O’ZBEKISTON RESPUBLIKASI MAKTABGACHA VA MAKTAB TA’LIMI VAZIRLIGI

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MEXANIKA VA MOLEKULYAR FIZIKA

1-kitob

Maktab o’qituvchilari uchun Fizika kursidan masalalar yechish metodikasi bo’yicha o’quv qo’llanma

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Kirish

Fizik masala qanday yechiladi?

Masala yechish noma'lum fizik kattalikni masala shartida berilgan kattaliklar orqali ifodalangan ishchi formulani chiqarib, masala shrtida berilgan kattaliklarning "XBS" sistemasidagi son qiymatlarini o'rniga qo'yib hisoblashdan iborat.

Har qanday masalani yechishdan oldin o'rta maktab uchun tavsiya etilgan darslikdan yoki qo'llanmalardan tegishli mavzularni o'qish, asosiy qonun-qoida va formulalarni o'rganish shart.

Zarur bo'lgan nazariy va amaliy bilimni olgach, kitobda izohli yechimi keltirilgan masalalar bilan mufassal tanishib chiqish lozim. Shundan keyin mustaqil yechishga tavsiya qilingan masalalarni yechishga kirishiladi.Masalalarni Xalqaro Birliklar Sistemasi "XBS"da yechish tavsiya qilinadi.To'g'ri yechilganda masalaning javobi va birligi kelib chiqadi. Aks holda masala noto'g'ri yechilgan bo'ladi.

Masalalarni yechishda quyidagi metodik ko'rsatmalarga amal qilish lozim.

1. Masalaning sharti bir necha marta o'qib chiqiladi va u fizikaning qaysi bo'limiga tegishli ekanligi aniqlanadi.

2. Masalaning mazmunini tushunib, masala shartida berilgan kattaliklarni "XBS" da ifodalab, topilishi kerak bo'lgan kattalik yoziladi.

3. Masalaning shartiga mos chizma chiziladi.

4. Masala yechishdan oldin uning shartida qanday fizik qonuniyatlar yotganligi aniqlanadi.

5. Masalani umumiy ko'rinishda yechish uchun ketma-ketlik usuli asosida masala shartidagi noma'lum kattaliklarni boshqa ma'lum kattaliklar bilan bog'lovchi ishchi formulalar topiladi. Agar hosil qilingan ishchi formulalar to'g'ri bo'lsa, masala javobidagi izohsiz yechim bilan bir xil ko'rinishda bo'ladi.

6. Natijaviy ishchi formulaga kattaliklarning "XBS" sistemadagi son qiymatlarini qo'yib, hisoblash ishlari bajarilsa, masalaning javobi kelib chiqadi.

7. Ayrim hollarda barcha berilgan kattaliklarning qiymatlarini bitta sistemaning o'zida ifodalashning hojati bo'lmay qoladi. Masalan, ishchi formuladagi kattaliklar surat va maxrajda ko'paytmadan iborat bo'lganda bu

kattaliklarning qaysi birlikda ifodalanishidan qat’iy nazar ularning o’lchov birligi bir xil bo’lishi kifoyadir.

8. Masalaning javobini chiqarishda oxirgi natijaning aniqlik darajasiga ahamiyat berish kerak. Bunda javobning aniqligi masala shrtida berilgan kattaliklarning aniqligidan oshmasligi lozim.

9. Masalani yechish davomida qo’llanilayotgan har bir qonun, qoida, formula va fizik kattaliklar qisqacha izohlab boriladi.

MEXANIKA.

Asosiy formulalar.

1. To'g'ri chiziqli tekis harakat:

Agar vaqt o'tishi bilan moddiy nuqtaning tezlik vektori o'zgarmas, ya'ni $\vec{\vartheta} = \text{const}$ bo'lsa, harakat to'g'ri chiziqli tekis harakatdan iborat bo'ladi. U holda to'g'ri chiziqli tekis harakatning tenglamasi quyidagicha bo'ladi;

$$\vec{\vartheta} = \frac{\vec{s}}{t}\,; \qquad \vartheta_x = \frac{s_x}{t} = \frac{x - x_0}{t}; \qquad \vec{s} = \vec{\vartheta}t;$$

$$\vec{s} = \vec{\vartheta}t = x - x_0; \qquad s = \vartheta t; \qquad x = x_0 + \vartheta_x t$$

bu yerda t-harakat vaqti, $\vec{S}$- t vaqt davomidagi ko'chish, $\vec{\vartheta}$ –tezlik, S_x va ϑ_x-ko'chishning va tezlikning x o'qidagi proyeksiyalari, S va ϑ-ko'chishning va tezlikning modullari, x_0-harakatlanayotgan nuqtaning boshlang'ich $(t = 0)$ paytdagi, x esa oxirgi (t) paytdagi koordinatalari.

2. Notekis harakat:

Harakat davomida jism tezligining son qiymati o‘zgaruvchan bo‘lsa, bunday harakat *notekis harakat* deyiladi.

Jism bosib o‘tgan umumiy yo‘lning shu yo‘lni bosib o‘tishga ketgan umumiy vaqtga nisbati bilan o‘lchanadigan kattalik *notekis harakatning o‘rtacha tezligi* deb ataladi.

$$\vec{\vartheta}_{o\prime r} = \frac{\vec{s}}{t}; \qquad (\vartheta_{o\prime r})_x = \frac{s_x}{t} = \frac{x - x_0}{t}; \qquad < \vartheta >= \left|\vec{\vartheta}\right|_{o\prime r} = \frac{l}{t};$$

$$\vec{s} = \vec{\vartheta}_{o\prime r}t; \qquad s_x = (\vartheta_{o\prime r})_x t = x - x_0; \qquad s = \vartheta_{o'r}t; \quad \vartheta_{o'r} = \frac{s}{t}\,;$$

$$l =< \vartheta > t = \int_0^t \vartheta(t)dt\,; \qquad x = x_0 + s_x = x_0 + (\vartheta_{o\prime r})_x t$$

$$\vec{\vartheta} = \frac{\Delta\vec{s}}{\Delta t} = \frac{d\vec{s}}{dt} = \vec{s}'; \qquad \vartheta_x = \frac{\Delta x}{\Delta t} = \frac{dx}{dt} = x';$$

Vaqt o'tishi bilan tezligi o'zgaradigan harakat o'zgaruvchan harakat deyiladi.

Harakat trayektoriyasi to'g'ri chiziqdan iborat bo'lgan o'zgaruvchan harakat *to'g'ri chiziqli o'zgaruvchan harakat* deb ataladi.

$$\vec{a} = \frac{\Delta\vec{\vartheta}}{\Delta t} = \frac{d\vec{\vartheta}}{dt} = \vec{\vartheta}'; \qquad a_x = \frac{\Delta\vartheta_x}{\Delta t} = \frac{d\vartheta_x}{dt} = \vartheta_x';$$

$$\vec{\vartheta} = \vec{\vartheta}_0 + \int_0^t \vec{a}\,(t)dt; \qquad \vartheta_x = \vartheta_{ox} + \int_0^t a_x(t)dt;$$

$$\vec{s} = \int_0^t \vec{\vartheta}\,(t)dt; \qquad s_x = \int_0^t \vartheta_x(t)dt;$$

bu yerda: $\vec{\vartheta}_{o\prime r} -$ t vaqt davomidagi o'rtacha tezlik, $\vartheta_{o\prime r}$ va $(\vartheta_{o\prime r})_x -$ uning moduli va x o'qidagi proyeksiyasi, $< \vartheta > -$tezlik modulining o'rtacha qiymati, $\vec{a}$ −tezlanish, a_x −uning x o'qidagi proyeksiyasi, $l - t$ vaqt davomida bosib o'tilgan yo'l, $\vec{\vartheta}_0$ −boshlang'ich $(t = 0)$ paytdagi tezlik, ϑ_{ox} −uning x o'qidagi proyeksiyasi, $\vec{\vartheta} = \vec{\vartheta}(t) - t$ paytdagi tezlik, $\vartheta = \vartheta(t)$ va $\vartheta_x = \vartheta_x(t)$ −uning moduli va x o'qidagi proyeksiyasi.

3. Tekis tezlanuvchan harakat $(a = \text{const})$:

$$\vec{a} = \frac{\vec{\vartheta} - \vec{\vartheta}_0}{t}; \qquad \vec{\vartheta} = \vec{\vartheta}_0 + \vec{a}t; \qquad \vec{\vartheta}_{o\prime r} = \frac{\vec{\vartheta} + \vec{\vartheta}_0}{2}; \qquad \vec{s} = \vec{\vartheta}_0 t + \frac{\vec{a}t^2}{2};$$

$$\vartheta_x = \vartheta_{ox} + a_x t = \sqrt{\vartheta_{ox}^2 + 2a_x s_x}\,; \qquad (\vartheta_{o\prime r})_x = \frac{\vartheta_{ox} + \vartheta_x}{2}\,;$$

To'g'ri chiziqli tekis o'zgaruvchan harakat bo'lganda, quyidagi ifodalar kelib chiqadi:

Bu tenglamalarda a tezlanish harakat tekis tezlanuvchan bo'lsa musbat $a > 0$ va tekis sekinlanuvchan bo'lsa manfiy $a < 0$ bo'ladi. Tekis o'zgaruvchan harakat tenglamalari quyidagicha ifodalanadi;

$$s_x = \vartheta_{ox}t + \frac{a_x t^2}{2} = (\vartheta_{o\prime r})_x t = \frac{\vartheta_x^2 - \vartheta_{ox}^2}{2a_x}\,; \qquad x = x_0 + \vartheta_{ox}t + \frac{a_x t^2}{2}\,;$$

$\vartheta_{ox} = 0$ bo'lganda: $\vartheta_x = a_x t = \sqrt{2a_x s_x}\,;$ $(\vartheta_{o\prime r})_x = \frac{\vartheta_x}{2}\,;$

$$s_x = \frac{a_x t^2}{2} = \frac{\vartheta_x^2}{2a_x}\ ; \qquad a_x = \frac{\vartheta_x^2}{2s_x}\ ; \qquad x = x_0 + \frac{a_x t^2}{2}\ ;$$

$n-$ sekundda jismning ko'chishi;

$$\Delta s_n = \vartheta_0 + \frac{a}{2} \cdot (2n-1)$$

$\vartheta_0 = 0$ hol uchun;

$$\Delta s_n = \frac{a}{2} \cdot (2n-1)$$

tezlanish esa;

$$a = \frac{2 \cdot \Delta s_n}{(2n-1)}$$

Tezlanuvchan harakatda jism o'tgan masofasi toq sonlarga proporsional (sekinlanuvchan harakatda teskari), ya'ni: $x;\ 3x;\ 5x;\ 7x;$ …

Isbot: Tezlanuvchan harakatda jismning $n-sekundda$ o'tgan masofasi, $n\ sekundda$ o'tgan masofasidan, 1 sekund oldin $(n-1)\ sekundda$ o'tgan masofasining farqiga teng. Jismning $n-sekundda$ o'tgan masofasi

$$s_n = \vartheta_0 \cdot n + \frac{a \cdot n^2}{2}$$

$(n-1)\ sekundda$ o'tgan masofasi esa;

$$s_{n-1} = \vartheta_0 \cdot (n-1) + \frac{a \cdot (n-1)^2}{2}$$

ga teng.

Jismning $n-sekundda$ o'tgan masofasini hisoblaymiz;

$$\Delta s_n = s_n - s_{n-1}$$

yoki;

$$\Delta s_n = \vartheta_0 \cdot n + \frac{a \cdot n^2}{2} - \left(\vartheta_0 \cdot (n-1) + \frac{a \cdot (n-1)^2}{2}\right)$$

Ifodani soddalashtiramiz;

$$\Delta s_n = \vartheta_0 \cdot n + \frac{a \cdot n^2}{2} - \left(\vartheta_0 n - \vartheta_0 + \frac{a}{2} \cdot (n^2 - 2n + 1) \right)$$

yuqoridagi ifodadan;

$$\Delta s_n = \vartheta_0 \cdot n + \frac{a \cdot n^2}{2} - \vartheta_0 n + \vartheta_0 - \frac{a \cdot n^2}{2} + an - \frac{a}{2}$$

o'xshash hadlarni ixchamlashtiramiz;

$$\Delta s_n = \vartheta_0 + an - \frac{a}{2}$$

va $a/2$ hadni qavsdan chiqarib, ifodani quyidagicha yozib olamiz;

$$\Delta s_n = \vartheta_0 + \frac{a}{2}(2n - 1)$$

Bu ifoda tekis tezlanuvchan harakatda $n - sekundda$ ko'chish formulasi. Agar jism boshlang'ich tezliksiz ($\vartheta_0 = 0$) harakatlansa;

$$\Delta s_n = \frac{a}{2}(2n - 1)$$

ifodaga ega bo'lamiz. Endi ko'chishni turli vaqtlarda tekshiramiz:

$n = 1\ da$

$$\Delta s_1 = \frac{a}{2} \cdot (2 \cdot 1 - 1) = \frac{a}{2} \cdot 1$$

$n = 2\ da$

$$\Delta s_2 = \frac{a}{2} \cdot (2 \cdot 2 - 1) = \frac{a}{2} \cdot 3$$

$n = 3\ da$

$$\Delta s_3 = \frac{a}{2} \cdot (2 \cdot 3 - 1) = \frac{a}{2} \cdot 5$$

Tezlanishning turli qiymatida jismning ko'chishi $\Delta s_1 : \Delta s_2 : \Delta s_3 ; \ldots = 1 : 3 : 5 ; \ldots$ toq sonlarga proporsional bo'lar ekan.

4. Aylana bo'ylab tekis harakat ($\vartheta = \text{const}$):

Tekis aylanma harakatning burchak tezligi deb, vaqt birligi ichida radius-vektorning burchagiga miqdor jihatidan teng bo'lgan fizik kattalikka

aytiladi. Agar ($\vec{\omega} = \text{const}$) bo'lsa, moddiy nuqtaning harakati tekis aylanma harakat bo'ladi.

$$T = \frac{t}{N} = \frac{2\pi R}{\vartheta} = \frac{1}{\nu}; \qquad \nu = \frac{N}{t} = \frac{1}{T}; \qquad \vartheta = \frac{2\pi R}{T} = 2\pi\nu;$$

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

bu yerda $N-$ t vaqtdagi aylanishlar soni, T −aylanishlar davri, ν −aylanishlar chastotasi, R −aylananing radiusi, a −markazga intilma tezlanish.

Egri chiziqli harakatda to'la tezlanish quyidagiga tengdir:

$$a = \sqrt{a_t^2 + a_n^2}\,.$$

Bunda a_t- tangensial tezlanish, a_n - normal (markazga intiltirma) tezlanish bo'lib

$$a_t = \frac{d\vartheta}{dt} \quad \text{va} \quad a_n = \frac{\vartheta^2}{R}$$

ko'rinishlarda hisoblanadi. Bunda υ-harakatning tezligi va R-trayektoriyaning berilgan nuqtadagi egrilik radiusi.

Umumiy holda o'zgaruvchan aylanma harakatda burchak tezlik;

$$\omega = \frac{d\varphi}{dt}$$

Burchak tezlanish esa

$$\varepsilon = \frac{d\omega}{dt} = \frac{d^2\varphi}{dt^2}$$

Tekis aylanma harakatda burchak tezlik quyidagiga tengdir

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

bunda T-aylanish davri, ν-aylanish chastotasi, ya'ni vaqt birligidagi aylanishlar soni.

Burchak tezlik ω chiziqli tezlik υ bilan quyidagi munosabat orqali bog‘langan

$$\upsilon = \omega R$$

Aylanma harakatda tangensial va normal tezlanishlarni quyidagicha ifodalash mumkin:

$$a_t = \varepsilon R \qquad a_n = \omega^2 R$$

Ilgarilanma va aylanma harakatining tenglamalari 1-jadvalda taqqoslangan.

1-jadval

Ilgarilanma harakat	Aylanma harakat
Tekis harakat	
$S = \upsilon t$	$\varphi = \omega t$
$\vartheta = const$	$\omega = const$
$a = 0$	$\varepsilon = 0$
Tekis o’zgaruvchan harakat	
$S = \vartheta_0 t + \frac{at^2}{2}$	$\varphi = \omega_0 t + \frac{\varepsilon t^2}{2}$
$\vartheta = \vartheta_0 + at$	$\omega = \omega_0 + \varepsilon t$
$a = const$	$\varepsilon = const$
Notekis harakat	
$S = f(t)$	$\varphi = f(t)$
$\vartheta = \frac{ds}{dt}$	$\omega = \frac{d\varphi}{dt}$
$a = \frac{d\vartheta}{dt} = \frac{d^2 s}{dt^2}$	$\varepsilon = \frac{d\omega}{dt} = \frac{d^2 \varphi}{dt^2}$

Masala yechish namunalari

1-masala: Yo'lovchi ko'cha bo'ylab 240 m yo'l o'tdi, so'ngra chorrahada burildi va perpendikulyar yo'nalishda yana 70 m yo'l yurdi. Yo'lovchi o'tgan yo'l uning ko'chishining modulidan necha foizga ko'p?

$Berilgan$: $S_1 = 240\ m;\ \ S_2 = 70\ m$;

$Topish\ kerak$; $\dfrac{S_{yo'l} - S_k}{S_k} \cdot 100\% = ?$

$Yechilishi$. Yo'lovchi to'g'ri yo'l bo'ylab ma'lum bir masofani o'tgach, chorrahadan burilib perpendikulyar harakatlanganda uning bosib o'tgan yo'li quyidagicha;

$$S_{yo'l} = S_1 + S_2 \qquad (1)$$

Ko'chishi esa;

$$S_k = \sqrt{S_1^2 + S_2^2} \qquad (2)$$

$Hisoblash$:

$$S_{yo'l} = S_1 + S_2 = 240\ m + 70\ m = 310\ m;$$

$$S_k = \sqrt{S_1^2 + S_2^2} = \sqrt{(240\ m)^2 + (70\ m)^2} = \sqrt{625000\ m^2} = 250\ m;$$

$$\frac{S_{yo'l} - S_k}{S_k} \cdot 100\% = \frac{310\ m - 250\ m}{250\ m} \cdot 100\% = 24\%\ .$$

2-masala: Motorli qayiq daryoda manzilga yetib borish uchun 1,8 soat, qaytib kelish uchun esa 2,4 soat vaqt sarfl adi. Agar sol jo'natilsa, manzilga qancha vaqtda yetib boradi?

$Berilgan$: $t_1 = 1{,}8\ soat;\ t_2 = 2{,}4\ soat$

$Topish\ kerak$; $t = ?$

$Yechilishi$. Motorli qayiqning manzilga borishda bosib o'tgan masofasi;

$$S = (\vartheta_q + \vartheta_0) \cdot t_1 \qquad (1)$$

Qaytishda esa;

$$S = (\vartheta_q - \vartheta_0) \cdot t_2 \qquad (2)$$

Agar sol jo'natilsa, oqim tezligida harakatlanib;

$$S = \vartheta_0 \cdot t \tag{3}$$

masofani bosib o'tadi.

(1)-va (2)-tengliklarni tenglashtirib qayiqning va oqimning tezliklarini o'zaro bog'lab olamiz;

$$(\vartheta_q + \vartheta_0) \cdot t_1 = (\vartheta_q - \vartheta_0) \cdot t_2 \tag{4}$$

(4)-tenglikdan qavslarni ochib chiqib;

$$\vartheta_q t_1 + \vartheta_0 t_1 = \vartheta_q t_2 - \vartheta_0 t_2 \tag{5}$$

(5)-ifodadan qayiqning tezligini topib olamiz;

$$\vartheta_q = \frac{t_1 + t_2}{t_2 - t_1} \cdot \vartheta_0 \tag{6}$$

(3)-ifodani yuqoridagi ixtiyoriy (1)-yoki (2)-tenglikka tenglashtiramiz;

$$(\vartheta_q + \vartheta_0) \cdot t_1 = \vartheta_0 \cdot t$$

yoki ;

$$\left(\frac{t_1 + t_2}{t_2 - t_1} \cdot +1\right) \vartheta_0 \cdot t_1 = \vartheta_0 \cdot t \tag{7}$$

Oqim tezliklarini qisqartirib;

$$t = \left(\frac{t_1 + t_2}{t_2 - t_1} \cdot +1\right) \cdot t_1 = \frac{2t_1 t_2}{t_2 - t_1} \tag{8}$$

$$Hisoblash:$$

$$t = \frac{2t_1 t_2}{t_2 - t_1} = \frac{2 \cdot 1{,}8 \cdot 2{,}4}{2{,}4 - 1{,}8}\ soat = 14{,}4\ soat\ .$$

3-masala: Moddiy nuqtaning berilgan sanoq sistemasidagi harakati $x = 4t - 2t^2;\ y = 3(t - 0{,}5t^2)$ tenglamalar bilan tavsiflanadi. Trayektoriya tenglamasini yozing.

$Berilgan:\ x = 4t - 2t^2;\ y = 3(t - 0{,}5t^2)$

$Topish\ kerak;\quad y = f(x)?$

$Yechilishi.$ Moddiy nuqtaning harakat trayektoriyasi tenglamasi $y = f(x)$ funksiyadan iborat bo'lib, uning ko'rinishini topish uchun masalaning shartidan berilgan

$$y = 3(t - 0{,}5t^2) \tag{1}$$

$$x = 4t - 2t^2 \tag{2}$$

tenglamalardan vaqtni yo'qotib, y bilan x orasidagi bog'lanishni aniqlaymiz. Buning uchun (1)-tenglamadan t ni qavsdan chiqarib $y = 3t(1 - 0{,}5t)$ va (2)-tenglamadan $4t$ ni qavsdan chiqarib $x = 4\,(1 - 0{,}5t)$ qiymatni hadma-had bo'lib, $(1 - 0{,}5t)$ bir xil hadlarni qisqartirib yuboramiz. Natijada esa;

$$\frac{y}{x} = \frac{3}{4} \tag{3}$$

yoki;

$$y = \frac{3}{4}x = 0{,}75x$$

ifodaga ega bo'lamiz. Demak, moddiy nuqtaning harakat tenglamasi

$$y = 0{,}75x$$

ko'rinishda ekan.

4-masala: Avtomobil A punktga 80 km/h tezlik bilan yaqinlashmoqda. U manzilga (A punktga) yetishiga 10 km qolganda A punktdan perpendikulyar yo'nalishda 60 km/h tezlikda yuk mashinasi yo'lga chiqdi. Avtomobil va yuk mashinasi orasidagi eng qisqa masofa qanchaga (km da) teng?

$Berilgan$: $v_1 = 80\ km/h$; $v_2 = 60\ km/h$; $s_1 = 10\ km - v_1 t$; $s_2 = v_2 \mathrm{t}$;

$Topish\ kerak$: $s_{min} = ?$

$Yechilishi$. Avtomobil va yuk mashinasi orasidagi eng qisqa masofa

$$s_{min} = \sqrt{{s_1}^2 + {s_2}^2} \tag{1}$$

(1)-formuladan;

$$s_{min} = \sqrt{(10\ km - v_1 t)^2 + (v_2 \mathrm{t})^2} \tag{2}$$

$Hisoblash$:

$$s_{min} = \sqrt{(10\ - 80t)^2 + (60\mathrm{t})^2} = \sqrt{100 - 1600t + 6400t^2 + 3600t^2}\ ;$$

$$s_{min} = \sqrt{10000t^2 - 1600t + 100};$$

$$x_0 = \frac{1600}{2 \cdot 10000} = 0{,}08 = \frac{2}{25}$$

$$y_0 = \sqrt{10000 \cdot \frac{4}{625} - 1600 \cdot \frac{2}{25} + 100} = \sqrt{36} = 6\ km$$

$$s_{min} = 6\ km$$

5-masala: Bola harakatlanayotgan eskalatorda yugurib, birinchi holda $n_1 = 50$ ta zina sanadi, ikkinchi holda o'sha yo'nalishda uch marta katta tezlik bilan yugurib $n_2 = 75$ ta zina sanagan bo'lsa, bola tinch turgan eskalatorda nechta zina sanaydi?

$Berilgan$: $n_1 = 50$; $n_2 = 75$;

$Topish\ kerak$: $n = ?$

$Yechilishi$. Odamning eskalatorga nisbatan tezligi u bo'lsin. l-eskalator uzunligi, n-undagi qadamlar soni. Eskalatorda bolaning tushish vaqti:

$$t = \frac{l}{(u+v)} \tag{1}$$

ga teng. Shu vaqtda bolaning bosib o'tgan masofasi;

$$S = u \cdot t = \frac{ul}{(u+v)} \tag{2}$$

Bolaning sanagan zinalar soni ya'ni uzunlik birligiga to'g'ri keluvchi zinalar soni;

$$n_1 = \frac{u \cdot l}{(u+v)} \cdot \frac{n}{l} \tag{3}$$

Ikkinchi holda esa zinalar soni;

$$n_2 = \frac{3u \cdot l}{(3u+v)} \cdot \frac{n}{l} \tag{4}$$

(4)-ifodadan quyidagi sistemani yechamiz:

$$\begin{cases} n_1 = \dfrac{u \cdot l}{(u+v)} \cdot \dfrac{n}{l} \\ n_2 = \dfrac{3u \cdot l}{(3u+v)} \cdot \dfrac{n}{l} \end{cases} \Rightarrow \begin{cases} 1 + \dfrac{v}{u} = \dfrac{n}{n_1} \\ 1 + \dfrac{v}{3u} = \dfrac{n}{n_2} \end{cases} \tag{5}$$

$Hisoblash$:

$$n = \frac{2n_1 n_2}{(3n_1 - n_2)} = \frac{2 \cdot 50 \cdot 75}{3 \cdot 50 - 75} = 100\ ta$$

6-masala: G'ildirak o'zgarmas $\varepsilon = 2\ rad/s^2$ burchak tezlanish bilan aylanadi. Harakat boshlanishidan 0,5 s o'tgacha, g'ildirakning to'la tezlanishi $a = 13{,}6\ cm/s^2$ ga teng bo'lsa, uning radiusini toping.

$Berilgan$: $\varepsilon = 2\ rad/s^2$; $t = 0{,}5\ s$; $a = 13{,}6\ cm/s^2 = 13{,}6 \cdot 10^{-2}\ m/s$;

$Topish\ kerak$: R =?

$Yechilishi$. G'ildirakning to'la tezlanishi;

$$a = \sqrt{a_n^2 + a_t^2}\ ,$$

bu yerda a_n va a_t −mos ravishda normal va tangensial tezlanishlar.

$a_n = \omega^2 R$, $a_t = \varepsilon R$ va $\omega = \varepsilon t$ ekanligini hisobga olsak, u holda to'la tezlanishning ifodasi

$$a = \sqrt{\omega^4 R^2 + \varepsilon^2 R^2} = \sqrt{\varepsilon^4 t^4 R^2 + \varepsilon^2 R^2} = \varepsilon R\sqrt{\varepsilon^2 t^4 + 1}$$

ko'rinishiga keladi. Bundan, g'ildirakning R radiusi

$$R = \frac{a}{\varepsilon\sqrt{\varepsilon^2 t^4 + 1}}$$

ga teng bo'ladi.

