bilan ta'siri natijasida boshqa yadroga aylanishiga **yadro reaksiyasi** deyiladi.

Sxemasi quyidagicha:

$$X_{Z_1}^{A_1} + y_{Z_2}^{A_2} \longrightarrow L_{Z_3}^{A_3} + K_{Z_4}^{A_4}$$

$$A_1 + A_2 = A_3 + A_4$$

$$Z_1 + Z_2 = Z_3 + Z_4$$

• Alyuminiy α zarrachalar bilan bombardimon qilinganda qandaydir element hosil bo'ldi va qandaydir elektron uchib chiqdi. Shunda..

$$Al_{13}^{27} + \alpha_2^4 \longrightarrow ?_{16}^{31} + e_{-1}^{0}$$

• Neytron zaryadsiz bo'lganligi uchun yadroga oson kira oladi va yadro reaksiyasini yuzaga keltiradi.

Yadro reaksiyasi natijasida ajralib chiqadigan yoki yutiladigan energiyaga **reaksiya energiyasi** deyiladi. va u quyidagicha topiladi.

$$Q = 931{,}5\left[(m_{A_1} + m_{A_2}) - (m_{A_3} + m_{A_4})\right]$$

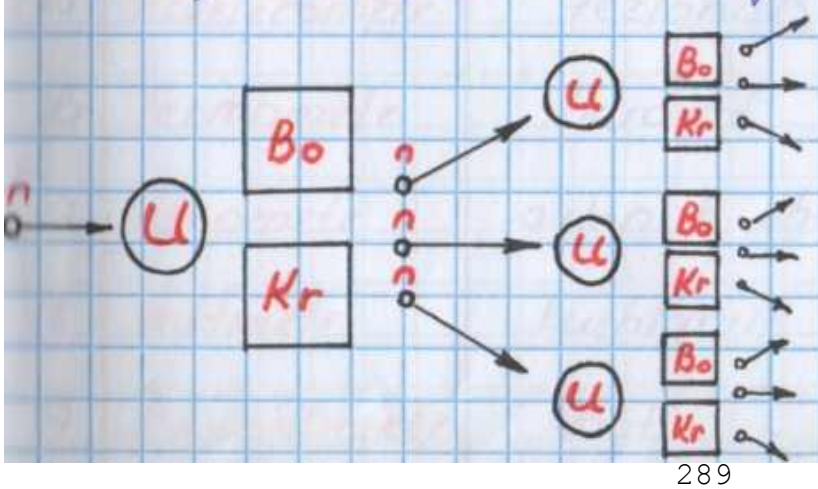
$Q > 0$ bo'lsa, energiya ajraladi
ekzotermik reaksiya

$Q < 0$ bo'lsa, energiya yutiladi
endotermik reaksiya.

• Boshqarilmaydigan yadro reaksiyasi bu **bomba** dir.

• Boshqariladigan yadro reaksiyasi amalga oshiradigan qurilmaga **yadro reaktori** d-di, yoki **atom reaktori** deyiladi.
Reaktorda zanjir yadro reaksiyasi amalga oshadi.

Zanjir yadro reaksiyasi deb, reaksiya natijasida ajralgan zarrachalar (neytronlar) yana reaksiya maxsuloti bo'ladigan jarayonga aytiladi.



$$k = \frac{N_o}{N}$$

k – ko'payish koeffitsiyenti

N_0 — dastlabki neytronlar soni
N — keyingi hosil bo'ladigan neytronlar soni

$k = 1,000$ bo'lsa normal reaksiya

$k > 1$ bo'lsa, portlash

$k < 1$ bo'lsa, sekinlash.

- Reaktorda yoqilg'i sifatida: uran, plutoniy, kripton,
- Reaksiyani sekinlashtirish sifatida: (neytronlarni yutuvchi) Bor, kadmiy, Grafit
- Issiqlik eltuvchi sifatida: geliy, og'ir suv, organik suyuqliklar, havo, karbonat angidrid, azot, suyuq metallar.
- Issiqlik nurlanish quvvatini Bolometr bilan o'lchanadi.

№	Fizik o'lchov asboblari	
1.	Ampermetr	tok kuchi
2	Areometr	suyuqlik zichligi
3	Barometr	atmosfera bosimi
4	Bolometr	issiqlik nurlanish quvvati
5	Dinomometr	kuch
6	Dozometr	nurlanish dozasi
7	Elektrometr	zaryad miqdori
8	Elektroskop	zaryad bor yoki yo'qligini aniqlaydi.
9	Galvonometr	kichik toklar
10	Gigrometr	Shudring nuqtasi
11	Manometr	suyuqlik yoki gazlar bosimi
12	Menzurka	suyuqlik hajmi
13	Psixrometr	nisbiy namlik
14	Tarozi	massa
15	Akselerometr	tezlanish
16	Termometr	harorat
17	Tahometr	aylanish chastotasi
18	Voltmetr	kuchlanish
19	Sekundometr	vaqt