$Hisoblash$:

$$R = \frac{a}{\varepsilon\sqrt{\varepsilon^2 t^4 + 1}} = \frac{13{,}6 \cdot 10^{-2}\ m/s}{2\frac{1}{s^2} \cdot \sqrt{4\frac{1}{s^4} \cdot (0{,}5)^4 s^4 + 1}} \approx 6{,}1\ m\ .$$

7-masala: Boshlang'ich tezligi $9\ m/s$ bo'lgan jism shunday sekinlana boshladiki, uning tezlanish moduli quyidagi tenglamaga ko'ra o'zgaradi: $a(t) = 2\sqrt{\vartheta(t)}$. Jismning tormozlanish yo'lini toping.

$Berilgan$: $\vartheta_0 = 9\ m/s$; $a(t) = 2\sqrt{\vartheta(t)}$;

$Topish\ kerak$: S_{tor} =?

Yechilishi. Tezlanish berilgan qonuniyat bo'yicha o'zgarganligi uchun, uning tenglamasini quyidagicha yozamiz;

$$a = \frac{d\vartheta}{dt} = 2\sqrt{\vartheta(t)} \qquad (1)$$

(1)-tenglamadan jismning harakat tezligi quyidagicha;

$$\frac{d\vartheta}{\sqrt{\vartheta}} = 2dt \qquad (2)$$

(2)-ifodani integrallaymiz.

$$\int \frac{d\vartheta}{\sqrt{\vartheta}} = 2\int dt \qquad (3)$$

natija esa quyidagicha;

$$2\sqrt{\vartheta} + 2\mathrm{C} = 2t \quad \text{yoki} \quad \vartheta = (t - \mathrm{C})^2 \qquad (4)$$

Harakatning boshlang'ich $(t = 0)$ paytida jismning tezligi boshlang'ich paytdagi 9 m/s ga teng, C koeffitsiyent esa $\mathrm{C} = 3$ qiymatni oladi. Tormozlanish oxirida esa jismning tezligi nol ga teng, bu qiymat esa $t = 3\ s$ ga mos keladi.

Tormozlanish yo'li esa;

Hisoblash:

$$S_{tor} = \int_0^t \vartheta(t)dt = \int_0^3 (t-3)^2 dt = \frac{(t-3)^3}{3} = 0 - \left(\frac{-27}{3}\right) = 9\ m\,.$$

8-masala: A va B shaharlardan ikkita avtobus bir vaqtda bir-biriga tomon yo'lga chiqdi. Shaharlar orasidagi masofa 200 km ga teng. A shahardan chiqqan avtobus B shahardan chiqqan ikkinchi avtobus bilan uchrashguncha 120 km yo'l bosib o'tdi. Agar keying avtobusning tezligi 50 km/h bo'lsa, birinchi avtobusning tezligi qancha bo'lgan? Avtobuslar qancha vaqtdan so'ng bir-biri bilan uchrashgan?

Berilgan: $s = 200\ km = 2 \cdot 10^5\ m, \quad s_1 = 120\ km = 12 \cdot 10^4\ m,$
$\vartheta_2 = 50\ km/h \approx 14\ m/s\,.$

Topish kerak: $\vartheta_1 = ? \quad t = ?$

Yechilishi. Ikkala avtobus bir vaqtda yo'lga chiqqanligi uchun ular uchrashuvga qadar bir xil vaqt o'tgan. Birinchi avtobusning tezligi $\vartheta_1$bilan, ikkinchi avtobusning bosib o'tgan yo'lini $s_2 = s - s_1$ bilan belgilasak, masalaning shartiga ko'ra;

$$t = \frac{s_1}{\vartheta_1} \quad \text{va} \quad t = \frac{s_2}{\vartheta_2} = \frac{s - s_1}{\vartheta_2}$$

ifodalarni yozish mumkin, bunda t −avtobuslarning bir-biri bilan uchrashguncha ketgan vaqt. Ikkala ifodani birgalikda yechib, ϑ_1 ni topamiz.

$$\vartheta_1 = \vartheta_2 \cdot \frac{s_1}{s - s_1}$$

$$Hisoblash:$$

$$\vartheta_1 = 14\frac{m}{s} \cdot \frac{1{,}2 \cdot 10^5\ m}{(2 - 1{,}2) \cdot 10^5 m} = 21\frac{m}{s}$$

$$t = \frac{1{,}2 \cdot 10^5\ m}{21\frac{m}{s}} = 5714\ s \approx 1{,}6\ soat.$$

9-masala: Poyezd ikki stansiya orasidagi masofani 72 km/h o'rtacha tezlik bilan 20 minutda o'tdi. Tezlanib olish va tormozlanish birgalikda 4 minut davom etdi, boshqa vaqtda esa poyezd tekis harakat qilgan. Tekis harakat qilayotgan poyezdning tezligi qancha bo'lgan?

$Berilgan$: $\vartheta_{o'r} = 72\ km/h = 20\ m/s,\ \ t = 20\ min = 1200\ s,$
$t_1 = 4\ min = 240\ s.$

$Topish\ kerak$: ϑ =?

Yechilishi. Ikki stansiya orasidagi s masofani uchta s_1, s_2 va s_3 masofalarga ajratamiz, u holda $s = s_1 + s_2 + s_3$ deb yozish mumkin, bu yerda s_1 −poyezning tezlanuvchan, s_2 −tekis, s_3 −sekinlanuvchan harakatlanganda bosib o'tgan yo'llari, s_1 va s_3 masofalar bir-biriga teng va poyezd bu masofalarning har birini o'tishda birday $t_1/2$ vaqt sarf qilgan. $s_1$masofa boshlang'ich tezligi nolga va oxirgi tezligi ϑ ga teng bo'lgan tekis tezlanuvchan harakatning yo'l formulasiga asosan aniqlanadi:

$$s_1 = \frac{a}{2}\left(\frac{t_1}{2}\right)^2 = \frac{1}{2} \cdot \frac{2\vartheta}{t_1} \cdot \frac{t_1^2}{4} \qquad (1)$$

Demak,

$$s_1 + s_3 = 2s_1 = 2 \cdot \frac{\vartheta t_1}{4} = \frac{\vartheta t_1}{2} \qquad (2)$$

s_2 masofani poyezd ϑ tezlik harakatlanib $(t - t_1)$ vaqtda o'tadi, binobarin,

$$s_2 = \vartheta \cdot (t - t_1) \qquad (3)$$

Nihoyat, ikki stansiya orasidagi masofa

$$s = \vartheta_{o\prime r} \cdot t \qquad (4)$$

ifodadan aniqlanadi. Shunday qilib yuqoridagi ifodalardan foydalanib,

$$\vartheta_{o\prime r} \cdot t = \frac{\vartheta t_1}{2} + \vartheta \cdot (t - t_1) = \vartheta \cdot \left(\frac{t_1}{2} + t - t_1\right) \qquad (4)$$

yoki;

$$\vartheta_{o\prime r} \cdot t = \vartheta \cdot \left(t - \frac{t_1}{2}\right) \qquad (5)$$

(5)-ifodadan quyidagi tenglamani hosil qilamiz;

$$\vartheta = \frac{2t}{2t - t_1} \cdot \vartheta_{o\prime r} \qquad (6)$$

$$Hisoblash:$$

$$\vartheta = \frac{2t}{2t - t_1} \cdot \vartheta_{o'r} = \frac{2 \cdot 1200\ s}{2 \cdot 1200\ s - 240\ s} \cdot 72\frac{km}{h} = 80\frac{km}{h}.$$

10-masala: Poyezd o'z harakat vaqtining dastlabki 3/4 qismida 80 km/h tezlikda, qolgan vaqtda esa 40 km/h tezlikda yurdi. Poyezdning butun yo'ldagi o'rtacha harakat tezligi (km/h da) qanday?

$Berilgan:\ t_1 = (3/4) \cdot t;\quad \vartheta_1 = 80\ km/h,\quad t_2 = (1/4) \cdot t;\quad \vartheta_2 = 40\ km/h,$

$Topish\ kerak:\quad \vartheta_{o\prime r} = ?$

Yechilishi. Poyezdning o'rtacha tezligini ta'rif bo'yicha quyidagicha yozamiz;

$$\vartheta_{o\prime r} = \frac{s_{um}}{t_{um}} = \frac{s_1 + s_2}{t_1 + t_2} \qquad (1)$$

Yo’lning birinchi qismida poyezdning bosib o’tgan masofasi;

$$s_1 = \vartheta_1 t_1 \tag{2}$$

Ikkinchi qismida esa;

$$s_2 = \vartheta_2 t_2 \tag{3}$$

(2)-va (3)-ifodalardan poyezning o’tgan masofalarini (1)-ifodaga nisbatan yechamiz;

$$\vartheta_{o\prime r} = \frac{\vartheta_1 t_1 + \vartheta_2 t_2}{t_1 + t_2} = \frac{\vartheta_1 \cdot \frac{3}{4} t + \vartheta_2 \cdot \frac{1}{4} t}{t} = \frac{3\vartheta_1 + \vartheta_2}{4} \tag{4}$$

$$Hisoblash:$$

$$\vartheta_{o\prime r} = \frac{3\vartheta_1 + \vartheta_2}{4} = \frac{3 \cdot 80 \ \frac{km}{h} + 40 \ \frac{km}{h}}{4} = 70 \ \frac{km}{h}.$$

Mustaqil yechish uchun masalalar

1. Koptok 3 m balandlikdan tushib, poldan sapchidi va 1 m balandlikka ko'tarilganda tutib olindi. Koptok o'tgan yo'l uning ko'chish modulidan necha marta katta?

Javob: 2

2. 20 m/s tezlikda yuruvchi tovar poyezdi stansiyadan yo'lga chiqdi. Oradan 10 daqiqa o'tib xuddi o'sha yo'nalishda tezligi 30 m/s bo'lgan ekspress yo'lga chiqdi. Stansiyadan qanday masofada (km da) ekspress tovar poyezdini quvib yetadi?

Javob: 36

3. 54 km/h tezlik bilan tekis harakatlanayotgan poyezdning yo'lovchisi qo'shni yo'lda, xuddi o'sha yo'nalishda katta tezlik bilan harakatlanayotgan, 300 m uzunlikli boshqa poyezdni 60 s davomida ko'radi. Ikkinchi poyezdning tezligini (km/h da) toping.

Javob: 72

4. Qayiqning suvga nisbatan tezligi daryo oqimining tezligidan ikki marta katta. Ikki punkt orasida oqimga qarshi suzib borish oqim bo'ylab borishga qaraganda necha marta ko'p vaqt oladi?

Javob: 3

5. Kengligi 800 m bo'lgan daryodan suzib o'tayotgan kater suv bilan bog'langan sanoq sistemasida daryo oqimiga tik yo'nalgan 4 m/s tezlik bilan harakatlandi. Agar daryo oqimining tezligi 1,5 m/s bo'lsa, kater oqim tomonidan qanchaga surib yuboriladi?

Javob: 300

6. Ikki velosipedchi o'zaro perpendikulyar yo'llarda 10,8 km/h va 14,4 km/h tezliklarda borishmoqda. Ularning nisbiy tezligi qanchaga teng (km da)?

Javob: 18

7. Velosipedchi dastlabki 5 s da 35 m yo'l o'tdi, keyingi 10 s da 100 m va oxirgi 5 s da 25 m. Butun yo'ldagi o'rtacha harakat tezligini toping.

Javob: 8

8. Yo'lning birinchi yarmini avtomobil 40 km/h tezlikda o'tdi, ikkinchisini 60 km/h tezlikda. Avtomobilning butun yo'ldagi o'rtacha harakat tezligini (km/h da) toping.

Javob: 48

9. Avtomobil yo'lning dastlabki choragida 60 km/h tezlikda harakatlandi, qolgan yo'lda 20 km/h tezlikda. Avtomobilning o'rtacha tezligini toping.

Javob: 24

10. Kater yo'lning birinchi yarmini ikkinchisiga qaraganda uch marta katta o'rtacha tezlikda o'tdi. Butun yo'ldagi o'rtacha tezlik 6 km/h ni tashkil qiladi. Katerning yo'lning birinchi yarmidagi o'rtacha tezligi qanday (km/h da)?

Javob: 12

11. Yo'lning birinchi yarmini avtomobil 60 km/h tezlikda o'tdi. Yo'lning qolgan qismidagi vaqtning yarmida u 35 km/h tezlik bilan harakatlandi, oxirgi uchastkani esa 45 km/h tezlikda o'tdi. Avtomobilning butun yo'ldagi o'rtacha harakat tezligini (km/h da) toping.

Javob: 48

12. Samolyot ko'tarilishi uchun bo'lgan yo'lning uzunligi 675 m. Agar samolyot tekis tezlanuvchan harakatlanib 15 s dan so'ng yerdan ko'tarilsa, uning yerdan uzilish tezligi qanday?

Javob: 90

13. Tinch holatidan boshlab 6 m/s^2 tezlanish bilan harakatlanayotgan raketa 75 m yo'lda qanday tezlik oladi?

Javob: 30

14. Tinch holatidan boshlab tekis tezlanuvchan harakatlanayotgan shar dastlabki sekundda 10 cm yo'l o'tdi. Harakat boshidan 3 sekund ichida u qanday (cm da) yo'l o'tadi?

Javob: 90

15. Miltiq stvolining 1/4 ini o'tgan o'qning tezligi stvoldan uchib chiqayotgandagidan necha marta kichik? O'qning tezlanishini doimiy deb hisoblang.

Javob: 2

16. Agar poyezd tormoz yo'lini 30 s da 0,5 m/s^2 tezlanish bilan o'tsa, u tormozlanish boshlanguncha qanday tezlikda harakatlangan?

Javob: 15

17. Agar haydovchi 20 m/s tezlikda darhol tormozni bossa, va tormozlash paytidan to'xtaguncha 6 s vaqt o'tsa, avtomobil to'liq to'xtaguncha qanday yo'l o'tadi?

Javob: 60

18. 15 km/h tezlikda avtomobilning tormoz yo'li 1,5 m ga teng. 90 km/h tezlikda uning tormoz yo'li qancha bo'ladi? Ikkala holda tormozlanish bir xil tezlanishda sodir bo'ladi.

Javob: 54

19. Harakatlanayotgan poyezddan oxirgi vagon ajratib yuborildi. Poyezd o'sha tezlik bilan harakatini davom ettiradi. Vagon doimiy tezlanish bilan harakatlanadi, deb hisoblab, uning to'xtaguncha o'tgan yo'li poyezdning shu vaqt momentigacha o'tgan yo'lidan necha marta kichikligini toping.

Javob: 2

20. Jism tinch holatdan tekis tezlanuvchan harakatlana boshladi va harakat boshidan beshinchi sekundda 27 m yo'l o'tdi. U qanday tezlanish bilan harakatlangan?

Javob: 6

Nyutonning ikkinchi qonuni (ilgarilanma harakat dinamikasining asosiy qonuni). Agar massa o'zgarmas bo'lsa, u holda,

$$F = m\frac{d\vartheta}{dt} = ma$$

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

$$\vec{F} = m\vec{a}\,; \quad F_x = ma_x; \quad \vec{a} = \frac{\vec{F}}{m}\,; \quad a_x = \frac{F_x}{m}$$

bu yerda: $\vec{a}$ −m massali jismning $\vec{F}$ kuch ta'siri ostida olgan tezlanishi, a_x va F_x −tezlanish va kuchning x o'qidagi proyeksiyalari.

Nyutonning uchinchi qonuni:

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

bu yerda: $\vec{F}_2$ −birinchi jism tomonidan ikkinchi jismga ta;sir etuvchi kuch, $\vec{F}_1$ −ikkinchi jism tomonidan birinchi jismga ta'sir etuvchi kuch.

Guk qonuni:

$$(F_{el})_x = -kx; \quad F_{el} = k\Delta l;$$

bu yerda: F_{el} va $(F_{el})_x$ − elastiklik kuchining moduli va proyeksiyasi, k −jismning bikrligi, Δl −jismning absolyut defotmatsiyasi (cho'zilish yoki siqilish), x −jismning tashqi kuch qo'yilgan nuqtasi koordinatasining o'zgarishi.

Butun olam tortishish qonuni:

$$F = G\frac{m_1 m_2}{r^2}$$

bu yerda: F −oralaridagi masofa r ga teng bo'lgan m_1 va m_2 massali moddiy nuqtalarning tortishish kuchi, $G = 6{,}6720 \cdot 10^{-11}\ N \cdot m^2/kg^2$ −butun olam tortishish doimiysi (gravitatsiya doimiysi).

Erkin tushish tezlanishi:

- sayyora sirtida $(h = 0)$

$$g = G\frac{M}{R^2}$$

❖ h balandlikda

$$g_h = G\frac{M}{(R+h)^2} = g\left(\frac{R}{R+h}\right)^2;$$

bu yerda M −sayyoraning massasi, R −uning radiusi.

Erkin tushish tezlanishi qutbdan ekvatorga qarab kamayib boradi: qutbda eng katta ($g_{ek} = 9{,}83\ m/s^2$), ekvatorda esa eng kichik ($g_{ek} = 9{,}78\ m/s^2$) qiymatga ega bo'ladi. Dengiz sathida va $\alpha = 45^0$geografik kenglikda erkin tushish tezlanishining qiymati *normal tezlanish* deyiladi. Normal tezlanish 9,81 m/s^2 (aniqrog'i (9,80655 m/s^2) ga teng.

Masalan, 300 km yuqoriga ko'tarilganda erkin tushish tezlanishi taxminan 1 m/s^2 ga kamayadi. Yerning radiusiga teng balandlikda esa erkin tushish tezlanishi 2,45 m/s^2 ga teng bo'ladi.

Jismning og'irlik kuchi:

$$\vec{P} = m\vec{g}\,; \qquad P = mg\,;$$

bu yerda: $\vec{g}$ −erkin tushish tezlanishi, g −uning moduli.

Jismning vazni (og'irligi):

$$\vec{G} = m(\vec{g} - \vec{a}); \quad G_y = m\left(g_y - a_y\right);$$

bu yerda: $\vec{a}$ −jismning tezlanishi, a_y −tezlanishning y o'qidagi proyeksiyasi. Vaznning moduli tezlanish yuqoriga yo'nalgan hol uchun

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

formuladan, tezlanish pastga yo'nalgan hol uchun esa

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

formuladan aniqlanadi.

O'ta yuklanish:

$$n = \frac{G}{P} = \frac{|\vec{g} - \vec{a}|}{g}$$

Ishqalanish kuchi (sirpanish ishqalanish kuchi va tinchlikdagi ishqalanish kuchining eng katta qiymati):

$$F_{ishq} = \mu N\ ;$$

bu yerda N −tayanch reaksiya kuchining moduli, μ −ishqalanish koeffitsiyenti.

Yer sathidan ϑ_0 tezlik bilan gorizontga α burchak ostida qiya otilgan jismning uchish vaqti, uchish uzoqligi va ko'tarilish balandligi:

$$\tau = \frac{2\vartheta_0 sin\alpha}{g}\ ; \qquad l = \frac{\vartheta_0^2 sin2\alpha}{g}\ ; \qquad h_{max} = \frac{\vartheta_0^2 sin^2\alpha}{2g}\ .$$

Birinchi kosmik tezlik:

$$\vartheta_1 = \sqrt{gR} = \sqrt{G\frac{M}{R}}$$

Sayyoraning sirtidan h balandlikda doiraviy orbita bo'ylab aylanayotgan yo'ldoshning tezligi:

$$\vartheta_h = \sqrt{G\frac{M}{R+h}} = \sqrt{g_h(R+h)} = R\sqrt{\frac{g}{R+h}} = \vartheta_1\sqrt{\frac{R}{R+h}}$$

Tormozlanish masofasi L va tormozlanish vaqti :

$$L = \frac{m\vartheta_0^2}{2F_{ishq}} = \frac{\vartheta_0^2}{2\mu g}\ ; \qquad \tau = \frac{m\vartheta_0}{F_{ishq}} = \frac{\vartheta_0}{\mu g}$$

(ϑ_0 −tormozlanishgacha bo'lgan tezlik).

Jism impulsining o'zgarishi:

$$m\vec{\vartheta} - m\vec{\vartheta}_0 = \vec{F}t$$

bu yerda: $\vec{F}t$ −jismga ta'sir qilayotgan $\vec{F}$ kuchning t vaqt davomidagi impulsi (kuch impulsi), $m\vec{\vartheta}$ −jismning impulsi (harakat miqdori).

Impulsning saqlanish qonuni:

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

bu yerda: $m_1$va m_2 −o'zaro ta'sirlashayotgan jismlarning massalari, $\vec{\vartheta}_1$ va $\vec{\vartheta}_2$ −ularning ta'sirlashishdan oldingi, $\vec{\vartheta}_1'$ va $\vec{\vartheta}_2'$ −esa ta'sirlashishdan keyingi tezliklari.

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

$$m_1\vartheta_1 + m_2\vartheta_2 + \ldots + m_n\vartheta_n = const$$

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

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

bunda ϑ_1 - birinchi jismning, ϑ_2 - ikkinchi jismning urilishdan ilgarigi tezligi.

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

$$u_1 = \frac{(m_1 - m_2)\vartheta_1 + 2m_2\vartheta_2}{m_1 + m_2}$$

va ikkinchi jismning urilishdan keyingi tezligi

$$u_2 = \frac{(m_2 - m_1)\vartheta_2 + 2m_1\vartheta_1}{m_1 + m_2}$$

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

Mexanik ish:

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

bu yerda: F −jismga ta'sir etuvchi kuchning moduli, s −to'g'ri chiziqli ko'chishning moduli, α −kuch va ko'chish orasidagi burchak.

Umumiy holda s masofani o'tishda F kuchning bajargan ishini integral ko'rinishda quyidagi formula bilan ifodalanidi:

$$A = \lim_{\Delta s \to 0} \sum_{i=1}^{\infty} F_s \, \Delta S = \int_{s_1}^{s_2} F_s \, dS$$

bunda F_s-kuchning siljishi yo'nalishidagi proyeksiyasi, ds-yo'l qismining kattaligi. Integral butun yo'l s bo'yicha olinadi. Agar kuchning miqdori hamda uning siljish yo'nalishi bilan hosil qilgan burchagi o'zgarmas bo'lsa, yuqoridagi formuladan hisoblanadi bajarilgan ish.

Quvvat: ΔA ishning shu ish bajarilgan Δt vaqtga bo'lgan nisbatiga N quvvat deyiladi:

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

Agar bu kattalik vaqt o'tishi bilan o'zgara borsa, u holda oniy quvvat quyidagiga teng bo'ladi.

$$N = \lim_{\Delta t \to 0} \frac{\Delta A}{\Delta t}$$

formula bilan ifodalanadi. Quvvat o'zgarmas bo'lsa

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

bo'ladi, bunda A - bajarilgan ish.

Xuddi shuningdek quvvat quyidagi formuladan aniqlanishi mumkin:

$$N = F \cdot \vartheta \cdot cos\alpha$$

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

bu yerda: $t - A$ ish bajarishga sarflangan vaqt, F −ish bajarayotgan kuchning moduli, ϑ −kuch qo'yilgan nuqtaning tezligi, α −kuch va tezlik orasidagi burchak.

ϑ tezlik bilan harakatlanayotgan m massali jismning kinetik energiyasi quyidagiga teng:

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

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

Potensial energiya:

$$W_p = mgh$$

- $h \ll R$ balandlikdagi m massali jismniki;
- $W_p = kx^2/2 -$ absolyut deformatsiyasi x ga, bikrligi esa k ga teng bo'lgan jismning elastik deformatsiyasi potensial energiyasi.

Jism yoki jismlar sistemasining potensial energiyasi ΔW_p ga o'zgargan vaqtda bajargan ishi:

$$A = -\Delta W_p$$

Kinetik energiya haqidagi teorema:

$$\Delta W_k = W_{k2} - W_{k1} = A$$

Mexanik jarayonlarda energiyaning saqlanish qonuni:

$$W_{k1} + W_{p1} = W_{k2} + W_{p2}$$

Tortishish kuchining potensial energiyasi

$$W_p = -G\frac{m_1 \cdot m_2}{R}$$

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

Keplerning uchinchi qonuni quyidagi ko'rinishga egadir:

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

Kuchlarni qo'shish. Jismga ta'sir qilayotgan $\vec{F}_i$ kuchlarni teng ta'sir etuvchisi (yig'indisi):

$$\vec{F} = \sum_i \vec{F}_i = F_1 + F_2 + \ldots$$

Xususan, jismga faqat ikkita kuch ta'sir qilayotgan holda

$$\vec{F} = \vec{F}_1 + \vec{F}_2 ; \quad F^2 = F_1^2 + F_1^2 - 2F_1F_2cos\alpha ;$$

bu yerda α −kuch vektorlari orasidagi burchak.

Jismlar sistemasining massalar mazrkazi koordinatalari:

$$x_0 = \frac{1}{m}\sum_{i=1}^{n} m_i x_i ; \quad y_0 = \frac{1}{m}\sum_{i=1}^{n} m_i y_i ; \quad z_0 = \frac{1}{m}\sum_{i=1}^{n} m_i z_i ;$$

bu yerda: $m_{i\,,}\ x_i,\ y_i,\ z_i - i$ −jismning massasi va massalar markazining koordinatalari,

$$m = \sum_{i=1}^{n} m_i$$

sistemaning massasi.

Kuch momenti:

$$M = F \cdot l$$

bu yerda l −kuch yelkasi (aylanish o'qidan kuchning ta'sir chizig'iga tushirilgan perpendikulyarning uzunligi). Jismni bir yo'nalishda aylantiruvchi kuchlarning momenti musbat hisoblansa, teskari yo'nalishda aylantiruvchi kuchlarning momenti manfiy hisoblanadi.

Jismning muvozanat shartlari:

$$\sum_i \vec{F}_i = F_1 + F_2 + \ldots = 0 ; \quad \text{va} \quad \sum M_i = M_1 + M_2 + \ldots = 0 ;$$

bu yerda: $\vec{F}_1,\ \vec{F}_2, \ldots$ −jismga qo'yilgan kuchlar, $M_1,\ M_2,\ \ldots$ −kuchlarning ixtiyoriy o'qqa nisbatan momentlari. Xususiy hol, richagning muvozanat sharti:

$$F_1 l_1 = F_2 l_2$$

yoki

$$\frac{F_1}{F_2} = \frac{l_2}{l_1}$$

bunda l_1 va l_2 −richagning yelkalari, F_1 va F_2 −richagga perpendikulyar yo'nalishda (bir tekislikda) qo'yilgan kuchlarning modullari.

Tebranishlar chastotasi ν va davri T:

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

ω −doiraviy (siklik) chastota.

Garmonik tebranishlar:

- nuqtaning muvozanat vaziyatidan siljishi:

$$x = x_m \sin(\omega t + \varphi_0)$$

- nuqta tezligining proyeksiyasi:

$$\vartheta_x = \frac{dx}{dt} = x_m \omega \cos(\omega t + \varphi_0)$$

- nuqta tezlanishining proyeksiyasi:

$$a_x = \frac{d\vartheta}{dt} = -x_m \omega^2 \sin(\omega t + \varphi_0)$$

bu yerda: x_m −amplituda (eng katta siljish), t − vaqt, φ_0 −boshlang'ich faza.

Matematik mayatnikning tebranish davri va chastotasi;

$$T = 2\pi\sqrt{\frac{l}{g}}\ ; \qquad \nu = \frac{1}{2\pi}\sqrt{\frac{g}{l}}\ ; \qquad \omega = \sqrt{\frac{g}{l}}\ ;$$

bu yerda: l −mayatnikning uzunligi, g −erkin tushish tezlanishi.

Prujinali mayatnikning tebranish davri va chastotasi;

$$T = 2\pi\sqrt{\frac{m}{k}}\ ; \qquad \nu = \frac{1}{2\pi}\sqrt{\frac{k}{m}}\ ; \qquad \omega = \sqrt{\frac{k}{m}}\ ;$$

bu yerda: m −prujinaga osilgan yukning massasi, k −prujinaning bikrligi (prujina massaga ega emas deb faraz qilinadi).

Ilgarilanma harakat qilib, garmonik tebranayotgan jismning to'liq mexanik energiyasi:

$$W = \frac{m}{2} x_m^2 \omega^2 = \frac{k x_m^2}{2}$$

To'lqin uzunligi λ, chastotasi ν, tebranish davri T va tarqalish tezligi ϑ orasidagi bog'lanish:

$$\lambda = \vartheta T \; ; \qquad \nu = \frac{\vartheta}{\lambda} \; ; \qquad \vartheta = \lambda \nu = \frac{\lambda}{T}$$

Moddaning zichligi ρ, massasi m va hajmi V orasidagi bog'lanish:

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

Bosim:

$$p = \frac{F}{S} \; ;$$

bu yerda $F - S$ yuzaga tik ta'sir etayotgan bosim kuchi.

Gidrostatik bosim:

$$p = \rho g h \; ;$$

bu yerda h −suyuqlik yoki gaz ustunining balandligi, ρ −uning zichligi, g −erkin tushish tezlanishi.

Gidravlik press:

$$\frac{F_1}{S_1} = \frac{F_2}{S_2} = p \quad \text{yoki} \quad \frac{F_1}{F_2} = \frac{S_1}{S_2} \; ;$$

bu yerda: S_1 va F_1 −pressning kichik porshenining yuzi va unga ta'sir qilayotgan kuch, S_2 va F_2 −pressning katta porshenining yuzi va unga ta'sir qilayotgan kuch, p −pressdagi suyuqlikning bosimi.

Arximed kuchi (suyuqlikka botirilgan jismga ta'sir qiluvchi ko'tarish kuchi):

$$F_A = \rho_s V_j g \; ;$$

bu yerda: ρ_s −suyuqlikning zichligi, V_j −siqib chiqarilgan suyuqlikning hajmi (jismning suyuqlik yoki gazga botgan qismining hajmi).

Oqimning uzluksizlik tenglamasi:

$$S_1\vartheta_1 = S_2\vartheta_2 = \ldots = Q\ ;$$

bu yerda: $\vartheta_1,\ \vartheta_2, \ldots$ −nayning kesim yuzasi $S_1,\ S_2, \ldots$ bo'lgan joylaridagi suyuqlikning oqish tezligi, Q −suyuqlik sarfi (naydan vaqt birligida oqib o'tadigan suyuqlikning hajmi).

Mexanizmning foydali ish koeffitsiyenti (FIK):

$$\eta = \frac{A_f}{A_{um}} \cdot 100\%\ ; \quad \eta = \frac{N_f}{N_{um}} \cdot 100\%\ ; \quad \eta = \frac{W_f}{W_{um}} \cdot 100\%\ ;$$

bu yerda: $A_f\ (N_f,\ W_f)$ −mexanizmning foydali ishi (quvvati, energiyasi), $A_{um}\ (N_{um},\ W_{um})$ −mexanizmning umumiy sarflagan ishi (quvvati, energiyasi).

Masala yechish namunalari

1-masala: Doimiy kuch ta'sirida harakatlana boshlagan 6 kg massali jism birinchi sekundda 15 m yo'l o'tdi. Kuchning miqdorini aniqlang.

$Berilgan$: $m = 6\ kg\ ;\ n = 1\ s\ ;\ \ s_n = 15\ m\ ;$

$Topish\ kerak$: $F = ?$

$Yechilishi$. Jismga ta'sir etayotgan kuchni Nyutonning ikkinchi qonunidan quyidagicha yozamiz;

$$F = ma$$

Jismning tezlanishini esa n −sekundda ko'chish fotmulasidan hisoblaymiz;

$$\Delta s_n = \frac{a}{2} \cdot (2n - 1)$$

Jismning tezlanishi;

$$a = \frac{2 \cdot \Delta s_n}{(2n - 1)}$$

Tezlanishning bu qiymatini Nyutonning ikkinchi qonuniga qo'yib, oxirgi ishchi formulani hosil qilamiz;

$$F = m \cdot \frac{2 \cdot \Delta s_n}{(2n - 1)}$$

$Hisoblash$:

$$F = m \cdot \frac{2 \cdot \Delta s_n}{(2n-1)} = 6\ kg \cdot \frac{2 \cdot 15\ m}{(2 \cdot 1 - 1)} = 180\ N$$

2-masala: Qiymatlari 30 N va 40 N bo‘lgan kuchlarning teng ta’sir etuvchisi 50 N bo‘lishi uchun ular o‘zaro qanday yo‘nalishda bo‘lishi kerak?.

$Berilgan$: $F_1 = 30\ N$; $F_2 = 40\ N$; $F_{nat} = 50\ N$;

$Topish\ kerak$: $\alpha = ?$

$Yechilishi$. Kuchlarning teng ta’sir etuvchisi;

$$F_{nat} = \sqrt{F_1^2 + 2F_1F_2cos\alpha + F_2^2} \qquad (1)$$

1-ifodadan α burchakni topishimiz uchun tenglikning ikkala tomonini kvadratga ko’taramiz;

$$F_{nat}^2 = F_1^2 + 2F_1F_2cos\alpha + F_2^2 \qquad (2)$$

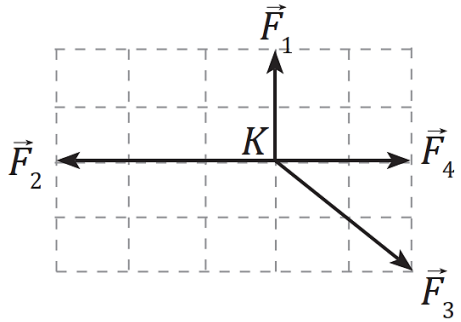
(2)-ifodadan;

$$cos\alpha = \frac{F_{nat}^2 - F_1^2 - F_2^2}{2F_1F_2} \qquad (3)$$

$Hisoblash$:

$$cos\alpha = \frac{F_{nat}^2 - F_1^2 - F_2^2}{2F_1F_2} = \frac{50^2 - 30^2 - 40^2}{2 \cdot 30 \cdot 40} = 0; \qquad \alpha = 90^0$$

3-masala: K nuqtada turgan jismga rasmda ko‘rsatilgandek kuchlar ta’sir etmoqda. Jism qaysi yo‘nalishda harakatlanadi?



$Yechilishi$. Rasmda berilgan kuchlarni $x; y$ koordinata bo’yicha proyeksiyalarga ajratamiz; $F_{1y} = 2\ N$ va F_3 kuchning y vertikal o’qdagi proyeksiyasi ham $F_{3y} = 2\ N$ ga teng. Bu kuchlarning ta’sir etuvchisi

$F_{nat} = 0$. $F_{2x} = 3\ N$; $F_{4x} = 2\ N$ va F_3 kuchning x gorizontal proyeksiyasi $F_{3x} = 2\ N$ ga teng. Unga ko'ra shu kuchlarning ta'sir etuvchisini topamiz.

Izoh: Har bir katak kattaligi 1 N dan deb hisoblandi!

Hisoblash:

$$F_{nat} = (F_{4x} + F_{3x}) - F_{2x} = (2\ N + 2\ N) - 3\ N = 1\ N;$$
$$x\ \ o'q\ bo'yicha\ \ o'ngga\ F_4\ tomonga.$$

4-masala: Massasi 3 kg bo‘lgan jism 2 rad/s burchak tezlik bilan aylanmoqda. Bunda markazdan qochma kuch 36 N ga teng bo‘lsa, aylanish radiusini toping.

$Berilgan$: $m = 3\ kg$; $\omega = 2\ rad/s$; $F_{m.q} = 36\ N$;

$Topish\ kerak$: $R =$?

$Yechilishi$. Markazdan qochma kuch;

$$F_{m.q} = \frac{mv^2}{R} \qquad (1)$$

(1)-ifodadan jismning tezligi;

$$v = \omega R \qquad (2)$$

ga teng. (2)-ifodani (1)-ifodadagi tezlik ifodasiga qo'yib;

$$F_{m.q} = \frac{m(\omega R)^2}{R} = m\omega^2 R \qquad (3)$$

(3)-ifodaga ega bo'lamiz. Aylanish radiusi;

$$R = \frac{F_{m.q}}{m\omega^2} \qquad (4)$$

$Hisoblash$:

$$R = \frac{F_{m.q}}{m\omega^2} = \frac{36\ N}{3\ kg \cdot 4\ rad^2/s^2} = 3\ m.$$

5-masala: Massasi 12 kg bo‘lgan jism radiusi 0,6 m bo‘lgan aylana bo‘ylab 2 Hz chastota bilan aylanmoqda. Jismga ta'sir etuvchi markazga intilma kuchni toping.

$Berilgan$: $m = 12\ kg$; $R = 0{,}6\ m$; $\nu = 2\ Hz$;

$Topish\ kerak$: $F_{m.i} = ?$

$Formula$: Markazga intilma kuch;

$$F_{m.i} = \frac{m\upsilon^2}{R} \qquad (1)$$

(1)-ifodadan jismning tezligi;

$$\upsilon = \omega \cdot R = 2\pi\nu R \qquad (2)$$

ga teng. (2)-ifodani (1)-ifodadagi tezlik ifodasiga qo'yib;

$$F_{m.i} = \frac{m \cdot (2\pi\nu R)^2}{R} = 4m\pi^2\nu^2 R \qquad (3)$$

$Hisoblash$:

$$F_{m.i} = 4m\pi^2\nu^2 R = 4 \cdot 12\ kg \cdot 3{,}14^2 \cdot (2\ Hz)^2 \cdot 0{,}6\ m = 1135{,}8\ N.$$

6-masala: Har biri 4 N dan bo'lgan va bir tekislikda yotgan uchta kuchning teng ta'sir etuvchisining moduli va yo'nalishini toping. Birinchi va ikkinchi hamda ikkinchi va uchinchi kuchlar orasidagi burchaklar 60^0 ga teng.

$Berilgan$: $F_1 = F_2 = F_3 = 4\ N$; $\alpha = 60^0$;

$Topish\ kerak$: $F_n = ?$

$Yechilishi$. O'zaro α burchak hosil qiluvchi kuchlarning natijaviysini;

$$F_n = \sqrt{F_1^2 + 2F_1F_2cos\alpha + F_2^2} \qquad (1)$$

(1)-ifodadan hisoblaymiz; birinchi va ikkinchi kuchlarning natijaviysi;

$$F_{1,2} = \sqrt{F_1^2 + 2F_1F_2cos\alpha + F_2^2} \qquad (2)$$

formuladan topsak, bu natijaviy kuch uchinchi kuch bilan 90^0 burchak hosil qiladi. Uni quyidagicha yozish mumkin;

$$F_n' = \sqrt{F_{1,2}^2 + F_3^2} \qquad (3)$$

$Hisoblash$:

$$F_{1,2} = \sqrt{(4N)^2 + 2 \cdot 4\ N \cdot 4\ N \cdot 0{,}5 + (4N)^2} = 4\sqrt{3}\ N.$$

$$F_n' = \sqrt{(4\sqrt{3}\ N)^2 + (4\ N)^2} = 8\ N; \quad ikkinchi\ kuch\ yo'nalishida.$$

7-masala: Ox o‘qi bo‘ylab yo‘nalgan 6 N kuch ta’sir etayotgan jismning harakat tenglamasi $x = 5 + 2t + 3t^2$ (m) ko‘rinishda bo‘lsa, jismning massasini toping.

$Berilgan$: $F = 6\ N$; $x_0 = 5$; $v_0 = 2\ m/s$; $a = 6\ m/s^2$;

$Topish\ kerak$: m =?

$Yechilishi$. Jism koordinatasining vaqtga bog’liqlik tenglamasi;

$$x = x_0 + v_0 t + \frac{at^2}{2} \qquad (1)$$

(1)-ifodadan jism tezlanishini topamiz va Nyutonning ikkinchi qonuni;

$$F = ma \qquad (2)$$

(2)-ifodadan jismning massasini hisoblaymiz.

$$m = \frac{F}{a} \qquad (3)$$

$Hisoblash$:

$$m = \frac{6\ N}{6\ \frac{m}{s^2}} = 1\ kg.$$

8-masala: Massasi Yerning massasidan 4 marta katta, radiusi esa Yer radiusiga teng bo‘lgan sayyora uchun birinchi kosmik tezlikni toping.

$Berilgan$: $M_s = 4 \cdot M_{yer}$; $R_s = R_{yer}$; $v_{yer} = 7{,}9\ km/s \approx 8\ km/s$;

$Topish\ kerak$: v_s =?

$Yechilishi$. Sayyorasi uchun birinchi kosmik tezlikni;

$$v_s = \sqrt{G\frac{M_s}{R_s}} = \sqrt{G\frac{4 \cdot M_{yer}}{R_{yer}}} \qquad (1)$$

Yer uchun esa;

$$v_{yer} = \sqrt{G\frac{M_{yer}}{R_{yer}}} \qquad (2)$$

(2)-ifodani (1)-ifodaga bog'lab quyidagiga ega bo'lamiz;

$$v_s = 2\sqrt{G\frac{M_{yer}}{R_{yer}}} = 2 \cdot v_{yer} \qquad (3)$$

$Hisoblash$:

$$v_s = 2 \cdot v_{yer} = 2 \cdot 8\ \frac{km}{s} = 16\ \frac{km}{s}.$$

9-masala: Ko'chmas blok orqali o'tkazilgan chilvirga massalari 0,3 kg va 0,2 kg bo'lgan yuklar osilgan. Yuklar qanday tezlanish olishini va chilvirning harakat vaqtidagi taranglik kuchini toping.

$Berilgan$: $m_1 = 0{,}3\ kg$; $m_2 = 0{,}2\ kg$; $g = 10\ m/s^2$

$Topish\ kerak$: $a = ?$ $T = ?$

$Yechilishi$. Yuklarning tezlanishi;

$$a = \frac{m_1 - m_2}{m_1 + m_2}\ g \qquad (1)$$

Chilvirning taranglik kuchi;

$$T = \frac{2m_1 m_2}{m_1 + m_2} g \qquad (2)$$

$Hisoblash$:

$$a = \frac{m_1 - m_2}{m_1 + m_2}\ g = \frac{0{,}3\ kg - 0{,}2\ kg}{0{,}3\ kg + 0{,}2\ kg} \cdot 10\ \frac{m}{s^2} = 2\ \frac{m}{s^2}\ .$$

$$T = \frac{2m_1 m_2}{m_1 + m_2} g = \frac{2 \cdot 0{,}3\ kg \cdot 0{,}2\ kg}{0{,}3\ kg + 0{,}2\ kg} \cdot 10\ \frac{m}{s^2} = 2{,}4\ N\ .$$

10-masala: Ko'chmas blok orqali o'tkazilgan ipning uchlariga 95 g va 105 g massali yuklar osib qo'yib yuborildi. 2 s o'tgandan keyin 105 g

massali yuk dastlabki vaziyatidan necha metr masofada bo‘ladi? g = 9,81 m/s^2.

$Berilgan$: $m_1 = 95\ g$; $m_2 = 105\ g$; $t = 2\ s$; $g = 9{,}81\ m/s^2$

$Topish\ kerak$: $h =?$

$Formula$: Yuklarning tezlanishi;

$$a = \frac{m_1 - m_2}{m_1 + m_2}\ g \qquad (1)$$

105 g massali yukning bosib o’tgan masofasi;

$$h = \frac{at^2}{2} = \frac{m_1 - m_2}{m_1 + m_2} \cdot \frac{gt^2}{2} \qquad (2)$$

$Hisoblash$:

$$h = \frac{m_1 - m_2}{m_1 + m_2} \cdot \frac{gt^2}{2} = \frac{105\ g - 95\ g}{105\ g + 95\ g} \cdot \frac{9{,}81\frac{m}{s^2} \cdot (2\ s)^2}{2} = 0{,}981\ m\ .$$

11-masala: Har birining massasi 100 g dan bo‘lgan ikki yuk qo‘zg‘almas blok orqali o‘tkazilgan ipning uchlariga osilgan. Yuklardan birining ustiga $m_0 = 50$ g qo‘shimcha yuk qo‘yilgan. Sistema harakatga kelganda qo‘shimcha yuk o‘zi turgan jismga qanday kuch bilan ta’sir qiladi?

$Berilgan$: $m_1 = m_2 = 100\ g$; $m_0 = 50\ g$; $g = 10\ m/s^2$

$Topish\ kerak$: $F =?$

$Yechilishi$. Sisitemaning tezlanishi;

$$a = \frac{(m_1 + m_0) - m_2}{(m_1 + m_0) + m_2}\ g \qquad (1)$$

Qo’shimcha yuk pastga harakatlangan, demak uning og’irligi kamayadi. Shu kamaygan og’irlik bilan yukni bosadi.

$$F = m_0 \cdot (g - a) \qquad (2)$$

$Hisoblash$:

$$a = \frac{(m_1 + m_0) - m_2}{(m_1 + m_0) + m_2}\ g = \frac{150\ g - 100\ g}{150\ g + 100\ g} \cdot 10\ \frac{m}{s^2} = 2\ \frac{m}{s^2}$$

$$F = m_0 \cdot (g - a) = 50 \cdot 10^{-3}\ kg \cdot \left(10\ \frac{m}{s^2} - 2\ \frac{m}{s^2}\right) = 0{,}4\ N.$$

12-masala: Vaznsiz blok orqali o‘tkazilgan ipning uchlariga 2 ta tosh osilgan. Bunda yengilroq tosh og‘irroq toshdan 2 m pastda turibdi. Agar toshlar og‘irlik kuchi ta’sirida harakatlansa, 2 s dan so‘ng ular bir xil balandlikda bo‘ladi. Toshlarning massalari nisbati qanday?

$Berilgan$: $h = 2\ m\ ;\ \ t = 2\ s\ ;\ \ g = 10\ m/s^2$

$Topish\ kerak$: $m_1/m_2 =?$

$Yechilishi$. Toshlarning olgan tezlanishi;

$$a = \frac{m_1 - m_2}{m_1 + m_2}\ g \qquad (1)$$

Toshlar bir xil balandlikda bo’lsa, ikkalasi ham h/2 masofani bosib o’tgan;

$$\frac{h}{2} = \frac{at^2}{2} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) \cdot \frac{gt^2}{2} \qquad (2)$$

(2)-ifodadan massalarning nisbatini;

$$\frac{m_1 - m_2}{m_1 + m_2} = \frac{h}{gt^2} \qquad (3)$$

(3)-ifodadan topamiz.

$Hisoblash$:

$$\frac{m_1 - m_2}{m_1 + m_2} = \frac{h}{gt^2} = \frac{2\ m}{10\ m/s^2 \cdot (2\ s)^2}$$

$$\frac{m_1 - m_2}{m_1 + m_2} = \frac{1}{20}$$

$$20m_1 - 20m_2 = m_1 + m_2$$

$$21m_2 = 19m_1 \qquad \frac{m_1}{m_2} = \frac{21}{19} = 1{,}105\ .$$

13-masala: Uzunligi 13 m, balandligi 5 m bo‘lgan qiya tekislikda massasi 26 kg bo‘lgan yuk turibdi. Yuk va qiya tekislik orasidagi ishqalanish

koeffitsiyenti 0,5 ga teng. Yukni yuqoriga tekis tortish uchun tekislik bo‘ylab unga qanday kuch qo‘yish kerak? Pastga tortish uchun-chi?

$Berilgan$: $l = 13\ m$; $h = 5\ m$; $m = 26\ kg$; $\mu = 0{,}5$; $g = 10\ m/s^2$

$Topish\ kerak$: $F_1 = ?$ $F_2 = ?$

$Yechilishi$. Qiya tekislikning asosi uzunligi L Pifagor teoremasidan ;

$$L = \sqrt{h^2 - l^2} \tag{1}$$

ga teng; (1)-ifodadan burchaklarni yozsak;

$$sin\alpha = \frac{h}{l}; \quad cos\alpha = \frac{L}{l} \tag{2}$$

Yukni yuqoriga tekis tortish uchun;

$$F_1 = mgsin\alpha + \mu mgcos\alpha \tag{3}$$

yoki, yana soddalashtirsak;

$$F_1 = mg \cdot (sin\alpha + \mu cos\alpha) \tag{4}$$

Pastga tortish uchun esa;

$$F_2 = \mu mgcos\alpha - mgsin\alpha \tag{5}$$

yoki;

$$F_2 = mg \cdot (\mu cos\alpha - sin\alpha) \tag{6}$$

$Hisoblash$:

$$F_1 = mg \cdot (sin\alpha + \mu cos\alpha) = 260\ N \cdot \left(\frac{5}{13} + 0{,}5 \cdot \frac{\sqrt{13^2 - 5^2}}{13}\right) = 220\ N\ .$$

$$F_2 = mg \cdot (\mu cos\alpha - sin\alpha) = 260\ N \cdot \left(0{,}5 \cdot \frac{\sqrt{13^2 - 5^2}}{13} - \frac{5}{13}\right) = 20\ N.$$

14-masala: Chana bilan undagi odamning umumiy massasi 100 kg. Shu chana balandligi 8 m va uzunligi 100 m bo‘lgan tepalikdan sirpanib tushmoqda. Agar boshlang‘ich tezlik nolga teng bo‘lib, tepalik oxirida chananing tezligi 10 m/s ga yetsa, chananing harakatiga o‘rtacha qarshilik kuchi qancha bo‘ladi?

$Berilgan$: $M = 100\ kg$; $h = 8\ m$; $l = 100\ m$; $\upsilon_0 = 0$; $\upsilon = 10\ m/s$;

$sin\alpha = \frac{h}{l} = 0{,}08$

$Topish\ kerak$: F_q =?

$Yechilishi$. Qiya tekislik bo'ylab pastga tushishda chanaga sudrovchi (qiya tekislik bo'ylab pastga yo'nalgan) va harakatga qarshilik kuchi (harakat yo'nalishiga teskari) kuchlar ta'sir etadi; kuchlar qarama-qarshi yo'nalganligi uchun shu kuchlar ayirmasi chanaga tezlanish beradi, ya'ni;

$$Ma = Mgsin\alpha - F_q \qquad (1)$$

(1)-ifodadan;

$$F_q = Mgsin\alpha - Ma \qquad (2)$$

Chana bilan odamning birgalikdagi tezlanishi;

$$a = \frac{\upsilon^2 - \upsilon_0^2}{2l} \qquad (3)$$

(2)-va (3)-ifodalardan; shartda $\upsilon_0 = 0$;

$$F_q = M\left(gsin\alpha - \frac{\upsilon^2}{2l}\right) \qquad (4)$$

$Hisoblash$:

$$F_q = M\left(g \cdot sin\alpha - \frac{\upsilon^2}{2l}\right) = 100\ kg \cdot \left(10\frac{m}{s^2} \cdot 0{,}08 - \frac{\left(10\frac{m}{s}\right)^2}{200\ m}\right) = 30\ N\ .$$

15-masala: Qiyalik burchagi 30° bo'lgan tekislikda yukni qiya tekislikka parallel bo'lgan 6 N kuch tutib turibdi. Ishqalanish koeffitsiyenti 0,4 ga teng. Yukning massasini toping.

$Berilgan$: $\alpha = 30^0$; $F = 6\ N$; $\mu = 0{,}4$; $g = 10\ m/s^2$

$Topish\ kerak$: m =?

$Yechilishi$. Qiya tekislik bo'ylab yukka pastga sudrovchi va harakat yo'nalishiga qarshi ishqalanish kuchi ta'sir etadi; bu ikki kuchning ayirmasi

tutib turuvchi kuchga teng bo'lsa, yuk qiya tekislikda muvozanatda turadi, ya'ni;

$$mgsin\alpha - \mu mgcos\alpha = F \qquad (1)$$

yoki; bundan yuk massasini topamiz;

$$m = \frac{F}{g \cdot (sin\alpha - \mu cos\alpha)} \qquad (2)$$

$Hisoblash$:

$$m = \frac{F}{g \cdot (sin\alpha - \mu cos\alpha)} = \frac{6\ N}{10\ m/s^2 \cdot (0{,}5 - 0{,}4 \cdot 0{,}87)} = 3{,}9\ kg.$$

16-masala: Qiya tekislik bo'ylab massasi 15 kg bo'lgan yukni tekis chiqarishda yukka ilingan dinamometr 40 N ni ko'rsatadi. Agar qiya tekislikning uzunligi 1,8 m, balandligi 30 cm bo'lsa, qiya tekislik FIK i ni toping.

$Berilgan$: $m = 15\ kg$; $F = 40\ N$; $l = 1{,}8\ m$; $h = 30\ cm = 0{,}3\ m$

$g = 10\ m/s^2$

$Topish\ kerak$: η =?

$Yechilishi$. Qiya tekislikning FIK i ;

$$\eta = \frac{A_f}{A_{um}} \cdot 100\% \qquad (1)$$

(1)-ifodadan;

$$\eta = \frac{mg \cdot h}{F \cdot l} \cdot 100\% \qquad (2)$$

$Hisoblash$:

$$\eta = \frac{mg \cdot h}{F \cdot l} \cdot 100\% = \frac{150\ N \cdot 0{,}3\ m}{40\ N \cdot 1{,}8\ m} \cdot 100\ \% = 62{,}5\ \%\ .$$

17-masala: Gorizontal tekislikda 5 kg massali jism yotibdi. Gorizontga nisbatan 60^0 burchak ostida yuqoriga yo'nalgan 50 N kuch ta'sirida jism 1 s vaqtda qancha yo'lni bosib o'tadi? Jism bilan tekislik orasidagi ishqalanish koeffitsiyenti 0,2 ga teng.

$Berilgan$: $m = 5\ kg$; $\alpha = 60^0$; $F = 50\ N$; $t = 1\ s$; $\mu = 0{,}2$;

$g = 10\ m/s^2$

$Topish\ kerak$: $s =$?

$Formula$: Izoh! Jismga kuch gorizontga α burchak ostida ta'sir etganda bu kuchning ikkita ta'sir etuvchisi, x o'qi bo'ylab gorizontal $F_x = Fcos\alpha$ va y o'qi bo'ylab vertikal yuqoriga tik yo'nalgan $F_y = Fsin\alpha$ kuchlar ta'sir etadi. $\cos 60^0 = 0{,}5$ $\sin 60^0 = 0{,}87$. Harakatga qarshi ishqalanish kuchi;

$$F_{ishq} = \mu \cdot N \tag{1}$$

(1)-ifodadan reaksiya kuchi, pastga ta'sir etuvchi og'irlik kuchi va vertikal yuqoriga tik yo'nalgan $F_y = Fsin\alpha$ kuchlarning ayirmasiga teng;

$$N = mg - Fsin\alpha \tag{2}$$

Jismga ta'sir etuvchi natijaviy kuch esa;

$$ma = Fcos\alpha - \mu \cdot N \tag{3}$$

yoki;

$$ma = Fcos\alpha - \mu \cdot (mg - Fsin\alpha) \tag{4}$$

bu ifodadan;

$$a = \frac{Fcos\alpha - \mu \cdot (mg - Fsin\alpha)}{m} \tag{5}$$

Jismning o'tgan masofasi;

$$s = \frac{at^2}{2} \tag{6}$$

(5)-ifodadan jism tezlanishini topib, (6)-ifodadan masofasini topamiz.

$Hisoblash$:

$$a = \frac{50\ N \cdot 0{,}5 - 0{,}2 \cdot (50\ N - 50 \cdot 0{,}87)}{5\ kg} = 4{,}74\ \frac{m}{s^2}$$

$$s = \frac{at^2}{2} = \frac{4{,}74\ \frac{m}{s^2} \cdot (1\ s)^2}{2} = 2{,}37\ m\ .$$

18-masala: Qiyalik burchagi 10^0 bo‘lgan qiya tekislikda jismga 10 m/s boshlang‘ich tezlik berildi. Agar jism va tekislik sirtlari orasidagi ishqalanish koeffitsiyenti 0,5 ga teng bo‘lsa, jismning to‘xtaguncha bosib o‘tgan yo‘lini va harakatlanish vaqtini toping: $\sin 10^0 \approx 0{,}17$; $\cos 10^0 \approx 0{,}98$.

$Berilgan$: $\alpha = 10^0$; $\upsilon_0 = 10\ m/s$; $\mu = 0{,}5$; $\upsilon = 0$; $g = 10\ m/s^2$

$Topish\ kerak$: $s = ?$ $t = ?$

$Yechilishi$. Jismga ta’sir etuvchi natijaviy kuch sudrovchi kuch va ishqalanish kuchlari yig’indisiga teng, ya’ni;

$$ma = mg\sin\alpha + \mu mg\cos\alpha \qquad (1)$$

(1)-ifodadan jismning tezlanishi;

$$a = g(\sin\alpha + \mu \cdot \cos\alpha) \qquad (2)$$

Jism o’tgan masofasi;

$$s = \frac{\upsilon^2 - \upsilon_0^2}{-2a} \qquad (3)$$

Masala shartidan;

$$s = \frac{\upsilon_0^2}{2a} \qquad (4)$$

(4)-ifodaga (2)-ifodani qo’yib;

$$s = \frac{\upsilon_0^2}{2g(\sin\alpha + \mu \cdot \cos\alpha)} \qquad (5)$$

Harakat vaqti esa;

$$t = \frac{\upsilon_0}{g(\sin\alpha + \mu \cdot \cos\alpha)} \qquad (6)$$

$Hisoblash$:

$$s = \frac{\upsilon_0^2}{2g(\sin\alpha + \mu \cdot \cos\alpha)} = \frac{\left(10\ \frac{m}{s}\right)^2}{2 \cdot 10\ \frac{m}{s^2} \cdot (0{,}17 + 0{,}5 \cdot 0{,}98)} = 7{,}6\ m;$$

$$t = \frac{v_0}{g(sin\alpha + \mu \cdot cos\alpha)} = \frac{10\ \frac{m}{s}}{10\ \frac{m}{s^2} \cdot (0{,}17 + 0{,}5 \cdot 0{,}98)} = 1{,}5\ s\ .$$

19-masala: Qiyalik burchagi 20^0, ishqalanish koeffitsiyenti esa 0,2 ga teng bo‘lsa, qiya tekislikda 5 t massali tirkama (pritsep)ni qiyalik bo‘ylab yuqoriga 1 m/s tezlik bilan tortib chiqishi uchun traktorning quvvati qanday bo‘lishi kerak? $\sin 20^0 \approx 0{,}34;\ \cos 20^0 \approx 0{,}9$.

$Berilgan$: $\alpha = 20^0;\ \ \mu = 0{,}2\ ;\ \ m = 5\ t = 5 \cdot 10^3\ kg\ ;\ \ v = 1\ m/s\ ;$

$g = 10\ \ m/s^2$

$Topish\ kerak$: $N =?$

$Formula$: Traktorning quvvati;

$$N = \frac{A}{t} = \frac{F_t \cdot s}{t} = F_t \cdot v \qquad (1)$$

Traktorning tortish kuchi;

$$F_t = mg \cdot (sin\alpha + \mu cos\alpha) \qquad (2)$$

(2)-ifodani (1)-ifodaga qo’yib traktorning quvvatini topamiz;

$$N = mg \cdot (sin\alpha + \mu cos\alpha) \cdot v \qquad (3)$$

$Hisoblash$:

$$N = 5 \cdot 10^4\ N \cdot (0{,}34 + 0{,}2 \cdot 0{,}9) \cdot 1\ \frac{m}{s} = 2{,}6 \cdot 10^4\ \text{W} = 26\ \text{kW}\ .$$

20-masala: Uzunligi 4 m, balandligi 0,8 m bo‘lgan qiya tekislikdan 2205 N og‘irlikdagi yuk chiqarilgan. Ishqalanish kuchi 220,5 N bo‘lsa, qiya tekislikning foydali ish koeffitsiyenti necha foiz bo‘ladi?

$Berilgan$: $l = 4\ m\ ;\ h = 0{,}8\ m\ ;\ P = 2205\ N\ ;\ \ F_{ishq} = 220{,}5\ N$

$Topish\ kerak$: $\eta =?$

$$sin\alpha = \frac{h}{l} = 0{,}2$$

$Yechilishi$. Qiya tekislikning FIK;

$$\eta = \frac{P \cdot h}{F \cdot l} \cdot 100\% \qquad (1)$$

(1)-ifodadan;

$$F = F_{ishq} + Psin\alpha \qquad (2)$$

(2)-ifodaga qo'yib;

$$\eta = \frac{Psin\alpha}{\left(F_{ishq} + Psin\alpha\right)} \cdot 100\% \qquad (3)$$

$Hisoblash$:

$$\eta = \frac{P \cdot sin\alpha}{\left(F_{ishq} + P \cdot sin\alpha\right)} \cdot 100\% = \frac{2205 \cdot 0{,}2}{(220{,}5\ N + 2205 \cdot 0{,}2)} \cdot 100\% \approx 67\%$$

21-masala: Uzunligi 1 m, balandligi 0,6 m bo'lgan qiya tekislikning FIK ini toping. Unda harakatlantirishdagi sirpanish ishqalanish koeffitsiyenti 0,1 ga teng.

$Berilgan$: $l = 1\ m$; $h = 0{,}6\ m$; $\mu = 0{,}1$;

$Topish\ kerak$: η =?

$sin\alpha = \frac{h}{l} = 0{,}6 \quad cos\alpha = \sqrt{1 - sin^2\alpha} = 0{,}8$

$Yechilishi$. Qiya tekislikning FIK ;

$$\eta = \frac{1}{1 + \mu ctg\alpha} \cdot 100\% \qquad (1)$$

(1)-ifodadan;

$$ctg\alpha = \frac{cos\alpha}{sin\alpha} \qquad (2)$$

(2)-ifodaga sinus va kosinuslarning ifodasini qo'yib hisoblaymiz.

$Hisoblash$:

$$\eta = \frac{1}{1 + \mu \cdot ctg\alpha} \cdot 100\ \% = \frac{1}{1 + 0{,}1 \cdot \frac{0{,}8}{0{,}6}} \cdot 100\ \% = 88{,}2\ \%\ .$$

22-masala: Agar elektropoyezdning massasi $1{,}2 \cdot 10^5$ kg, ishqalanish koeffitsiyenti 0,05 ga teng bo‘lsa, $\alpha = 10^0$ bo‘lgan qiyalik bo‘ylab yuqoriga 1,5 m/s^2 tezlanish bilan 100 m masofaga ko‘tarilganda elektropoyezdning dvigatellari qancha ish bajaradi? $\sin 10^0 \approx 0{,}17;\ \cos 10^0 \approx 0{,}98$.

$Berilgan$: $m = 1{,}2 \cdot 10^5\ kg$; $\mu = 0{,}05$; $\alpha = 10^0$; $a = 1{,}5\ m/s^2$;

$s = 100\ m$;

$Topish\ kerak$: $A = ?$

$Yechilishi$. Elektropoyezd dvigatellari bajatgan ishi;

$$A = F \cdot s \qquad (1)$$

(1)-ifodadan;

$$F = F_{ishq} + F_s + ma \qquad (2)$$

(2)-ifodani (1)-ifodaga qo’yib;

$$A = \left(F_{ishq} + F_s + ma\right) \cdot s \qquad (3)$$

(3)-ifodaga ega bo’lamiz; ishqalanish kuchi va sudrovchi kuch ifodalarini (3)-ifodaga qo’yamiz;

$$A = (\mu mg cos\alpha + mg sin\alpha + ma) \cdot s \qquad (4)$$

(4)-ifodadan massani qavsdan chiqarib;

$$A = (\mu g cos\alpha + g sin\alpha + a) \cdot m \cdot s \qquad (5)$$

(5)-ifodaga ega bo’lamiz.

$Hisoblash$:

$$A = \left(0{,}05 \cdot 10\frac{m}{s^2} \cdot 0{,}98 + 10\frac{m}{s^2} \cdot 0{,}34 + 1{,}5\frac{m}{s^2}\right) \cdot 12 \cdot 10^5 \cdot 10^2 m;$$

$$A = 442{,}8 \cdot 10^5\ \text{J}.$$

23-masala: Qiyalik burchagi 30^0, ishqalanish koeffitsiyenti 0,3 ga teng bo‘lgan qiya tekislikda massasi 400 kg bo‘lgan yukni 2 m balandlikka chiqarish uchun qancha ish bajarish kerak? Qiya tekislikning FIK i nimaga teng?

$Berilgan$: $\alpha = 30^0$; $\mu = 0{,}3$; $m = 400\ kg$; $h = 2\ m$; $g = 10\ m/s^2$

$Topish\ kerak$: $A_{um} = ?\quad \eta = ?$

$sin\alpha = \frac{h}{l}\quad h = l \cdot sin\alpha$

$Yechilishi$. Qiya tekislikning FIK;

$$\eta = \frac{A_f}{A_{um}} \cdot 100\% = \frac{P \cdot h}{F \cdot l} \cdot 100\% \qquad (1)$$

(1)-ifodadan;

$$\eta = \frac{mg \cdot h}{mg(sin\alpha + \mu cos\alpha) \cdot l} \cdot 100\% \qquad (2)$$

yoki;

$$\eta = \frac{1}{1 + \mu \cdot ctg\alpha} \cdot 100\% \qquad (3)$$

Umumiy ish esa;

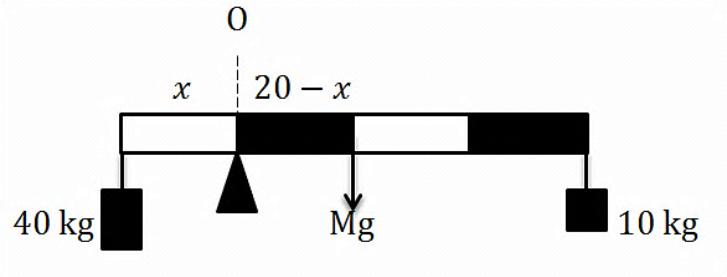
$$A_{um} = \frac{A_f}{\eta} \cdot 100\% = \frac{mgh}{\eta} \cdot 100\% \qquad (4)$$

$Hisoblash$:

$$\eta = \frac{1}{1 + \mu \cdot ctg\alpha} \cdot 100\ \% = \frac{1}{1 + 0{,}3 \cdot 1{,}73} \cdot 100\ \% = 65{,}8\ \%\ .$$

$$A_{um} = \frac{mgh}{\eta} \cdot 100\% = \frac{400 \cdot 10\frac{m}{s^2} \cdot 2\ m}{65{,}8\ \%} \cdot 100\ \% = 12158\ \text{J}\ .$$

24-masala: Massasi 10 kg va uzunligi 40 cm bo‘lgan sterjenning uchlariga massalari 40 kg va 10 kg bo‘lgan yuklar osilgan. Sterjen muvozanatda turishi uchun tayanchni birinchi uchidan qancha masofaga qo‘yish kerak?



Yechilishi. Kuch momenti;

$$M = F \cdot l \tag{1}$$

Momentlar qoidasi;

$$F_1 \cdot l_1 = F_2 \cdot l_2 \tag{2}$$

Aylanish o'qidan chap va o'ng tomon kuch momentlarini tenglashtiramiz;

$$m_1 \cdot l_1 = m_2 \cdot l_2 + M \cdot l_3 \tag{3}$$

yoki;

$$m_1 \cdot x = m_2 \cdot (40 - x) + M \cdot (20\ - x) \tag{4}$$

(4)-ifodadan x ni topamiz;

Hisoblash:

$$40 \cdot x = 10 \cdot (40 - x) + 10 \cdot (20\ - x)$$

$$4 \cdot x = (40 - x) + (20\ - x)$$

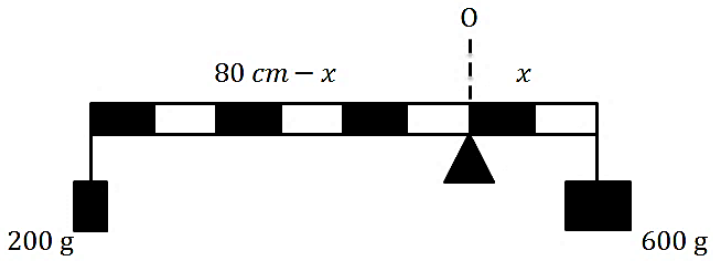
$$6x = 60\ cm \qquad x = 10\ cm;\quad 40\ cm - 10\ cm = 30\ cm$$

Birinchi yukdan 10 cm va ikkinchi yukdan 30 cm masofada sterjen muvozanatda turadi.

25-masala: Uzunligi 80 cm bo'lgan vaznsiz richagining chetlariga 200 g va 600 g massali yuklar osildi. Richag muvozanatda bo'lishi uchun katta yukdan qancha masofada tayanch qo'yish kerak?

Berilgan: $L = 80\ cm$; $m_1 = 200\ g$; $l_1 = L - x$; $m_2 = 600\ g$; $l_2 = x$

Topish kerak: $x = ?$



$Yechilishi$. Momentlar qoidasi;

$$F_1 \cdot l_1 = F_2 \cdot l_2 \quad (1)$$

Aylanish o'qidan chap va o'ng tomon kuch momentlarini tenglashtiramiz;

$$m_1 \cdot l_1 = m_2 \cdot l_2 \quad (2)$$

yoki;

$$m_1 \cdot (L - x) = m_2 \cdot x \quad (3)$$

(3)-ifodadan x ni topamiz;

$$m_1 \cdot L - m_1 x = m_2 \cdot x \quad (4)$$

yoki;

$$x = \frac{m_1}{m_1 + m_2} \cdot L \quad (5)$$

$Hisoblash$:

$$x = \frac{m_1}{m_1 + m_2} \cdot L = \frac{200\ g}{800\ g} \cdot 80\ cm = 20\ cm;$$

Javob: $katta\ yukdan\ 20\ cm\ masofada.$

26-masala: Vodoprovod quvurining tirqishidan suv tik yuqoriga 1,25 m balandlikkacha otilayotgan bo'lsa, suvning quvur tirqishidan otilib chiqish tezligini toping.

$Berilgan$: $h = 1{,}25\ m$; $g = 10\ m/s^2$

$Topish\ kerak$: $\upsilon = ?$

$Yechilishi$. Quvurda hosil bo'ladigan dinamik bosim;

$$P = \frac{\rho v^2}{2} \quad (1)$$

Suv ustunining gidrostatik bosimi;

$$P = \rho g h \tag{2}$$

(1)-va (2)-ifodalarni tenglaymiz;

$$\frac{\rho v^2}{2} = \rho g h \tag{3}$$

(3)-ifodadan Torrichelli formulasi;

$$\upsilon = \sqrt{2gh} \tag{4}$$

$Hisoblash$:

$$\upsilon = \sqrt{2gh} = \sqrt{2 \cdot 10\ \frac{m}{s^2} \cdot 1{,}25\ m} = 5\ \frac{m}{s}.$$

27-masala: Kesimi o‘zgaruvchan, gorizontal joylashgan quvurdan suv oqadi. Quvurning diametri keng qismida suvning tezligi 20 cm/s bo‘lsa, diametri undan 1,5 marta kichik bo‘lgan tor qismida suvning tezligini aniqlang.
$Berilgan$: $v_2 = 20\ cm/s$; $d_1 = d_2\ /1{,}5$;

$Topish\ kerak$: $v_1 = ?$

$Yechilishi$. Oqim uzluksizlik tenglamasi;

$$S_1 v_1 = S_2 v_2 \tag{1}$$

yoki;

$$d_1^2 \cdot v_1 = d_2^2 \cdot v_2 \tag{2}$$

(2)-ifodadan;

$$v_1 = \frac{d_2^2}{d_1^2} \cdot v_2 \tag{3}$$

$Hisoblash$:

$$v_1 = \frac{d_2^2}{d_1^2} \cdot v_2 = \frac{1{,}5^2 \cdot d_1^2}{d_1^2} \cdot 20\ \frac{cm}{s} = 45\ \frac{cm}{s} = 0{,}45\ \frac{m}{s}.$$

28-masala: Gorizontal joylashgan quvurning keng qismida neftning oqish tezligi 2 m/s. Agar quvurning keng va tor qismlaridagi statik bosimlar farqi 6,65 kPa bo‘lsa, quvurning tor qismida neftning tezligini aniqlang.

$Berilgan$: $v_1 = 2\frac{m}{s}$; $\Delta P = 6{,}65\ kPa = 6{,}65 \cdot 10^3\ Pa$;

$\rho = 800\ kg/m^3$

$Topish\ kerak$: $v_2 = ?$

$Yechilishi$. Quvurdagi bosimlar farqi;

$$\Delta P = \frac{\rho}{2}(v_2^2 - v_1^2) \quad (1)$$

(1)-ifodadan;

$$v_2 = \sqrt{\frac{2\Delta P}{\rho} + v_1^2} \quad (2)$$

$Hisoblash$:

$$v_2 = \sqrt{\frac{2\Delta P}{\rho} + v_1^2} = \sqrt{\frac{2 \cdot 6{,}65 \cdot 10^3\ Pa}{800\ kg/m^3} + 4\ \frac{m^2}{s^2}} = 4{,}5\frac{m}{s}.$$

29-masala: Suv quvuri teshilib, tepaga suv otilib chiqa boshladi. Agar tirqish yuzasi 4 mm², suvning otilib chiqish balandligi 80 cm bo‘lsa, bir sutkada qancha (kg) suv isrof bo‘ladi?

$Berilgan$: $S = 4\ mm^2 = 4 \cdot 10^{-6}\ m^2$; $h = 80\ cm = 0{,}8\ m$;

$t = 1\ sutka = 86400\ s$; $\rho = 10^3\ kg/m^3$; $g = 10\ m/s^2$

$Topish\ kerak$: $m = ?$

$Yechilishi$. Suv hajmi;

$$V = S \cdot l = S \cdot vt \quad (1)$$

Ikkinchi tomondan;

$$m = \rho V \quad (2)$$

va Torrichelli formulasiga ko’ra;

$$v = \sqrt{2gh} \quad (3)$$

Suvning massasi;

$$m = \rho S\sqrt{2gh} \cdot t \quad (4)$$

$Hisoblash$:

$$m = 10^3 \frac{kg}{m^3} \cdot 4 \cdot 10^{-6}\ m^2 \cdot \sqrt{16}\ \cdot 86400s = 1382{,}4\ kg\ .$$

30-masala: Neft quduqdan diametri 60 mm bo‘lgan quvur orqali ko‘tariladi. Har soatda 9,12 t neft ko‘tarilayotgan bo‘lsa, neftning oqish tezligini toping. Neftning zichligi 800 kg/m^3.

$Berilgan$: $d = 60\ mm = 6 \cdot 10^{-2}\ m$; $t = 1\ soat = 3600\ s$;

$m = 9{,}12\ t = 9120\ kg$; $\rho = 0{,}8\ g/cm^3 = 800\ kg/m^3$; $\pi = 3{,}14$.

$Topish\ kerak$: $v =$?

$Yechilishi$. Neftning oquvchanligi;

$$\frac{V}{t} = s \cdot v \qquad (1)$$

Neft hajmi;

$$V = \frac{m}{\rho} \qquad (2)$$

Quvur yuzasi;

$$s = \frac{\pi d^2}{4} \qquad (3)$$

Yuqoridagi ifodalardan neftning oqish tezligi;

$$v = \frac{4m}{\rho \pi d^2 t} \qquad (4)$$

$Hisoblash$:

$$v = \frac{4m}{\rho \pi d^2 t} = \frac{4 \cdot 9120\ kg}{800\ \frac{kg}{m^3} \cdot 3{,}14 \cdot (6 \cdot 10^{-2}\ m\ )^2 \cdot 3600\ s} = 1{,}12\ \frac{m}{s}\ .$$

31-masala: Bikrligi 250 N/m bo‘lgan prujinaga osilgan jism 16 s ichida 20 marta tebrandi. Jismning massasini (kg) toping.

$Berilgan$: $k = 250\ N/m$; $t = 16\ s$; $N = 20$; $\pi = 3{,}14$

$Topish\ kerak$: $m =$?

Yechilishi. Prujinali mayatnikning tebranish davri;

$$T = 2\pi\sqrt{\frac{m}{k}} \qquad (1)$$

yoki;

$$T = \frac{t}{N} \qquad (2)$$

(1)-va (2)-ifodalarni tenglashtirib, yuk massasini topamiz;

$$\frac{t}{N} = 2\pi\sqrt{\frac{m}{k}} \qquad (3)$$

(3)-ifoda ikkala tomonini kvadratga oshiramiz;

$$\frac{t^2}{N^2} = \frac{4\pi^2 m}{k} \qquad (4)$$

(4)-ifodadan yuk massasi;

$$m = \frac{kt^2}{4\pi^2 N^2} \qquad (5)$$

Hisoblash:

$$m = \frac{kt^2}{4\pi^2 N^2} = \frac{250\ \frac{N}{m} \cdot (16\ s)^2}{4 \cdot (3{,}14)^2 \cdot 20^2} = 4\ kg.$$

32-masala: Ikkita matematik mayatnikka osilgan yuklar bir xil vaqt ichida biri 10 marta, ikkinchisi esa 30 marta tebrandi. Mayatniklar iplarining uzunliklari qanday nisbatda bo‘ladi?
Berilgan: $\mathrm{t}_1 = t_2$; $\mathrm{N}_1 = 10$; $\mathrm{N}_2 = 30$;

Topish kerak: $l_2/l_1 = ?$

Yechilishi. Matematik mayatnikning tebranish davri;

$$T = 2\pi\sqrt{\frac{l}{g}} \qquad (1)$$

yoki;

$$T = \frac{t}{N} \qquad (2)$$

(1)-va (2)-ifodalarni tenglashtirib, yuk massasini topamiz;

$$\frac{t}{N} = 2\pi\sqrt{\frac{l}{g}} \qquad (3)$$

(3)-ifoda ikkala tomonini kvadratga oshiramiz;

$$\frac{t^2}{N^2} = \frac{4\pi^2 l}{g} \qquad (4)$$

(4)-ifodadan yuk massasi;

$$l = \frac{gt^2}{4\pi^2 N^2} \qquad (5)$$

O'zgarmas kattaliklarni qisqartirib, uzunliklar nisbatini yozamiz;

$$\frac{l_2}{l_1} = \frac{N_1^2}{N_2^2} \qquad (6)$$

$Hisoblash$:

$$\frac{l_2}{l_1} = \frac{N_1^2}{N_2^2} = \frac{10^2}{30^2} = \frac{1}{9} \quad \Rightarrow \quad l_2 = 9l_1$$

33-masala: Tebranish davri 2 s ga teng bo'lganda mayatnik ipining uzunligi qanday bo'ladi?

$Berilgan$: $T = 2\ s$; $\mathrm{g} = 10\ m/s^2$; $\pi = 3{,}14$

$Topish\ kerak$: $l = ?$

$Yechilishi$. Matematik mayatnikning tebranish davri;

$$T = 2\pi\sqrt{\frac{l}{g}} \qquad (1)$$

(1)-ifodadan ikkala tomonini kvadratga oshirib, uning uzunligini topamiz;

$$T^2 = \frac{4\pi^2 l}{g} \qquad (2)$$

(2)-ifodadan;

$$l = \frac{g \cdot T^2}{4\pi^2} \qquad (3)$$

$Hisoblash$:

$$l = \frac{g \cdot T^2}{4\pi^2} = \frac{10\,\frac{m}{s^2} \cdot (2\ s)^2}{4 \cdot 3{,}14^2} = 1\ m.$$

34-masala: Jism x o‘qi bo‘ylab $x = 0{,}06 \sin 3\pi t$ (m) qonunga muvofiq tebranmoqda. Jismning tebranish amplitudasini, davrini va chastotasini toping.

$Berilgan$: $x = 0{,}06 \sin 3\pi t$ (m) ; $x = A \sin \omega t$ (m)

$Topish\ kerak$: $A = ?$ $T = ?$ $\nu = ?$

$Yechilishi$. Tebranish davri;

$$T = \frac{2\pi}{\omega} \qquad (1)$$

Tebranishlar chastotasi;

$$\nu = \frac{\omega}{2\pi} \qquad (2)$$

$Hisoblash$:

$$A = 0{,}06.$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{3\pi} = \frac{2}{3} = 0{,}67\ s\,. \qquad \nu = \frac{\omega}{2\pi} = \frac{3\pi}{2\pi} = 1{,}5\ \text{Hz}\,.$$

35-masala: Bikrligi 160 N/m bo‘lgan prujinaga osilgan 400 g massali yukning tebranish chastotasini toping.

$Berilgan$: $k = 160\ N/m$; $m = 400\ g = 0{,}4\ kg$; $\pi = 3{,}14$

$Topish\ kerak$: $\nu = ?$

$Formula$: Prujinali mayatnik tebranish davri;

$$T = 2\pi\sqrt{\frac{m}{k}} \qquad (1)$$

Tebranishlar chastotasi esa;

$$\nu = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \qquad (2)$$

$Hisoblash$:

$$\nu = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2 \cdot 3{,}14}\sqrt{\frac{160\ N/m}{0{,}4\ kg}} = \frac{20}{6{,}28}\ \text{Hz} = 3{,}2\ \text{Hz}\,.$$

36-masala: Qanday balandlikda erkin tushish tezlanishi Yer sirtidagi tezlanishning 25 foizini tashkil etadi?

$Berilgan$: $g_h = 0{,}25 \cdot g_{yer}$

$Topish\ kerak$: $h = ?$

$Yechilishi$. Yer sirtidan biror balandlikda erkin tushish tezlanishi yerdagi erkin tushish tezlanishi bilan quyidagicha bog'langan;

$$g_h = g_{yer}\left(\frac{R}{R+h}\right)^2 \qquad (1)$$

$Hisoblash$:

$$0{,}25 \cdot g_{yer} = g_{yer}\left(\frac{R}{R+h}\right)^2$$

$$\frac{1}{4} = \left(\frac{R}{R+h}\right)^2 \ yoki\ \ \frac{1}{2} = \frac{R}{R+h} \ \Rightarrow \ \ 2R = R + h \ \ \Rightarrow \ h = R.$$

37-masala: Tezkor lift yerga nisbatan 5 m/s² tezlanish bilan tushmoqda. Vaqtning bir momentida liftning shiftidan bolt tushishni boshladi. Lift balandligi 2,5 m. Boltning tushish vaqtini aniqlang.
$Berilgan$: $a = 5\ m/s^2$; $h = 2{,}5\ m$; $g = 10\ m/s^2$

$Topish\ kerak$: $t = ?$

$Yechilishi$. Boltning tushish vaqti;

$$t = \sqrt{\frac{2h}{g'}} \qquad (1)$$

Lift pastga tezlanuvchan harakat qilganligi uchun, bolt yerga nisbatan g va liftga nisbatan $g' = g - a$ tezlanish bilan liftning poliga tushadi; shunday ekan;

$$t = \sqrt{\frac{2h}{g-a}} \qquad (2)$$

$$Hisoblash:$$

$$t = \sqrt{\frac{2h}{g-a}} = \sqrt{\frac{2 \cdot 2{,}5\ m}{10\ \frac{m}{s^2} - 5\ \frac{m}{s^2}}} = 1\ s.$$

38-masala: Yuqoriga ko‘tarilayotgan samolyot 5 km balandlikda 360 km/h tezlikka erishadi. Samolyotning tezligini oshirishga sarf bo‘lgan ishdan ko‘tarilishda og‘irlik kuchiga qarshi bajarilgan ish necha marta katta?

$Berilgan$: $h = 5\ km = 5 \cdot 10^3\ m$; $v_0 = 0$; $v = 360\ km/h = 10^2\ m/s$; $g = 10\ m/s^2$

$Topish\ kerak$: A_2/A_1 =?

$Yechilishi$. Samolyot tezligini oshirishda bajarilgan ish, kinetik energiyaning o’zgarishiga teng;

$$A_1 = \Delta E_k = \frac{mv^2}{2} - \frac{mv_0^2}{2} \qquad (1)$$

Samolyot ko’tarilishida og’irlik kuchiga qarshi bajarilgan ish esa, potensial energiya o’zgarishiga teng;

$$A_2 = \Delta E_p = mgh \qquad (2)$$

Shartga ko’ra;

$$\frac{A_2}{A_1} = \frac{mgh}{\frac{mv^2}{2} - \frac{mv_0^2}{2}} = \frac{mgh}{\frac{mv^2}{2}} \qquad (3)$$

yoki;

$$\frac{A_2}{A_1} = \frac{2gh}{v^2} \qquad (4)$$

Hisoblash:

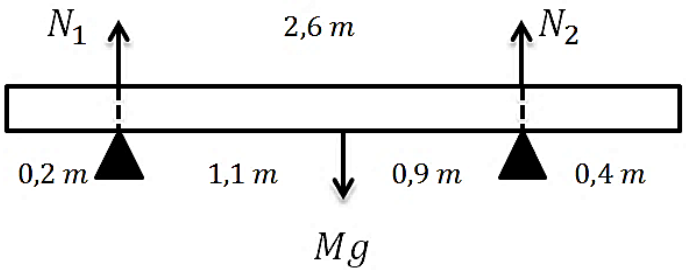
$$\frac{A_2}{A_1} = \frac{2gh}{v^2} = \frac{2 \cdot 10\ \frac{m}{s^2} \cdot 5 \cdot 10^3\ m}{\left(10^2\ \frac{m}{s}\right)^2} = 10.$$

39-masala: Uzunligi 2,6 m va massasi 80 kg bo‘lgan bir jinsli xoda ikki tayanchda yotibdi. Xodaning chap uchidan chap tayanchgacha bo‘lgan masofa 0,2 m, xodaning o‘ng uchidan o‘ng tayanchgacha bo‘lgan masofa esa 0,4 m. Xodaning chap tayanchga bosim kuchi qanday (N)?

Berilgan: $L = 2{,}6\ m$; $M = 80\ kg$; $l_1 = 0{,}2\ m$; $l_2 = 0{,}4\ m$;

$g = 10\ m/s^2$

Topish kerak: N_1 =?



Yechilishi. Momentlar qoidasiga ko’ra;

$$M_1 = M_2 \qquad (1)$$

Xodaning og’irligi ikkita tayanchga tushadi, ya’ni;

$$N_1 + N_2 = Mg \qquad (2)$$

Chizmadan ko’rinib turibdiki ikkinchi tomondan;

$$N_1 \cdot \left(\frac{L}{2} - l_1\right) = N_2 \cdot \left(\frac{L}{2} - l_2\right) \qquad (3)$$

Hisoblash:

$$\begin{cases} N_1 \cdot \left(\frac{2{,}6\ m}{2} - 0{,}2\ m\right) = N_2 \cdot \left(\frac{2{,}6\ m}{2} - 0{,}4\ m\right) \\ N_1 + N_2 = 80\ kg \cdot 10\frac{m}{s^2} = 800\ N \end{cases}$$

$$\begin{cases} 1{,}1N_1 = 0{,}9N_2 \\ N_1 + N_2 = 800\ N \end{cases} \Rightarrow \begin{cases} N_2 = \frac{11}{9}N_1 \end{cases}$$

$$N_1 + \frac{11}{9}N_1 = 800\ N \quad \Rightarrow \quad \frac{20}{9}N_1 = 800\ N \quad \Rightarrow \quad N_1 = 360\ N.$$

40-masala: Baliqchi po‘kak 10 s ichida to‘lqinda 20 marta tebranganini payqadi. To‘lqinning qo‘shni do‘ngliklari orasidagi masofa 1,2 m. To‘lqinlarning tarqalish tezligi qanday?

$Berilgan$: $\mathrm{t} = 10\ s$; $N = 20$; $\lambda = 1{,}2\ m$;

$Topish\ kerak$: $\upsilon = ?$

$Yechilishi$. To’lqin uzunligi;

$$\lambda = \upsilon \cdot T \tag{1}$$

(1)-ifodadan tebranishlar davri;

$$T = \frac{t}{N} \tag{2}$$

(1)-va (2)-ifodalarni birga yechib;

$$\lambda = \upsilon \cdot \frac{t}{N} \tag{3}$$

(3)-ifodaga ko’ra to’lqinning tarqalish tezligini topamiz;

$$\upsilon = \frac{\lambda \cdot N}{t} \tag{4}$$

$Hisoblash$:

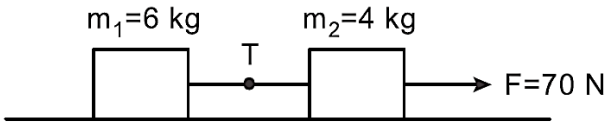
$$\upsilon = \frac{\lambda \cdot N}{t} = \frac{1{,}2\ m \cdot 20}{10\ s} = 2{,}4\ \frac{m}{s}.$$

41-masala: Ishqalanishsiz sirtda 70 N kuch ta’sirida harakatlanayotgan yuklar orasidagi ipdagi taranglik kuchi topilsin (N).

$Berilgan$: $m_1 = 6\ kg$; $m_2 = 4\ kg$; $F = 70\ N$;

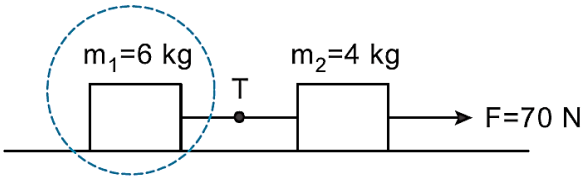
$Topish\ kerak$: $T = ?$

$Yechilishi$. Dastavval 70 N kuch ta’sirida gorizontal sirtda ishqalanishsiz harakatlanayotgan yuklar sistemasining tezlanishini hisoblab olamiz;



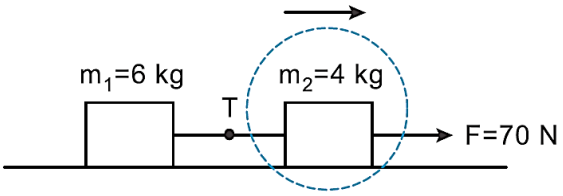
$$a = \frac{F}{m_1 + m_2} = \frac{70\ N}{6\ kg + 4\ kg} = 7\frac{N}{kg}$$

1-usul: Birinchi yukka ta'sir etuvchi natijaviy kuch ipdagi taranglik kuchiga teng va bu yuk 7 m/s² tezlanish bilan harakatlanmoqda. Shunday ekan;



$$F_{nat} = m_1 a \quad \text{yoki} \quad T = m_1 a = 6\ kg \cdot 7\frac{N}{kg} = 42\ N$$

2-usul: ikkinchi yukka ta'sir etuvchi natijaviy kuch ya'ni bu yukka tezlanish beruvchi kuch 70 N kuch bilan ipdagi taranglik kuchi ayirmasiga teng;



$$F_{nat} = m_2 a \quad \text{yoki} \quad F - T = m_2 a \quad \Rightarrow \quad 70\ N - T = 4\ kg \cdot 7\ \frac{N}{kg} = 28\ N$$

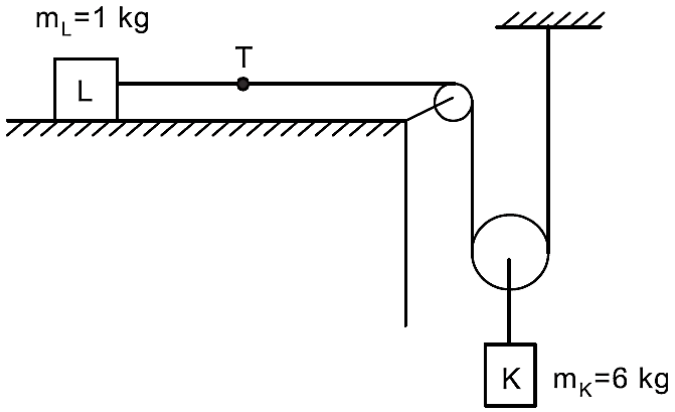
$$T = 70\ N - 28\ N = 42\ N$$

42-masala: Rasmda berilgan sistemada 1 kg massali yuk va gorizontal sirt ishqalanishga ega va ishqalanish koeffitsiyenti 0,5 . Shunga ko'ra, arqonning T taranglik kuchi necha Nyutonga teng? g=10 m/s².

$Berilgan$: $m_K = 6\ kg$; $m_L = 1\ kg$; $\mu = 0{,}5$; $g = 10\ m/s^2$;

$Topish\ kerak$: $T = ?$

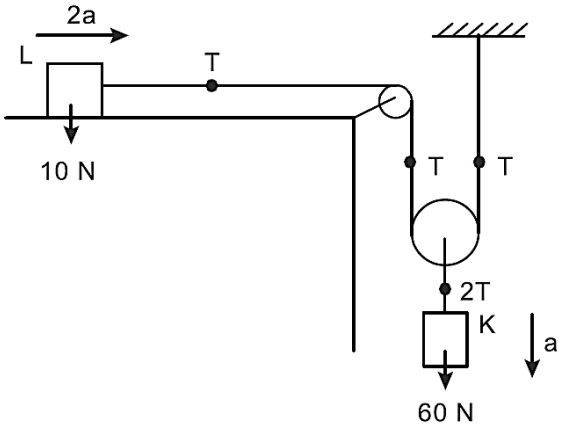
$Yechilishi.$



L jism bilan tekislik orasidagi ishqalanish kuchi;

$$F_{ish} = \mu N \quad \text{yoki} \quad F_{ish} = \mu m_{\mathrm{L}} g \quad \Rightarrow \quad F_{ish} = 0{,}5 \cdot 1\ kg \cdot 10 \frac{m}{s^2} = 5\ N$$

K jismga bog'langan arqonning taranglik kuchi 2T ga teng va K jismning tezlanishi a bo'lsa, L jismga bog'langan arqonning taranglik kuchi T ga, shuning uchun L jismning tezlanishi 2a ga teng. har ikki jism uchun $F_{nat} = ma$ munosabatni ipdagi taranglik kuchi orqali bog'laymiz;



K yuk uchun natijaviy kuch;

$$F_{nat} = m_K \cdot a_K \quad \Rightarrow \quad 60 - 2T = m_K \cdot a \quad \Rightarrow \quad 60 - 2T = 6a$$

L yuk uchun esa natijaviy kuch;

$$F_{nat} = m_L \cdot a_L \quad \Rightarrow \quad T - F_{ish} = m_L \cdot 2a \quad \Rightarrow \quad T - 5 = 2a$$

Yuqoridagi yuklar sistemasining birgalikdagi yechimi;

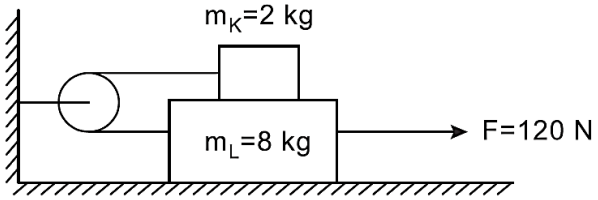
$$60 - 2T = 6 \cdot \frac{T-5}{2} \quad \Rightarrow \quad 5 \cdot T = 75 \quad \Rightarrow \quad T = 15\ N.$$

43-masala: Agar rasmda sirtlarning ishqalanish koeffitsiyentlari teng ya'ni 0,5 bo'lsa va 8 kg massali jismga rasmdagidek 120 N kuch ta'sir etayotgan bo'lsa, jismlarning harakat tezlanishi qanday (m/s²)? g=10 m/s².

$Berilgan$: $m_K = 2\ kg$; $m_L = 8\ kg$; $\mu = 0{,}5$; $g = 10\ m/s^2$; $F = 120\ N$;

$Topish\ kerak$: $a = ?$

$Yechilishi$.



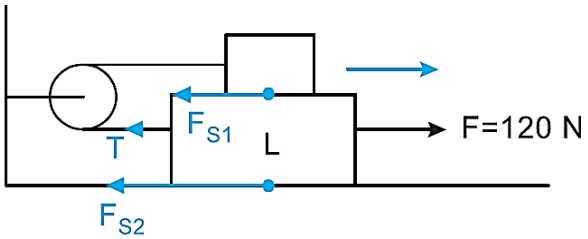
K jism va L jism orasidagi ishqalanish kuchi;

$$F_{S1} = \mu \cdot N \quad \Rightarrow \quad F_{S1} = \mu \cdot m_K \cdot g = 0{,}5 \cdot 2 \cdot 10 = 10\ N$$

L jism bilan yer orasidagi ishqalanish kuchi esa;

$$F_{S2} = \mu \cdot N \quad \Rightarrow \quad F_{S1} = \mu \cdot (m_K + m_L) \cdot g = 0{,}5 \cdot (2 + 8) \cdot 10 = 50\ N$$

L jism F kuch bilan tortilganda L jismga ta'sir qiluvchi kuchlar;



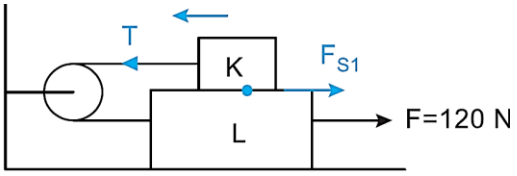
L jismning harakat tezlanishi rasmda ko'rsatilganidek;

$$F_{nat} = m_L \cdot a$$

yoki

$$F - F_{S1} - F_{S2} - T = m_L \cdot a$$

munosabatlar bilan, K jism L jismga nisbatan qarama-qarshi yo'nalishda harakat qilganda, K jismga ta'sir qiluvchi kuchlar;



K jismning harakat tezlanishi rasmda ko'rsatilganidek;

$$F_{nat} = m_K \cdot a$$

yoki

$$T - F_{S1} = m_K \cdot a$$

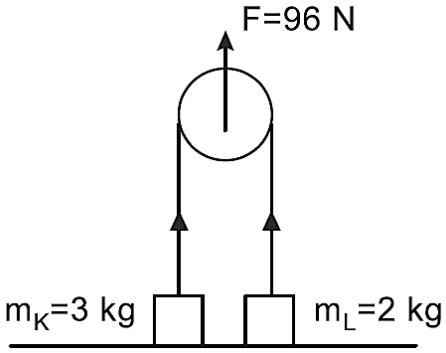
munosabat bilan topiladi. Agar barcha ma'lum qiymatlar ushbu munosabatlar orqali yozilsa va tenglamalar yechilsa, jismlar harakatining tezlanishi;

$$120 - 10 - 50 - T = 8a \quad \text{va} \quad T - 10 = 2a \quad \Rightarrow \quad T = 10 + 2a$$

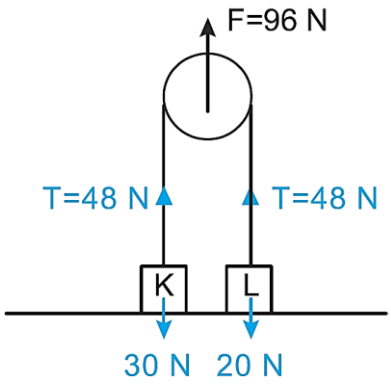
yoki;

$$120 - 10 - 50 - (10 + 2a) = 8a \quad \Rightarrow \quad 50 = 10a \quad \Rightarrow \quad a = 5\ \frac{m}{s^2}.$$

44-masala: Rasmda ko'rsatilgan ishqalanishsiz tizimda K va L jismlar blokka osilgan vaznsiz arqon yordamida F=96 N kuch bilan tortiladi. Shunga ko'ra K va L jismlarning harakat tezlanishlarini toping (m/s^2).



Blok F=96 N kuch bilan tortilganda, arqonlarda hosil bo'lgan taranglik kuchlari teng va 48 N dan.



K jismga ta'sir etuvchi natijaviy kuch;

$$F_{nat} = m_K a_K \;\Rightarrow\; T - m_K g = m_K a_K \;\Rightarrow\; 48 - 30 = 3a_K \;\Rightarrow\; a_K = 6\ m/s^2$$

L jismga ta’sir etuvchi natijaviy kuch;

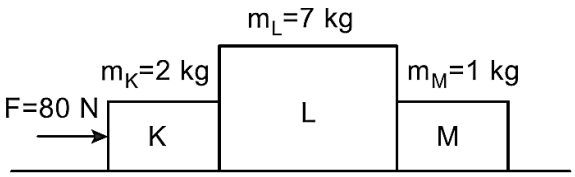
$$F_{nat} = m_L a_L \;\Rightarrow\; T - m_L g = m_L a_L \;\Rightarrow\; 48 - 20 = 2a_L \;\Rightarrow\; a_L = 14\ m/s^2$$

45-masala: Rasmdagi gorizontal sirt ishqalanishga ega va sirtning ishqalanish koeffitsiyenti 0,5 ga teng. K, L, M jismlarga sirtga parallel ravishda 80 N kuch ta’sir qiladi. Shunga ko’ra, L jismning K jismga ta’sir kuchi necha Nyutonga teng? g=10 m/s².

$Berilgan$: $m_K = 2\ kg$; $m_L = 7\ kg$; $m_M = 7\ kg$; $\mu = 0{,}5$; $g = 10\ m/s^2$; $F = 80\ N$;

$Topish\ kerak$: $F' = ?$

$Yechilishi$. Sistemani harakatga keltiradigan kuchlarni toppish uchun birinchi navbatda har bir jismga ta’sir qiuluvchi ishqalanish kuchini topamiz.



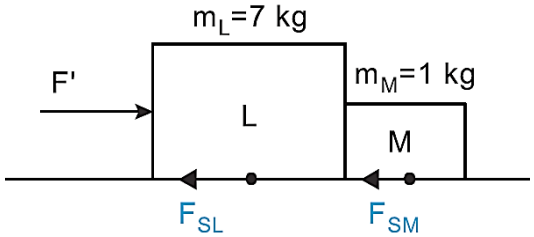
$$F_{ishq} = \mu \cdot N$$

$$F_{SK} = \mu \cdot m_K \cdot g \qquad F_{SL} = \mu \cdot m_L \cdot g \qquad F_{SM} = \mu \cdot m_M \cdot g$$
$$F_{SK} = 0{,}5 \cdot 2 \cdot 10 \qquad F_{SL} = 0{,}5 \cdot 7 \cdot 10 \qquad F_{SL} = 0{,}5 \cdot 1 \cdot 10$$
$$F_{SK} = 10\ N \qquad F_{SL} = 35\ N \qquad F_{SL} = 5\ N$$

Keyin sistemaning tezlanishini topamiz;

$$F_{nat} = (m_K + m_L + m_M) \cdot a$$
$$F - F_{SK} - F_{SL} - F_{SM} = (m_K + m_L + m_M) \cdot a$$
$$80 - 10 - 35 - 5 = (2 + 7 + 1) \cdot a$$
$$a = 3\ m/s^2$$

L jismning K jismga reaksiya kuchi K jismning L va M jismlarni harakatga keltiruvchi kuchga teng. Agar bu kuch F' deb atalsa;



L va M jismlarni harakatga keltiruvchi natijaviy kuch;

$$F_{nat} = (m_L + m_M) \cdot a$$

munosabatdan F' kuchi;

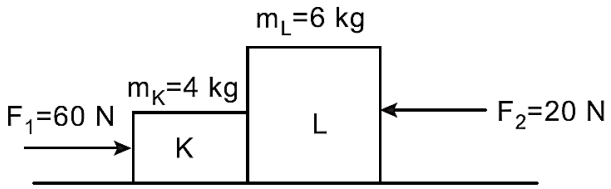
$$F' - F_{SL} - F_{SM} = (m_L + m_M) \cdot a$$

yoki

$$F' - 35 - 5 = (7 + 1) \cdot 3 \quad \Rightarrow \quad F' = 64\ N$$

sifatida topiladi.

46-masala: Massalari 4 kg va 6 kg bo'lgan jismlarga rasmda ko'rsatilganidek, F_1 va F_2 kuchlar ishqalanishsiz sirtda ta'sir etmoqda. Shunga ko'ra, L jismning K jismga ta'sir kuchi necha Nyutonga teng?



Sistemaning harakat tezlanishini Nyutonning ikkinchi qonuni orqali hisoblaymiz;

$$F_{nat} = (m_K + m_L) \cdot a$$

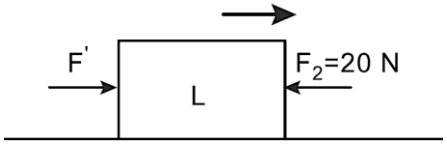
yoki;

$$F_1 - F_2 = (m_K + m_L) \cdot a$$

mos qiymatlarni qo'yib tezlanishni hisoblaymiz;

$$60\ \text{N} - 20\ \text{N} = (4\ kg + 6\ kg) \cdot a \quad \Rightarrow \quad a = 4\frac{m}{s^2}.$$

L jismning K jismga reaksiya kuchi K jismning L jismni harakatga keltiruvchi kuchiga teng va bu kuch;



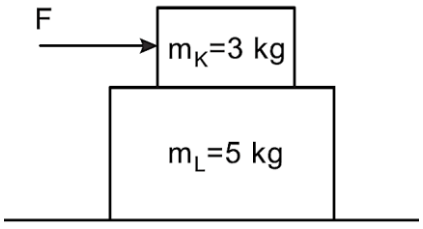
yuqoridagi chizmadan;

$$F' = m_L \cdot a \quad \Rightarrow \quad F' - F_2 = m_L \cdot a$$

bu ifodadan;

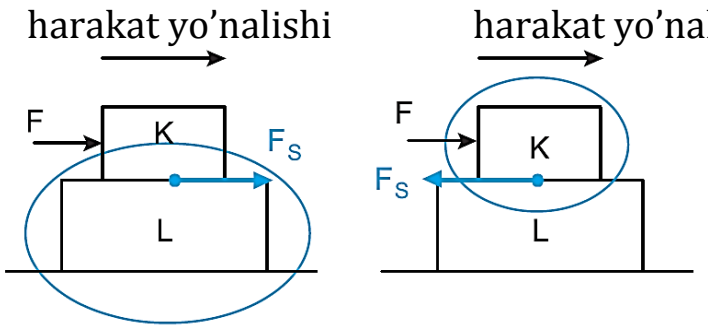
$$F' - 20\ N = 6\ kg \cdot 4\frac{m}{s^2} \quad \Rightarrow \quad F' = 44\ N$$

47-masala: Ishqalanish faqat K va L jismlar orasida va ishqalanish koeffitsiyenti 0,5 ga teng. jismlarni birgalikda harakatga keltira oladigan eng katta kuch necha Nyutonga teng?



Ikki jism orasidagi ishqalanish kuchi K jismning harakatlanishiga to'sqinlik qiladi, shu bilan birga L jismning harakatlanishiga imkon beradi. Ikki jism orasidagi ishqalanish kuchi;

$$F_s = \mu \cdot N = \mu \cdot m_K \cdot g = 0{,}5 \cdot 3\ N \cdot 10\frac{m}{s^2} = 15\ \text{N}\,.$$



1-rasm 2-rasm

Ikki jism birgalikda harakatlanishi uchun ularning tezlanishlari teng bo'lishi kerak. 1-rasmda jismlarning umumiy tezlanishlari L jismga ta'sir etuvchi kuch yordamida topiladi.

$$F_{nat} = m_{\mathrm{L}} \cdot a \quad \Rightarrow \quad F_s = m_{\mathrm{L}} \cdot a \quad \Rightarrow \quad 15\ \mathrm{N} = 5\ kg \cdot a \quad \Rightarrow \quad a = 3\frac{m}{s^2}.$$

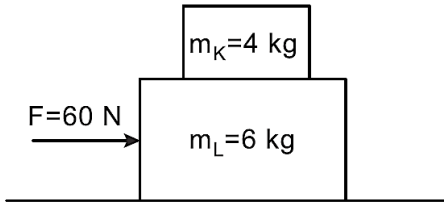
2-rasmda F kuch K jismga ta'sir etuvchi kuch yordamida topiladi.

$$F_{nat} = m_{\mathrm{K}} \cdot a \quad \Rightarrow \quad F - F_s = m_{\mathrm{L}} \cdot a \quad \Rightarrow \quad F - 15\ \mathrm{N} = 3\ kg \cdot 3\frac{m}{s^2}$$

bunga ko'ra;

$$F = 24\ \mathrm{N}.$$

48-masala: Ishqalanish faqat K va L jismlar orasida va ishqalanish koeffitsiyenti 0,3 ga teng. K va L jismlarda 60 N doimiy kuch ta'sirida hosil bo'lgan tezlanish qanday m/s^2 bo'ladi?

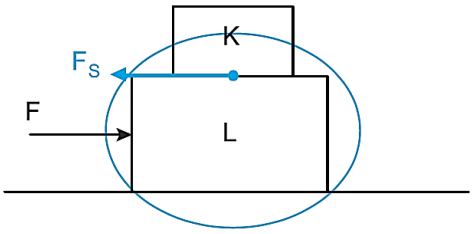


K va L jismlar orasidagi ishqalanish kuchi;

$$F_s = \mu \cdot N = \mu \cdot m_K \cdot g = 0{,}3 \cdot 4\ N \cdot 10\frac{m}{s^2} = 12\ \mathrm{N}.$$

Rasmda ko'rsatilgan sistemada F kuch qanchalik kuchli bo'lmasin, K jismni harakatga keltira oladigan eng katta kuch ishqalanish kuchi bo'lib uning kattaligi 12 N ga teng. Shunga ko'ra, K jismning tezlanishi;

$$F_{nat} = m_{\mathrm{K}} \cdot a_K \quad \Rightarrow \quad F_s = m_{\mathrm{K}} \cdot a_K \quad \Rightarrow \quad 12\ \mathrm{N} = 4\ kg \cdot a_K \quad \Rightarrow \quad a_K = 3\ m/s^2$$



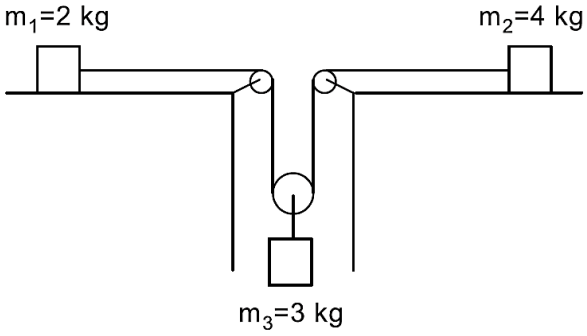
F kuchi L jismni harakatga keltiruvchi kuch, F_s kuch esa L jismni harakatlanishiga to'sqinlik qiladigan kuchdir. Shunga ko'ra; L jismning tezlanishi;

$$F_{nat} = m_{\mathrm{L}} \cdot a_L \quad \Rightarrow \quad F - F_s = m_{\mathrm{L}} \cdot a_L \quad \Rightarrow \quad 60\ \mathrm{N} - 12\ \mathrm{N} = 6\ kg \cdot a_L$$

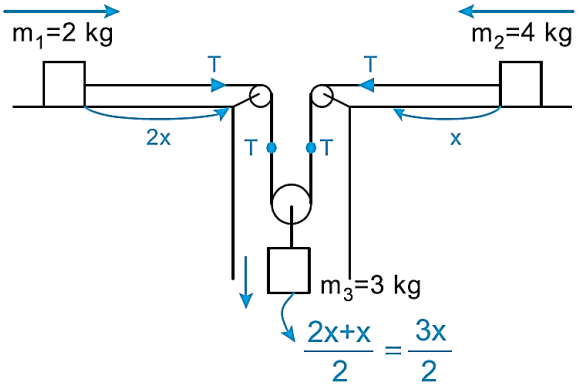
yuqorida ifodadan;

$$a_L = 8\frac{m}{s^2}.$$

49-masala: Rasmdagi ishqalanishsiz sirtda harakatlanayotgan jismlarning tezlanishlarini taqqoslang.



Sistema harakatlangan paytda m_3 massali jism pastga rasmda ko'rsatilgan yo'nalishda, m_1 va m_2 massali jismlar esa ipda hosil bo'ladigan taranglik kuchi hisobiga rasmda ko'rsatilgan yo'nalish bo'yicha harakatga keladi.



m_1 va m_2 massali jismlarning tezlanishlari $F_{nat} = m \cdot a$ dan;

$$F_{nat} = m_1 \cdot a_1 \quad \Rightarrow \quad T = 2\ kg \cdot a_1 \quad \Rightarrow \quad a_1 = \frac{T}{2} \quad \Rightarrow \quad a_1 = 2a$$

yoki

$$F_{nat} = m_2 \cdot a_2 \quad \Rightarrow \quad T = 4\ kg \cdot a_2 \quad \Rightarrow \quad a_2 = \frac{T}{4} \quad \Rightarrow \quad a_2 = a$$

Jism bosib o'tgan masofa;

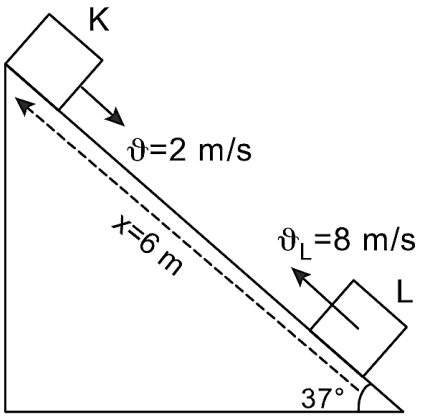
$$x = \frac{at^2}{2}$$

ekanligidan, jismning tezlanishi uning bosib o'tgan masofasiga to'g'ri proporsional ekanligidan;

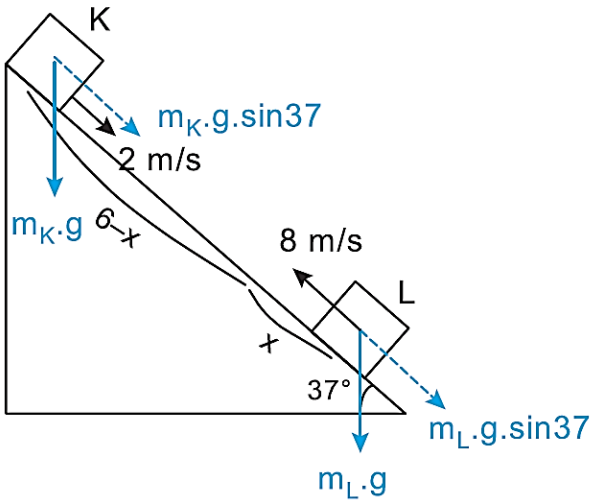
$$a_1 > a_3 > a_2$$

munosabat kelib chiqadi.

50-masala: Bir-biriga qarab 2 m/s va 8 m/s tezlikda harakat boshlagan K va L jismlar ishqalanishsiz qiya tekislikda uchrashishlari uchun qancha vaqt kerak bo'ladi? ($g = 10\ m/s^2; sin37^0 = 0{,}6.$)



Ishqalanishsiz qiya tekislikda pastga qarab harakatlanayotgan K jismning tezlanuvchan harakat tezlanishi, yuqoriga qarab harakatlanayotgan L jismning sekinlanuvchan tezlanishiga kattalik jihatdan teng. Chunki bir xil qiyalikda harakatlanayotgan barcha jismlarning tezlanish kattaliklari massaga bog'liq emas.



K jism uchun;

$$F_{nat} = m_K \cdot a_K \quad \Rightarrow \quad m_K \cdot g \cdot sin37^0 = m_K \cdot a_K \quad \Rightarrow \quad a_K = g \cdot sin37^0 = a$$

L jism uchun;

$$F_{nat} = m_L \cdot a_L \quad \Rightarrow \quad m_L \cdot g \cdot sin37^0 = m_L \cdot a_L \quad \Rightarrow \quad a_L = g \cdot sin37^0 = a$$

Agar bir-biridan 6 m masofada joylashgan L jism uchrashguncha x masofani bosib o'tgan bo'lsa, K jism bir vaqtning o'zida $6 - x$ masofani bosib o'tadi.

$$x = \vartheta_0 t - \frac{at^2}{2}$$

munosabatdan, K jism uchun;

$$6 - x = 2 \cdot t + \frac{at^2}{2}$$

L jism uchun esa;

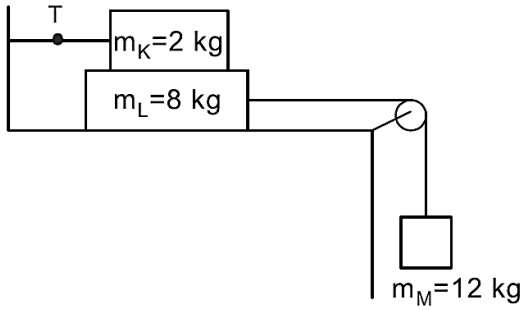
$$x = 8 \cdot t - \frac{at^2}{2}$$

Bu ikki tenglamani birgalikda yechamiz va;

$$6 - 8 \cdot t + \frac{at^2}{2} = 2 \cdot t + \frac{at^2}{2}$$

ifodadan uchrashish vaqti $t = 0{,}6\ s$ ekanligi kelib chiqadi.

51-masala: Rasmda ko'rsatilgan sistemada ishqalanish koeffitsiyenti barcha sirtlar uchun bir xil. Agar M jism doimiy harakatlansa, arqonning T taranglik kuchi necha Nyutonga teng?



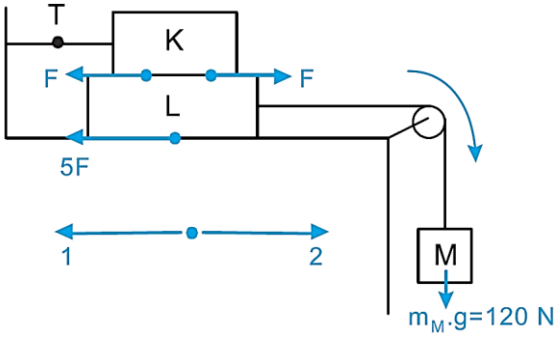
K jism bilan L jism orasidagi ishqalanish kuchi F_{s1};

$$F_{s1} = \mu \cdot m_K \cdot g \quad \Rightarrow \quad F_{s1} = \mu \cdot 2\ kg \cdot 10\frac{m}{s^2} = 20\mu = F$$

Agar quyidagicha qabul qilsak, L jism va sirt orasidagi ishqalanish kuchi F_{s2};

$$F_{s2} = \mu \cdot (m_K + m_L) \cdot g \quad \Rightarrow \quad F_{s2} = \mu \cdot 10\ kg \cdot 10\frac{m}{s^2} = 100\mu = 5F$$

ko'rinishga keladi.



1-chi yo'nalishdagi F va 5F ishqalanish kuchlari M jismni ko'rsatilgan yo'nalish bo'yicha harakatlanishiga to'sqinlik qilishga harakat qilsa, 2-yo'nalishdagi ishqalanish kuchi F esa K jismni 2-yo'nalishda harakatlantirishga harakat qiladigan kuchdir. K jism sirtga arqon bilan bog'langan va harakatlana olmagani uchun arqondagi T taranglik kuchi 2-yo'nalishdagi ishqalanish kuchi F ga teng (T=F). Doimiy tezlikda harakatlanuvchi L va M jismlar uchun quyidagi munosabatni yozamiz;

$$F_{nat} = (m_K + m_L) \cdot a$$

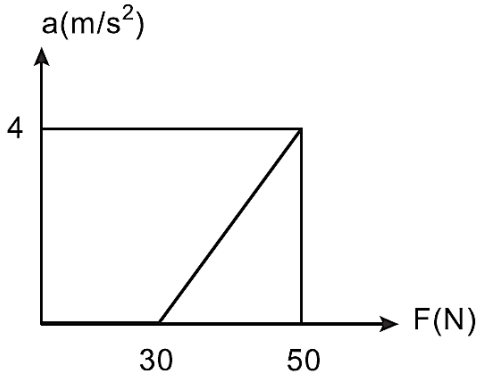
yoki;

$$m_M \cdot g - F_s = (m_K + m_L) \cdot a$$

Sistema doimiy tezlikda harakat qilgani uchun L va M jismlarning umumiy tezlanishi 0 ga teng. Shuning uchun ishqalanish kuchi ifodalaridan quyidagi tenglikni yozamiz;

$$120\ \text{N} - \text{F} - 5\text{F} = 0 \quad \Rightarrow \quad \text{F} = 20\ \text{N} = \text{T}\,.$$

52-masala: Gorizontal tekislikdagi jismga F gorizontal kuch ta'sir etganda, jismning tezlanishi va bu kuch orasidagi bog'liqlik grafigi berilgan. Shunga ko'ra, sirtning ishqalanish koeffitsiyenti qanday?



Grafikka ko'ra, jismning tezlanishi 30 N kuchga qadar nolga teng, 30 N kuchdan keyin esa jismning tezlanishi noldan farq qiladi. Jismning tezlanishi 30 N kuchgacha nolga teng bo'lishining sababi shundaki, ishqalanish kuchi 30 N. Shunga ko'ra jismning massasi;

$$F_{nat} = m \cdot a$$

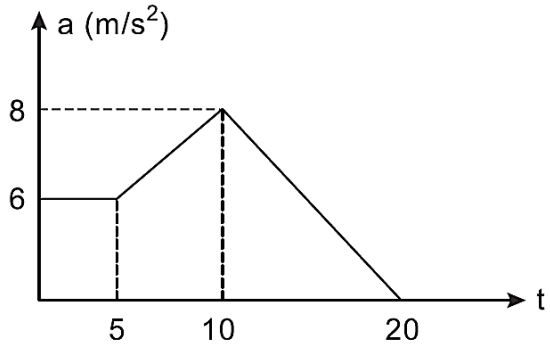
yoki;

$$F - F_s = m \cdot a \quad \Rightarrow \quad 50\ N - 30\ N = m \cdot 4\frac{m}{s^2} \quad \Rightarrow \quad m = 5\ kg\,.$$

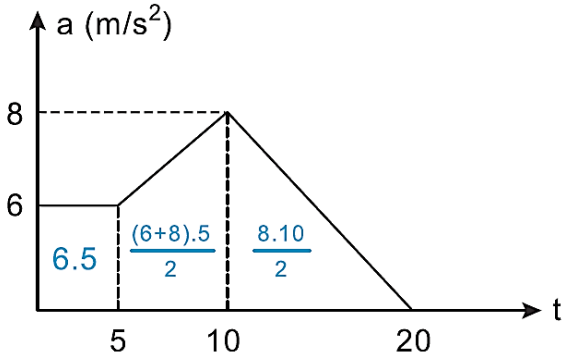
Gorizontal sirtdagi ishqalanish kuchi esa;

$$F_s = \mu \cdot N \quad \Rightarrow \quad F_s = \mu \cdot m \cdot g \quad \Rightarrow \quad 30\ N = \mu \cdot 5\ kg \cdot 10\frac{m}{s^2} \quad \Rightarrow \quad \mu = 0{,}6\,.$$

53-masala: Grafikda 2 kg massali jismning tezlanishning vaqtga bog'liqligi keltirilgan. 20 s dan keyin jismning impulsi qanday o'zgaradi?



Tezlanishning vaqtga bog'liqlik grafigidan yuza jism tezligining o'zgarishini beradi.



$$\Delta\vartheta = 6 \cdot 5 + \frac{(6+8)\cdot 5}{2} + \frac{8 \cdot 10}{2}$$

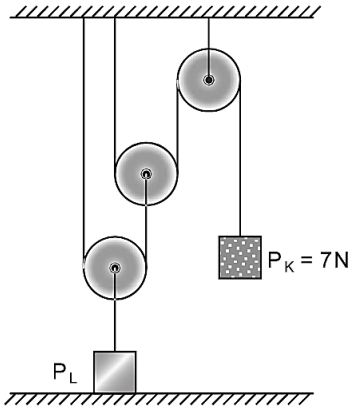
hisoblashlardan so'ng quyidagi natijaga ega bo'lamiz;

$$\Delta\vartheta = 30\frac{m}{s} + 35\frac{m}{s} + 40\frac{m}{s} = 105\frac{m}{s}$$

Jism impulsining o'zgarishi;

$$\Delta P = m \cdot \Delta\vartheta = 2\ \text{kg} \cdot 105\frac{\text{m}}{s} = 210\ kg \cdot \frac{m}{s}.$$

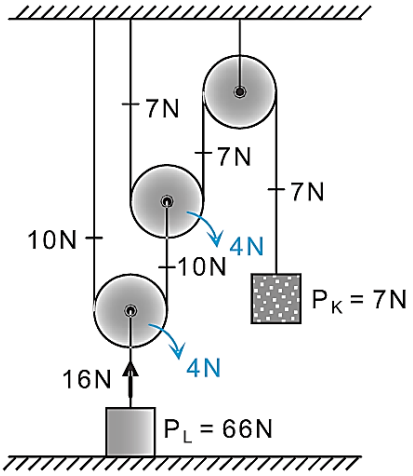
54-masala: Rasmdagi sistema muvozanatda va har bir blokning og'irligi 4 n ni tashkil qiladi. agar K jismning og'irligi 7 N, L jismning og'irligi 66 N va L jismning tayanch yuzasi 2,5 cm^2 bo'lsa, L jismning Yerga bosimi qanday (N/cm^2).



Rasmdagidek kuchlarni qo'yilsa L jismga bog'langan arqonning taranglik kuchi 16 N ga teng, shuning uchun L jismning Yerga ta'sir qiladigan bosim kuchi;

$$\text{F} = 66\ \text{N} - 16\ \text{N} = 50\ \text{N};$$

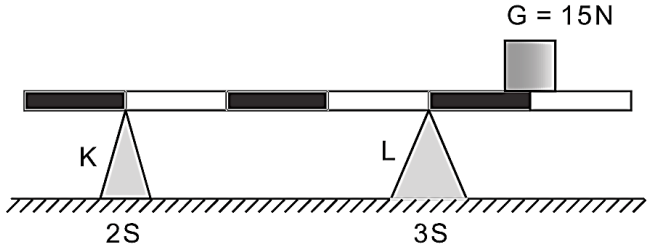
ga teng ekanligi kelib chiqadi.



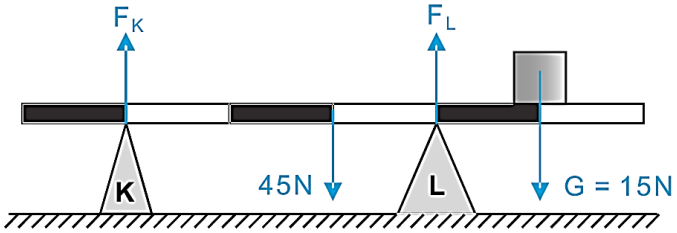
Shunga ko'ra, L jismning Yerga ko'rsatadigan bosimi;

$$P = \frac{F}{S} = \frac{50\ N}{2{,}5\ cm^2} = 20\frac{N}{cm^2}.$$

55-masala: Og'irligi 45 N bo'lgan bir jinsli sterjen rasmda ko'rsatilganidek, G=15 N yuk bilan tayanchlarda muvozanatda turibdi. Tayanchlarning yuzalari 2S va 3S ga teng, ularning og'irliklari har biri P=10 N ga teng bo'lsa, tayanchlar tomonidan Yerga beradigan bosimlari nisbati P_K/P_L topilsin.



Tayanchlarning Yerga bosimini topish uchun ularning og'irligi va sterjen va yukning ta'sir kuchlarini bilishimiz kerak. Agar K tayanchga tushadigan kuch F_K deyilsa va L tayanchga tushadigan kuchni esa F_L ga teng bo'ladi. Momentni K tayanchga nisbatan olamiz.



Momentlar qoidasiga ko'ra; aylanish o'qini K tayanchdan olib, F_L-reaksiya kuchidan K aylanish o'qigacha bo'lgan kuch yelkasi $3x$ (har bir katak oralig'ini x deb qabul qilamiz); bir jinsli sterjen og'irligi 45 N dan esa K tayanchgacha kuch yelkasi $2x$ ga teng bo'ladi. 15 N yukning K aylanish o'qigacha bo'lgan kuch yelkasi $4x$ deb olib, quyidagi tenglikni yozamiz;

$$M_1 = M_2 + M_3 \qquad (1)$$

yoki;

$$F_L \cdot 3x = 15\ N \cdot 4x + 45\ N \cdot 2x \quad \Rightarrow \quad F_L = 50\ N$$

yoki ikkinchi tomondan;

$$F_K + F_L = 45\ N + 15\ N \quad \Rightarrow \quad F_K + 50\ N = 60\ N \quad \Rightarrow \quad F_K = 10\ N$$

Bunga ko'ra;

$$P_K = \frac{F_K + P}{2S} = \frac{10\ N + 10\ N}{2S} = \frac{20\ N}{2S} = \frac{10\ N}{S};$$

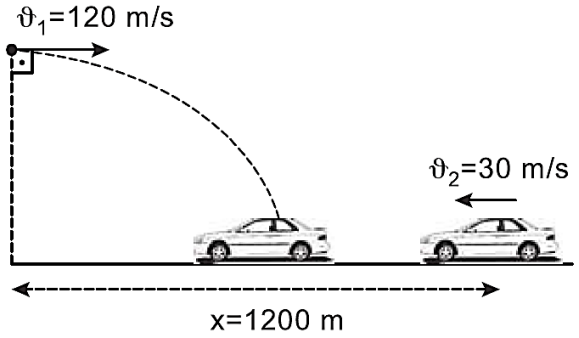
va

$$P_L = \frac{F_L + P}{2S} = \frac{50\ N + 10\ N}{3S} = \frac{60\ N}{3S} = \frac{20\ N}{S};$$

Endi bosimlar nisbatini topamiz;

$$\frac{P_K}{P_L} = \frac{\frac{10}{S}}{\frac{20}{S}} = \frac{10}{20} = \frac{1}{2}.$$

56-masala: Gorizontal va doimiy tezlikda 120 m/s tezlikda uchayotgan samolyotdan qarama-qarshi yo'nalishda doimiy tezlikda harakatlanayotgan avtomobilga jism tashlandi, ular orasida gorizontal tekislikda 1200 m masofa mavjud. Jism avtomobilga tegishi uchun samolyot yerdan necha metr balandlikda bo'lishi kerak?



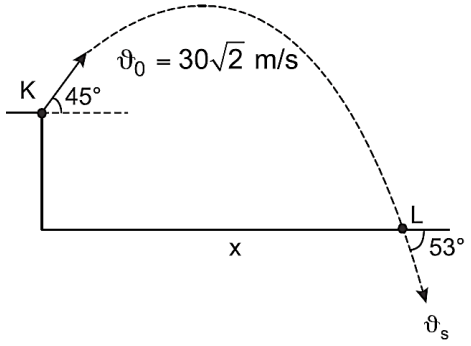
120 m/s va 30 m/s tezlikda bir-biriga qarab harakatlanayotgan ikkita transport vositasining nisbiy tezligi 150 m/s va ular orasidagi masofa 1200 m. shunga ko'ra, samolyotdan avtomobilga jism tushgan, demak;

$$x = \vartheta_{nis} \cdot t \quad \Rightarrow \quad 1200\ m = 150\frac{m}{s} \cdot t \quad \Rightarrow \quad t = 8\ s.$$

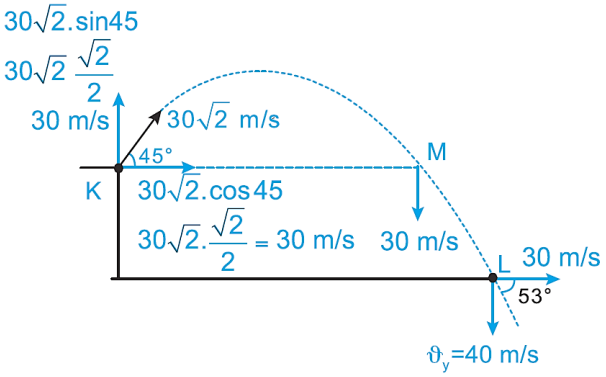
Bu vaqtda esa erkin tushishdagi jism vertikal yo'nalishda harakat qiladi;

$$h = \frac{g \cdot t^2}{2} = 5\frac{m}{s^2} \cdot t^2 \quad \Rightarrow \quad h = 5\ \frac{m}{s^2} \cdot (8\ s)^2 = 320\ m.$$

57-masala: Agar K nuqtadan $30\sqrt{2}$ m/s tezlik bilan rasmda ko'rsatilgandek otilgan jism L nuqtaga gorizontal bilan 53^0 burchak ostida tushsa, jismning gorizontal yo'lining uzunligi qancha bo'ladi? $(sin45^0 = \sqrt{2}/\,2;\ cos53^0 = 0{,}6;\ g = 10\ m/s^2)$.



Jismning gorizontal bo'ylab o'tgan yo'lining uzunligini toppish uchun jismning havoda bo'lish vaqtini bilishimiz kerak. K nuqtadan $30\sqrt{2}$ m/s tezlik bilan otilgan jismning gorizontal tezligi L nuqtaga yetmaguncha o'zgarmaydi.



$$tg53^0 = \frac{\vartheta_y}{\vartheta_x} = \frac{\vartheta_y}{30\ \frac{m}{s}} = \frac{4}{3} \quad \Rightarrow \quad \vartheta_y = 40\frac{m}{s}\ ;$$

K nuqtadan otilgan jism tezligining vertikal tashkil etuvchisi 30 m/s va jism K nuqtadan M nuqtaga harakat qiladi.

$$t_{uch} = \frac{2 \cdot \vartheta_y}{g} = \frac{2 \cdot 30\ m/s}{10} = 6\ s\ ;$$

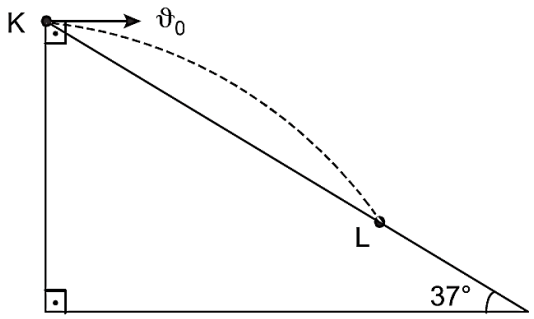
Tezligi 1 sekundda 10 m/s ga ortgan jism M nuqtadan L nuqtaga kelayotib tezligini 30 m/s dan 40 m/s gacha oshiradi. Shunga ko'ra; L va M nuqtalar oralig'ida tezligini 10 m/s ga oshiruvchi jism shu nuqtalar orasidan 1 sekundda, K va L nuqtalar orasidan o'tadi;

$$t_{um} = 6\ s + 1\ s = 7\ s;$$

ga teng; Shuning uchun jami jism gorizontal;

$$x = \vartheta_x \cdot t = 30\frac{m}{s} \cdot 7\ s = 210\ m\ .$$

58-masala: Rasmda ko'rinib turibdiki, K nuqtadan gorizontal otilgan jism 6 sekunddan so'ng L nuqtaga tushadi. Shunga ko'ra, jismning otilish tezligi qanday (m/s)? $\sin 37^0 = 0{,}6$;

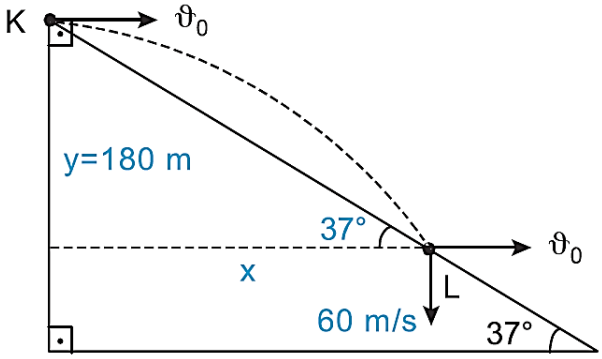


K nuqtadan gorizontal yo'nalishda otilgan jism L nuqtaga 6 sekunddan so'ng yetib kelganligi sababli, jismning vertikal yo'nalishdagi tezligi har soniyada 10 m/s ga oshadi va L nuqtaga yetib kelganida uning vertikal tezligi 60 m/s ga teng bo'ladi. Jismning vertikal yo'nalishdagi o'rtacha tezligi;

$$\vartheta_{oy} = \frac{0 + 60\ m/s}{2} = 30\ m/s;$$

va vertikal ravishda bosib o'tgan masofasi;

$$y = \vartheta_{oy} \cdot t = 30\frac{m}{s} \cdot 6\ s = 180\ m\ ;$$



Jismning gorizontal bo'ylab bosib o'tgan masofasini quyidagicha topamiz;

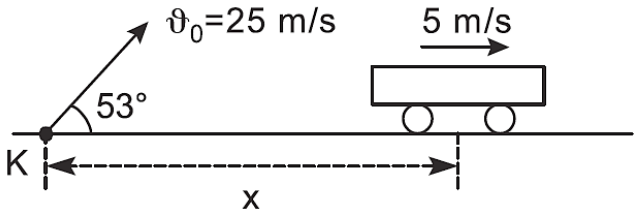
$$tg37^0 = \frac{y}{x} \quad \Rightarrow \quad \frac{0{,}6}{0{,}8} = \frac{180}{x} \quad \Rightarrow \quad x = 240\ m\ ;$$

Yuqoridagi idodalardan, jismning gorizontal tezligi;

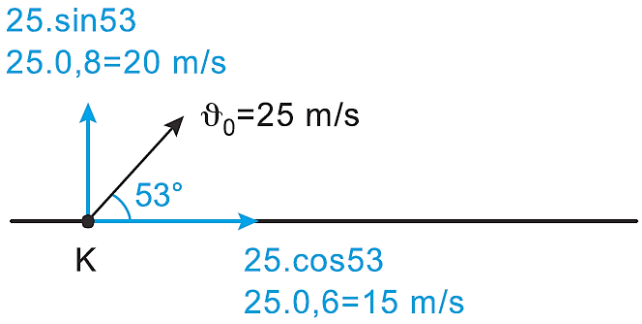
$$x = \vartheta_0 \cdot t \quad \Rightarrow \quad 240\ m = \vartheta_0 \cdot 6\ s \quad \Rightarrow \quad \vartheta_0 = 40\frac{m}{s}\ ;$$

ga teng.

59-masala: Jism rasmda ko'rsatilgandek 25 m/s tezlik bilan uloqtiriladi. Aravacha esa doimiy 5 m/s tezlikda K nuqtadan uzoqlashmoqda. Otilgan jism aravachaga tegishi uchun jism bilan aravacha orasidagi x masofa necha metr bo'lishi kerak? $(\sin 53^0 = 0{,}8;\ \cos 53^0 = 0{,}6;\ \ g = 10\ m/s^2)$.



K nuqtadan gorizont bilan 53^0 burchak ostida uloqtirilgan jismning gorizontal va vertikal tezliklari rasmda tasvirlangan.



Jismning aravachaga tekkuncha havoda qoladigan vaqti;

$$t_{uch} = 2 \cdot t_k = \frac{2 \cdot \vartheta_y}{g} = \frac{2 \cdot 20\ m/s}{10\ m/s^2} = 4\ s\ ;$$

Agar aravacha shu vaqt ichida x' masofaga siljisa;

$$x' = \vartheta \cdot t_{uch} = 5\frac{m}{s} \cdot 4\ s = 20\ m\ ;$$

Otilgan jism va aravacha orasidagi masofa;

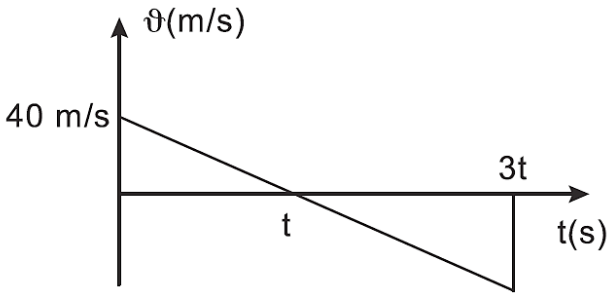
$$x + x' = \vartheta_y \cdot t$$

yoki;

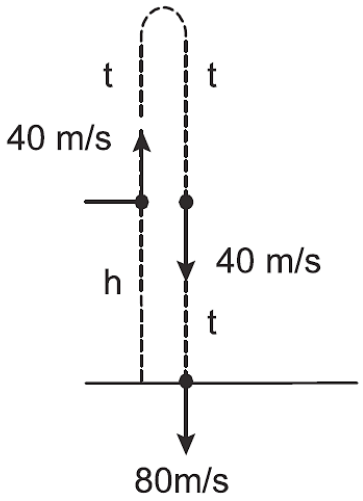
$$x + 20\ \text{m} = 15\frac{m}{s} \cdot 4\ s \quad \Rightarrow \quad x = 40\ m;$$

ga teng.

60-masala: Yerdan h balandlikdagi nuqtadan vertikal yuqoriga 40 m/s tezlik bilan otilgan jism 3t vaqtdan keyin yerga tushadi. Jism yerdan uloqtirilgan nuqtaning balandligi qancha (m)? g=10 m/s^2.



Erkin tushish tezlanishi 10 m/s^2 bo'lgan ishqalanishsiz muhitda 40 m/s tezlikda vertikal yuqoriga otilgan jismning tezligi sekundiga 10 m/s ga, jism esa tezligini 40 m/s dan pasaytiradi va 4 s da nolga teng bo'ladi.



Har bir t vaqtda tezligi 40 m/s ga ortib borayotgan jismning yerga urilish tezligi 80 m/s ga teng. Shunday ekan, o'rtacha tezlik;

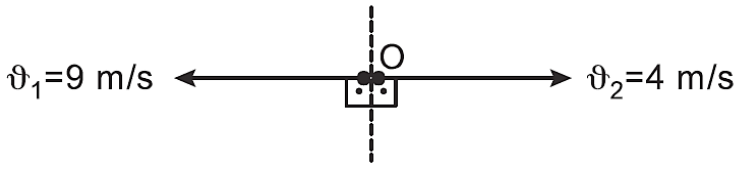
$$\vartheta_{o'rt} = \frac{40\frac{m}{s} + 80\frac{m}{s}}{2} = 60\frac{m}{s}\ ;$$

Jism yerdan uloqtirilgan nuqtaning balandligi esa;

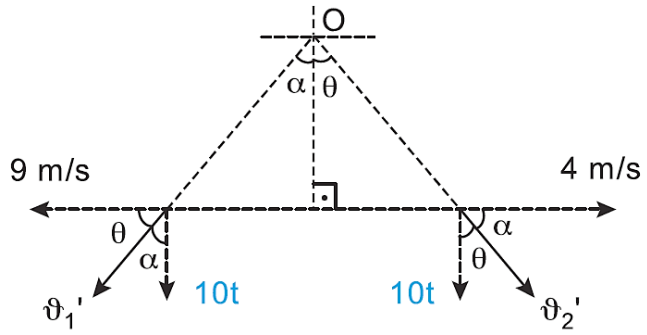
$$h = \vartheta_{o'rt} \cdot t = 60\frac{m}{s} \cdot 4\ s = 240\ m\ ;$$

sifatida topiladi.

61-masala: O nuqtadan bir vaqtda 9 m/s va 4 m/s tezlik bilan uloqtirilgan ikkita jismning tezlik vektorlari orasidagi burchak necha soniyadan keyin 90^0 ga teng bo'ladi?



Gorizontal yo'nalishda har xil tezlikda otilgan jismlar gorizontal yo'nalishda turli yo'llarni bosib o'tgan bo'lsa, vertikal yo'nalishda erkin tushishi sababli ular vertikal yo'nalishda teng masofalarni bosib o'tadi. t vaqtdan keyin 9 m/s va 4 m/s tezlikda otilgan jismlarning harakat yo'nalishlari orasidagi burchak 90^0 bo'lsin, u holda;



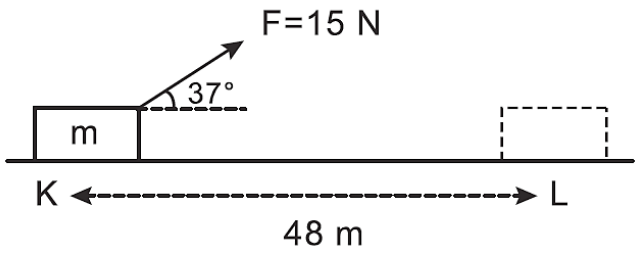
Tezligi sekundiga 10 m/s ga ortgan jismlarning vertikal tezligi rasmda ko'rsatilganidek, t vaqtdan keyin 10t ga teng bo'ladi. $\alpha + \theta = 90^0$ bo'lgani uchun ikkala tezlik vektori uchun tgα yozilsa;

$$\text{tg}\alpha = \frac{9\ m/s}{10t} = \frac{10t}{4\ m/s} \quad \Rightarrow \quad 100t^2 = 36\ m^2/s^2$$

ekanligidan

$$t = 0{,}6\ s\ .$$

62-masala: Ishqalanishsiz sirtda yotgan 2 kg massali jismga K dan L gacha bo'lgan 15 N doimiy kuch qo'yilgan. Bu masofada jismga ta'sir etuvchi kuch impulsi qancha (N·s) ga teng?



Jismga berilgan kuch impulsi;

$$\vec{I} = \vec{F} \cdot \Delta t$$

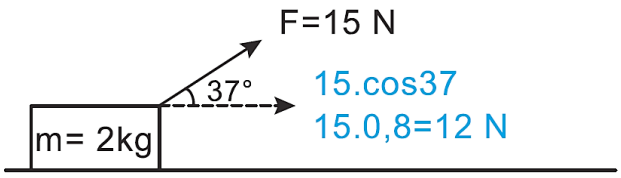
munosabat bilan topiladi. O'tgan vaqt kerak bo'lgani uchun, shuningdek, ta'sir qiluvchi kuch;

$$\vec{F} = ma$$

Birinchi munosabatdan, harakatning tezlanishi;

$$x = \frac{a \cdot \Delta t^2}{2}$$

harakat vaqti munosabatdan topiladi.



$$12\ N = 2\ kg \cdot a \quad \Rightarrow \quad a = 6\ m/s^2$$

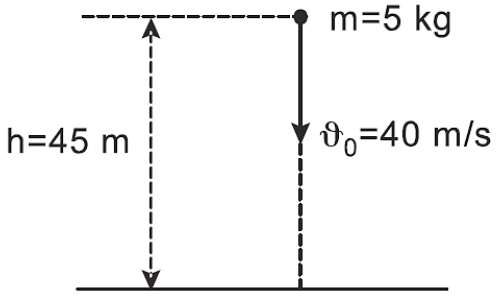
Harakat vaqtini hisoblaymiz;

$$48\ m = \frac{6\ m/s^2 \cdot \Delta t^2}{2} \quad \Rightarrow \quad \Delta t^2 = 16\ s^2 \quad \Rightarrow \quad \Delta t = 4\ s\ ;$$

Bunga ko'ra kuch impulsi;

$$\vec{I} = 12\ N \cdot 4\ s = 48\ \text{N} \cdot s\ .$$

63-masala: Rasmdagi massasi 5 kg bo'lgan jism 40 m/s tezlikda pastga otilib, yerga tekkanda 30 m/s tezlik bilan yuqoriga sakraydi. Agar jism va yer orasidagi o'zaro ta'sir 0,2 sekund davom etsa, gorizontal sirtning jismga ta'sir qiladigan o'rtacha kuchi necha Nyutonga teng?



Energiyaning saqlanish qonuniga ko'ra, yerdan 45 m balandlikdan pastga qarab 40 m/s tezlikda tashlangan jismning yerga urilish tezligi;

$$\frac{1}{2}m\vartheta_0^2 + mgh = \frac{1}{2}m\vartheta_1^2$$

Jism massasini qisqartirib, bu tenglikni quyidagicha yozamiz;

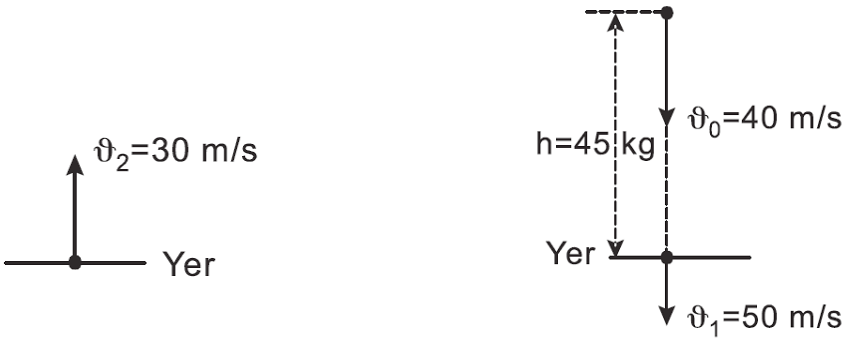
$$\frac{1}{2}(40\ m/s)^2 + 10\frac{m}{s^2} \cdot 45m = \frac{1}{2}\vartheta_1^2$$

Bu tenglikdan;

$$800\frac{m^2}{s^2} + 450\frac{m^2}{s^2} = \frac{1}{2}\vartheta_1^2$$

yoki;

$$\vartheta_1^2 = 2500\ \frac{m^2}{s^2} \quad \Rightarrow \quad \vartheta_1 = 50\frac{m}{s}\ ;$$



Agar jismning birinchi harakat yo'nalishi (-) va ikkinchi holda harakat yo'nalishi esa (+) sifatida qabul qilinsa;

$$\vec{I} = \Delta\vec{P}$$

yoki;

$$\vec{F} \cdot \Delta t = m \cdot \left(\vec{\vartheta}_2 - \vec{\vartheta}_1\right)$$

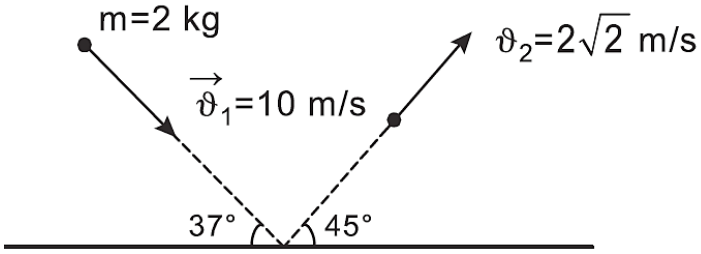
Yerning o'rtacha qarshilik kuchi esa;

$$\vec{F} \cdot 0{,}2\ s = 5\ kg \cdot \left(30\frac{m}{s} - \left(-50\frac{m}{s}\right)\right)$$

ifodadan;

$$\vec{F} = 2000\ \text{N}.$$

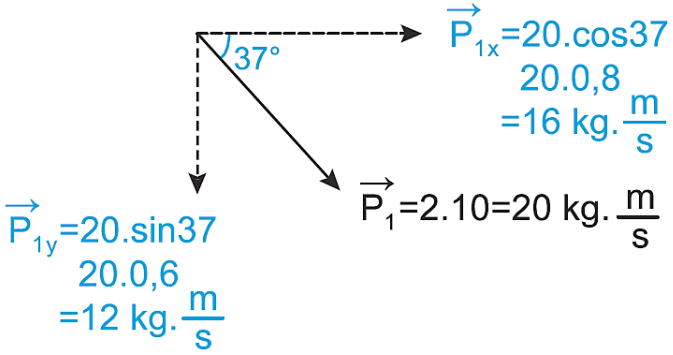
64-masala: Massasi 2 kg bo'lgan jism devorga 10 m/s tezlik bilan uriladi va rasmda ko'rsatilgandek elastik qaytadi. Jism impulsining o'zgarishi necha $kg \cdot m/s$ ga teng?



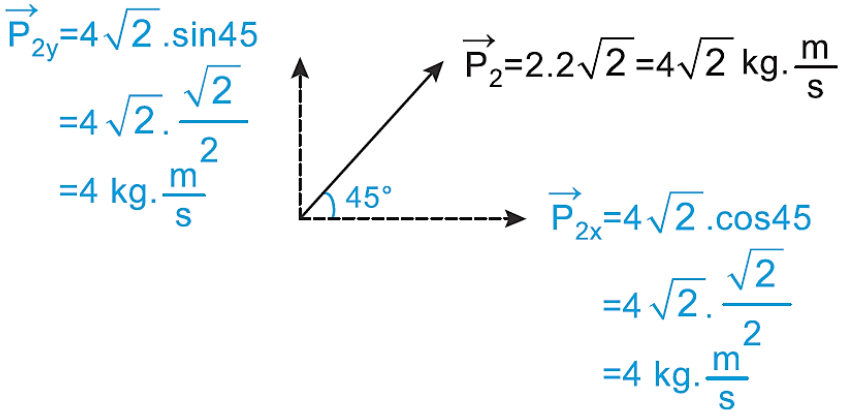
Jism impulsining o'zgarishi;

$$\Delta\vec{P} = \vec{P}_2 - \vec{P}_1$$

munosabat orqali topiladi. Shunga ko'ra, jismning boshlang'ich va oxirgi impulslarining gorizontal va vertikal tashkil etuvchilari topiladi va gorizontal va vertikal yo'nalishdagi impuls o'zgarishlari hisoblanadi. Birinchi holda jism impulsining proyeksiyasi;



Ikkinchi holatda jism impulsining proyeksiyasi esa;



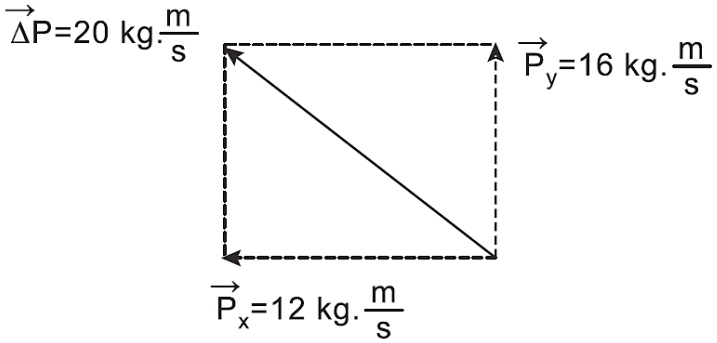
Jismning gorizontal yo'nalishdagi o'zgarishi;

$$\Delta\vec{P}_x = \vec{P}_{2x} - \vec{P}_{1x} = 4\ kg \cdot \frac{m}{s} - 16\ kg \cdot \frac{m}{s} = -12\ kg \cdot \frac{m}{s}\ ;$$

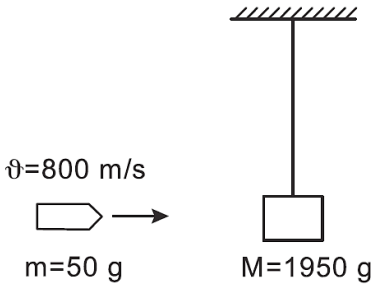
Jismning vertikal yo'nalishdagi o'zgarishi esa;

$$\Delta\vec{P}_y = \vec{P}_{2y} - \vec{P}_{1y} = -4\ kg \cdot \frac{m}{s} - 12\ kg \cdot \frac{m}{s} = -16\ kg \cdot \frac{m}{s}\ ;$$

Jism imulsining o'zgarishini esa quyidagicha hisoblaymiz;



65-masala: 800 m/s tezlikda harakatlanuvchi 50 g massali o'q rasmdagidek ipga osilgan 1950 g massali jismga gorizontal kelib urilsa, to'qnashuvdan so'ng M massali jsim necha metrga ko'tarilishi mumkin?

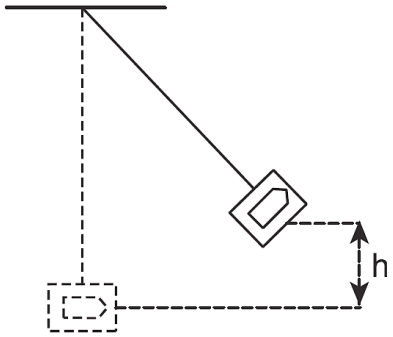


Impulsning saqlanish qonuniga ko'ra;

$$m\vec{\vartheta} = (m + M) \cdot \vec{u}$$

bu ifodadan to'qnashuvdan keying tezlikni hisoblab olamiz;

$$\vec{u} = \frac{m}{(m+M)}\vec{\vartheta} = \frac{50\ g}{2000\ g} \cdot 800\frac{m}{s} = 20\frac{m}{s}\ ;$$



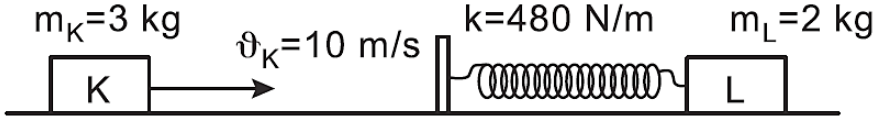
Energiyaning saqlanish qonunidan, jismning qancha balandlikka ko'tarilishini hisoblaymiz;

$$\frac{1}{2}(m + M) \cdot \vec{u}^2 = (m + M) \cdot g \cdot h$$

yoki

$$h = \frac{\vec{u}^2}{2g} = \frac{\left(20\frac{m}{s}\right)^2}{20\frac{m}{s^2}} = 20\ m\ .$$

66-masala: Ishqalanishsiz gorizontal tekislikda joylashgan 2 kg massali L jismga biriktirilgan prujina mahkamlangan taglikka 10 m/s tezlikda harakatlanayotgan 3 kg massasi K jism uriladi. Shunga ko'ra, prujina bikrligi 480 N/m bo'lsa, u qanchaga siqiladi (m)?



K jism prujinani maksimal siqqanda, K va L jismlarning tezligi tenglashadi va jismlar o'zini elastik bo'lmagan to'qnashuv kabi tutadi. Shunga ko'ra, birinchi navbatda jismlarning umumiy tezliklari impulsning saqlanish qonunidan hisoblanadi va energiyaning saqlanish qonunidan prujinaning deformatsiyasi hisoblanadi.

$$m_K\vartheta_K = (m_K + m_L) \cdot \vec{u}$$

To'qnashuvdan keying tezlik;

$$\vec{u} = \frac{m_K}{(m_K + m_L)}\vartheta_K = \frac{3\ kg}{5\ kg} \cdot 10\frac{m}{s} = 6\frac{m}{s}\ ;$$

K jismning jastlabki kinetik energiyasi;

$$E_{K1} = \frac{1}{2}m_K \cdot \vartheta_K^2 = \frac{1}{2} \cdot 3\ kg \cdot \left(10\frac{m}{s}\right)^2 = 150\ \text{J}\ ;$$

To’qnashuvdan keyin esa;

$$E_{K2} = \frac{1}{2}(m_K + m_L)\cdot \vec{u}^2 = \frac{1}{2}\cdot 5\ kg \cdot \left(6\frac{m}{s}\right)^2 = 90\ \text{J};$$

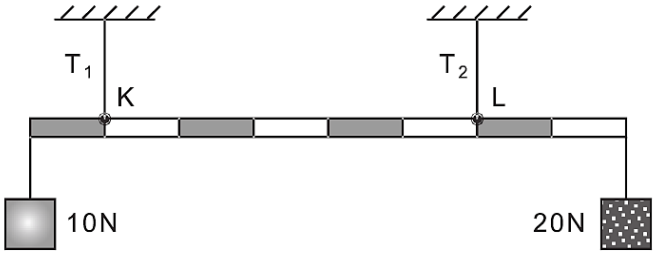
Kinetik energiyaning kamayishi hisobiga prujina siqilgan;

$$E_{K1} - E_{K2} = \frac{k\Delta x^2}{2}$$

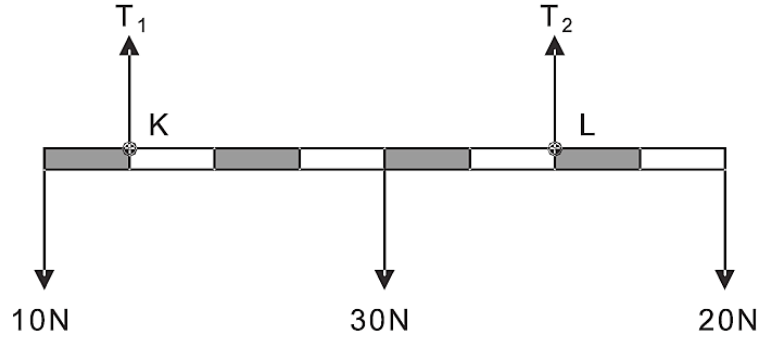
yoki;

$$150\ J - 90\ J = 240\frac{N}{m}\cdot \Delta x^2 \quad \Rightarrow \quad \Delta x = 0{,}5\ m\ .$$

67-masala: Bir jinsli teng bo’laklarga bo’lingan 30 N og’irlikdagi sterjen rasmda ko’rsatilgandek K va L nuqtalardan iplarga osilgan holda muvozanatda turibdi. Arqondagi taranglik kuchlarini hisoblang (N).



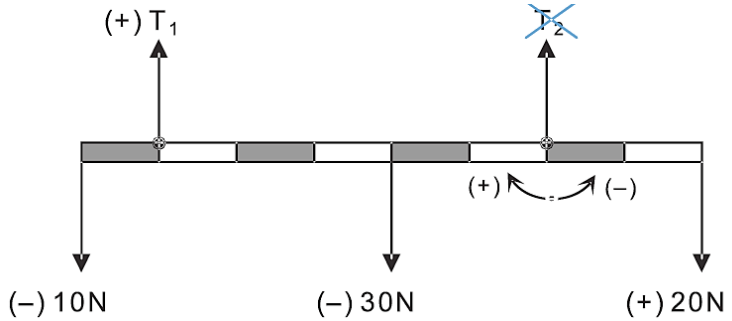
Arqonlar yordamida muvozanatda turgan sterjenga ta’sir qiluvchi barcha kuchlar rasmda tasvirlangan va bir-birini muvozanatlashtirgan qarama-qarshi kuchlar tenglashtiriladi.



$$T_1 + T_2 = 10\ N + 30\ N + 20\ N \quad \Rightarrow \quad T_1 + T_2 = 60\ N\ ;$$

Keyin moment olinadigan nuqta (aylanish o’qi) aniqlanadi, bu nuqtaga ko’ra belgi yo’nalishlari aniqlanadi va bir xil yo’nalishdagi va qarama-qarshi yo’nalishdagi kuchlarning momentlari tenglashtiriladi.

Shunga ko’ra;



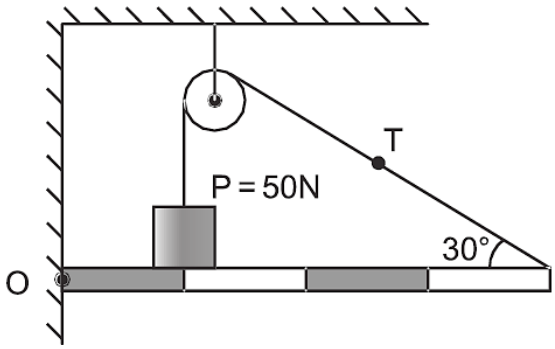
T_2 taranglik kuchi qo'yilgan nuqtani aylanish o'qi deb hisoblab, momentlar qoidasini yozamiz. Har bir katakni bir birlik deb olamiz.

$$T_1 \cdot 5 + 20\ N \cdot 2 = 10\ N \cdot 6 + 30\ N \cdot 2 \quad \Rightarrow \quad T_1 = 16\ N\ ;$$

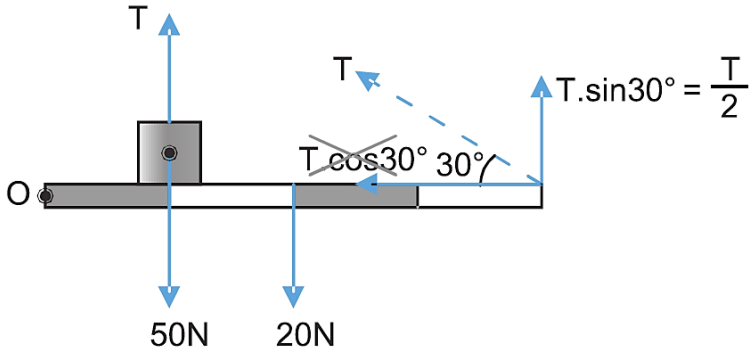
Yuqoridagi ifodadan;

$$T_1 + T_2 = 60\ N \quad \Rightarrow \quad 16\ N + T_2 = 60\ N \quad \Rightarrow \quad T_2 = 44\ N\ .$$

68-masala: Bir jinsli va teng bo'laklarga bo'lingan balkaning og'irligi 20 N. Agar sistema muvozanat holatida bo'lsa, arqonning taranglik kuchi necha Nyutonga teng?

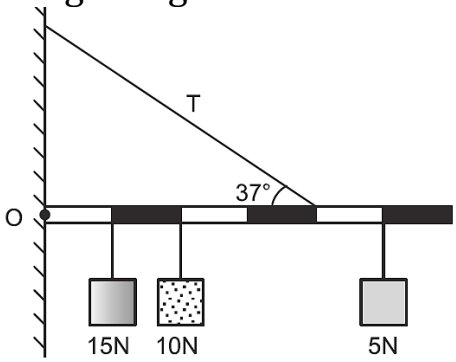


Agar taranglik kuchi T bo'lgan arqon uzilsa, O nuqtaga nisbatan siztemaning muvozanati buziladi. O nuqta moment olinadigan (aylanish o'qi) bo'lgani uchun, momentlar qoidasini quyidagicha yozamiz;

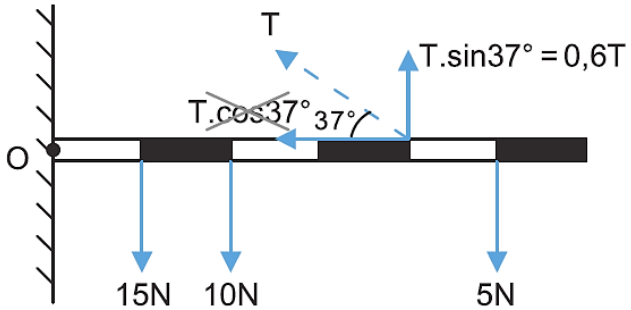


$$T \cdot 1 + \frac{T}{2} \cdot 4 = 50\ N \cdot 1 + 20\ N \cdot 2 \quad \Rightarrow \quad 3T = 90\ N \quad \Rightarrow \quad T = 30\ N\ .$$

69-masala: Teng bo'lingan, vaznsiz sterjen rasmda ko'rsatilganidek muvozanatda bo'lsa, shunga ko'ra, O nuqtada devorning sterjenga bo'lgan reaksiya kuchi necha Nyutonga teng?

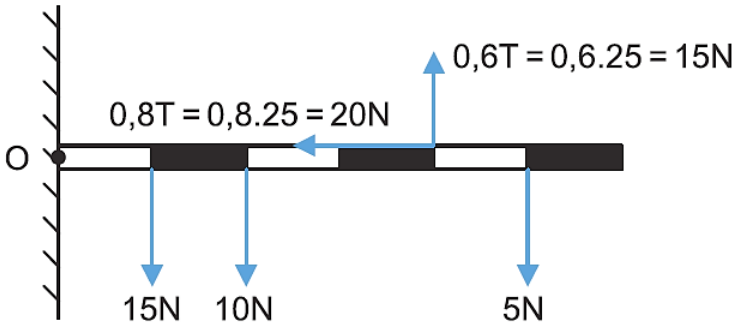


Birinchidan, T taranglik kuchi O nuqtaga nisbatan momentni olish orqali topiladi.

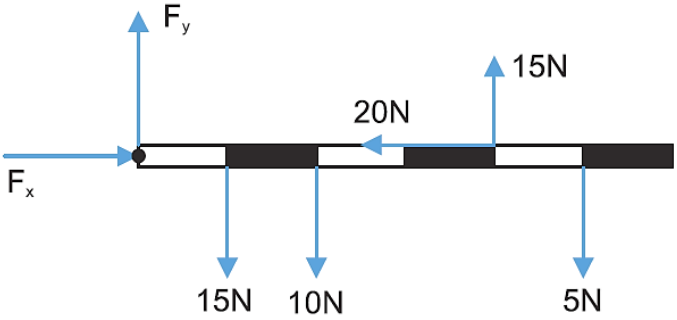


$$0{,}6 \cdot T \cdot 4 = 15\ N \cdot 1 + 10\ N \cdot 2 + 5\ N \cdot 5 \quad \Rightarrow \quad T = 25\ N\ .$$

Keyin barcha vertikal va gorizontal kuchlarni chizmada tasvirlaymiz.



Vertikal va gorizontal kuchlarni muvozanatlash uchun devordagi O aylanish o'qidan boshlab muvozanatlashtiruvchi vertikal va gorizontal reaksiya kuchlarini tasvirlaymiz.

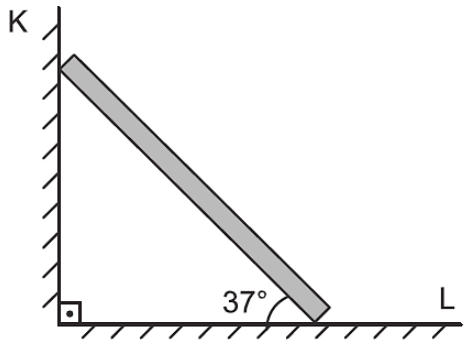


$$F_x = 20\ N\ ; \quad F_y + 15\ N = 15\ N + 10\ N + 5\ N\ ; \quad F_y = 15\ N\ .$$

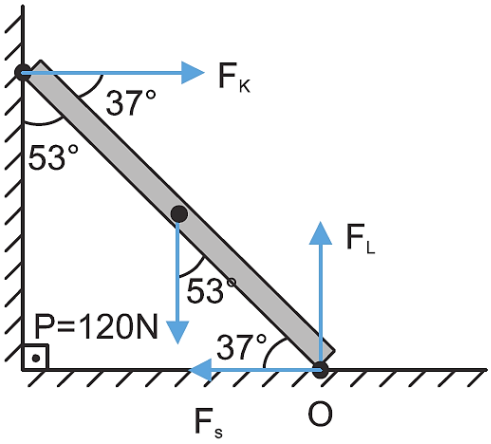
Shunga ko'ra, devorning sterjenga gorizontal va vertikal reaksiya kuchlarining natijasi;

$$F^2 = F_x^2 + F_y^2\ ; \quad \Rightarrow \quad F^2 = (20\ N)^2 + (15\ N)^2 \quad \Rightarrow \quad F = 25\ N\ .$$

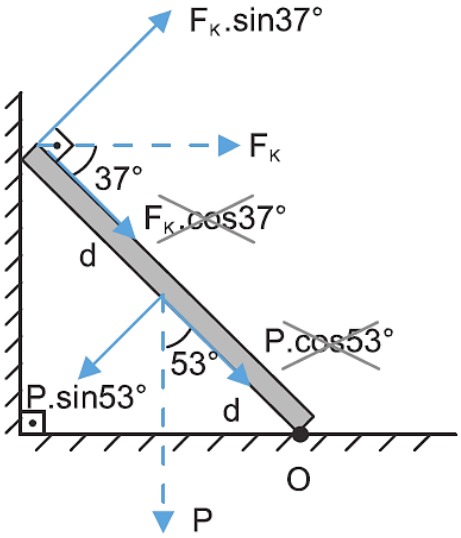
70-masala: Rasmda ko'rsatilgan sistemada K sirt ishqalanishsiz va L sirtda ishqalanish mavjud. Bir jinsli to'sinning og'irligi 120 N va sistema muvozanatda. Shunga ko'ra, ishqalanish kuchi necha Nyutonga teng? $sin53^0 = 0{,}8\ ;\ sin37^0 = 0{,}6\ ;$



K yuzasi ishqalanishsiz va L yuzasi ishqalanishli bo'lgani uchun to'singa ta'sir etuvchi barcha kuchlarni tasvirlab olamiz.



Shunga ko'ra; gorizontal va vertikal kuchlarni tasvirlaymiz. Agar aylanish o'qini O nuqtaga olinsa;



Momentlar qoidasiga ko'ra;

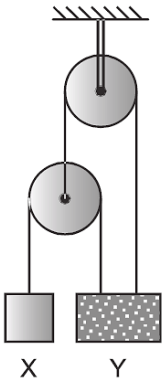
$$F_K \cdot sin37^0 \cdot 2d = P \cdot sin53^0 \cdot d\ ;$$

yoki;

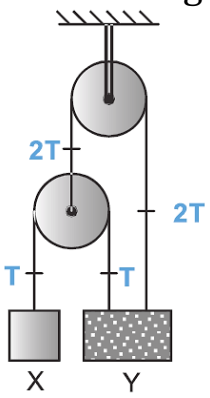
$$F_K \cdot 0{,}6 \cdot 2d = P \cdot 0{,}8 \cdot d\ ; \quad \Rightarrow \quad F_K = 80\ N\ ;$$

Chizmadan ko'rinib turibdiki sistema muvozanatda qolishi uchun ishqalanish kuchi F_K ga qarama-qarshi yo'nalganligi uchun bu kuchlar teng bo'lishi kerak. Demak ishqalanish kuchi ham $F_K = F_s = 80\ N$ ga teng.

71-masala: Agar rasmdagi sistema muvozanatda bo'lsa, Y yukning massasi X yukning massasidan necha marta katta?

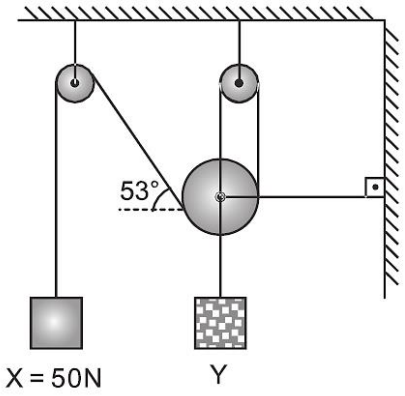


X yukni ko'taruvchi arqonning taranglik kuchi T ga teng bo'lsa, $m_X = T$ ga va Y yukning massai esa $m_Y = T + 2T = 3T$ ga teng bo'ladi.

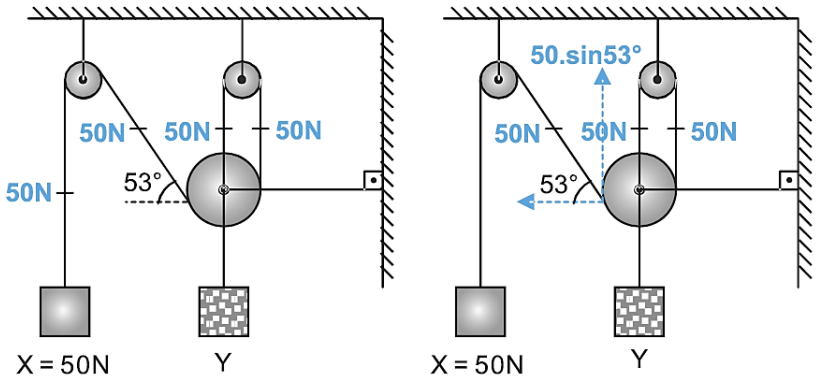


Shunga ko'ra, Y yukning massasi X yukning massasidan 3 marta katta.

72-masala: Sistema muvozanatda bo'lsa, Y yukning og'irligi necha Nyutonga teng? $sin53^0 = 0{,}8$;



Muvozanat shartini chizmada kuchlarni qo'yish orqali hisoblaymiz.

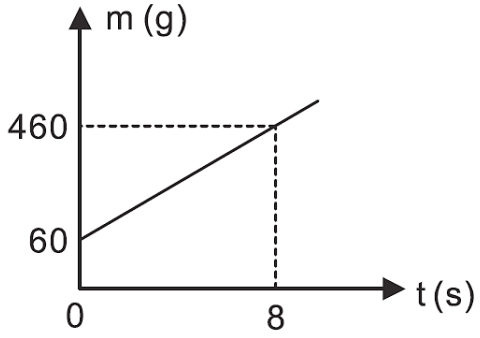


$$F_y = 50\ N \cdot sin53^0 + 50\ N + 50\ N \quad \Rightarrow \quad F_y = 50\ N \cdot 0{,}8 + 100\ N\ ;$$

yoki:

$$F_y = 140\ N\ .$$

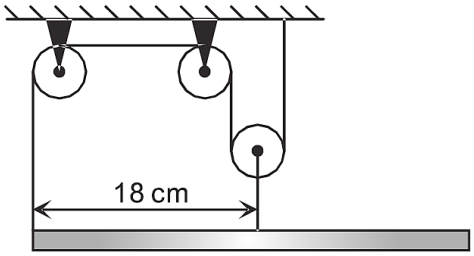
73-masala: Bo'sh idish sekundiga 20 cm^3 suyuqlik oqadigan kran bilan to'ldiriladi. Agar idish massasining ortishining vaqtga bog'liqligi rasmda ko'rsatilganidek bo'lsa, jo'mrakdan oqib chiqayotgan suyuqlikning necha g/cm^3 bo'ladi?



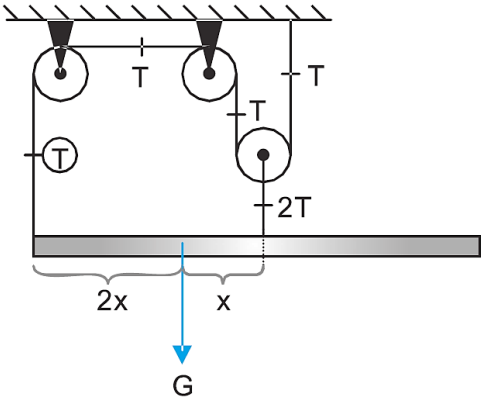
Grafikdan ko'rinib turibdiki, dastlabki massa 60 g. shunga ko'ra, bo'sh idishning massasi 60 g. Bo'sh idishning massasi 8 sekunddan keyin 460 g bo'lganligi sababli, bu vaqt ichida idishga quyilgan suyuqlikning massasi 400 g va uning hajmi $20\ cm^3 \cdot 8 = 160\ cm^3$ ni tashkil etadi. Shuning uchun suyuqlikning zichligi,

$$\rho = \frac{m}{V} = \frac{400\ g}{160\ cm^3} = 2{,}5\,\frac{g}{cm^3}\ .$$

74-masala: Agar rasmda ko'rsatilgandek bir jinsli sterjen ishqalanishsiz sistemada vaznsiz shkivlar yordamida muvozanatda bo'lsa, sterjenning uzunligi qancha?



Agar sterjen osilgan chap tomondagi ipning taranglik kuchi T ga teng bo'lsa va arqonni davom etishida hosil bo'ladigan taranglik kuchlarini T orqali quyidagicha ifodalaymiz;

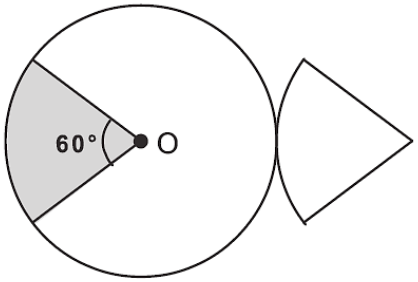


Arqonlarning bir xil tayoqning og'irlik markazigacha bo'lgan masofalari taranglik kuchiga teskari proporsionaldir. Shunga ko'ra;

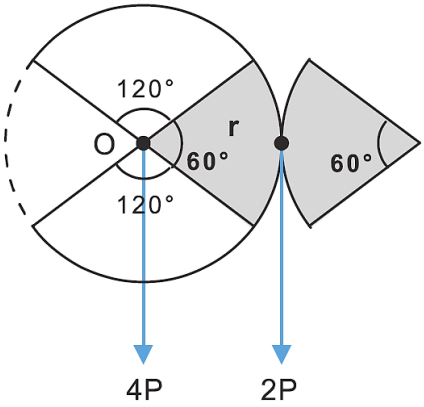
$$3x = 18\ cm \quad \Rightarrow \quad x = 6\ cm\ ;$$

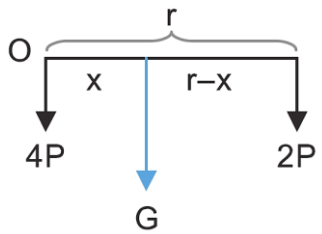
Agar sterjenning yarim uzunligi $2x$ bo'lsa, sterjenning butun uzunligi $4x$ bo'ladi. Shunday qilib, sterjenning butun uzunligi $4x = 4 \cdot 6\ cm = 24\ cm$.

75-masala: Shakldagi radiusi r bo'lgan doiradan, rasmdagidek bo'yalgan qismi kesib olinib uning yon tomoniga qo'shiladi. Natijada aylananing og'irlik markazi qanchaga siljiydi?



60^0 ga mos keladigan qismning og'irligi agar P deyilsa, butun shaklning og'irligi 6P ga teng. 60^0 li qismning og'irlik markazining joylashuvi noma'lum. Shuning uchun, savolni hal qilishda ushbu qismga o'xshash qismni olib ularning og'irliklari va massa markazlari quyidagicha topiladi.

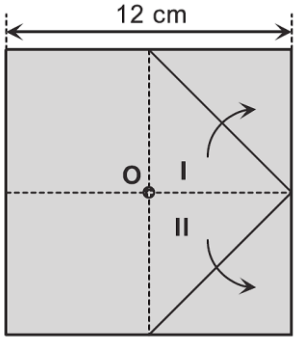




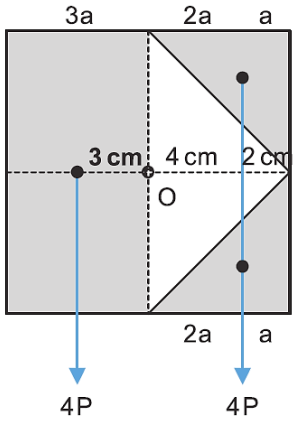
Momentlar qoidasiga ko'ra;

$$4P \cdot x = 2P \cdot (r - x) \quad \Rightarrow \quad 3x = r \quad \Rightarrow \quad x = \frac{r}{3}.$$

76-masala: Qirrasining uzunligi 12 cm bo'lgan bir jinsli kvadrat plastinkaning I va II qismlari o'qlar bilan ko'rsatilgan yo'nalishlarda simmetrik qatlanadi. Yangi shaklning massa markazi dastlabki holatga nisbatan necha cm ga siljiydi?



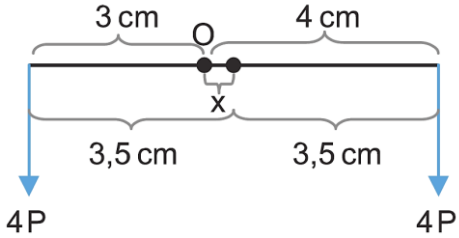
Har bir uchburchak shaklidagi bo’lakning og’irligini P deb olsak, yangi shaklning og’irliklari ko’rsatilgan bo’limlardagi qismlar o’z-o’zidan qo’shilgandan keyin hisoblanadi.



Rasmga ko’ra;

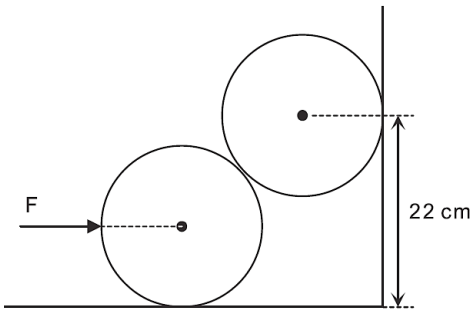
$$6a = 12\ cm \quad \Rightarrow \quad a = 2\ cm\ ;$$

ga teng va yuqorida ko’rsatilganidek;

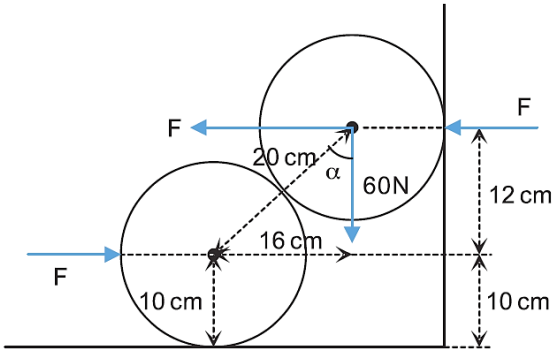


$$3\ cm + x = 3{,}5\ cm \quad \Rightarrow \quad x = 0{,}5\ cm\ .$$

77-masala: Radiusi 10 cm va og’irligi 60 N bo’lgan bir xil va bir jinsli sharlarni rasmda ko’rsatilgandekmuvozanatda ushlab turuvchi F kuch necha Nyuton?

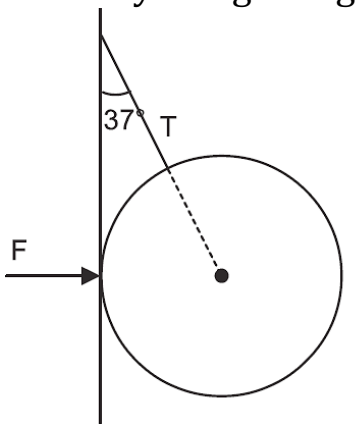


Sharlarga ta’sir etuvchi kuchlarni tasvirlab, muvozanat shartini yozib olamiz;

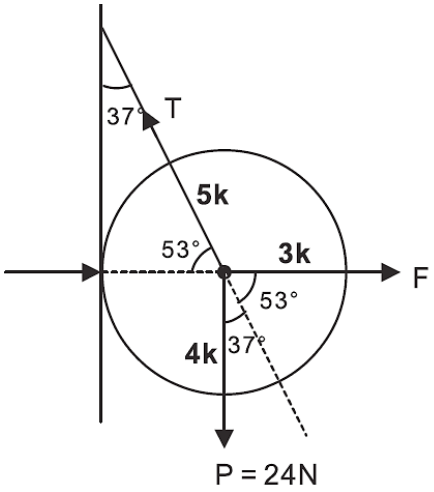


$$tg\alpha = \frac{16\ cm}{12\ cm} = \frac{F}{60\ N} \quad \Rightarrow \quad F = 80\ N\ .$$

78-masala: Og'irligi 24 N bo'lgan bir jinsli shar rasmda ko'rsatilgandek ishqalanishsiz muhitda muvozanatda bo'lsa, sirtning reaksiya kuchi F va arqonning taranglik kuchi T necha Nyutonga teng?



Sharga ta'sir etuvchi kuchlar va bu kuchlar orasidagi burchaklarni chizmada tasvirlab olamiz.



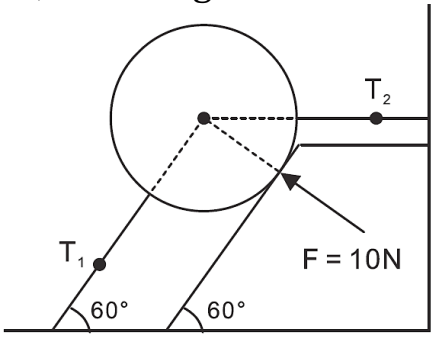
Shunga ko'ra;

$$P = 4k = 24\ N \quad \Rightarrow \quad k = 6\ N$$

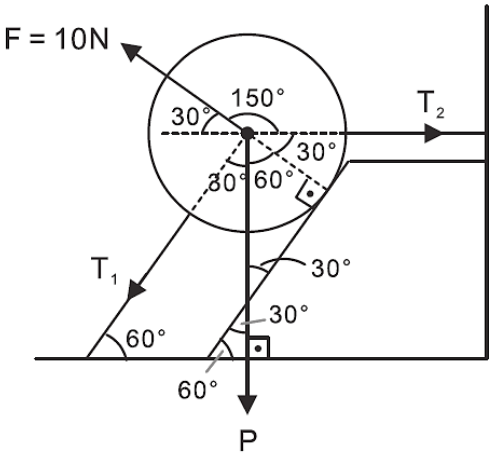
Arqondagi T taranglik kuchini va sirtning F ta'sir kuchini k ga nisbatan yozib olamiz;

$$F = 3k = 3 \cdot 6\ N = 18\ N\ ; \quad \Rightarrow \quad T = 5k = 5 \cdot 6\ N = 30\ N\ .$$

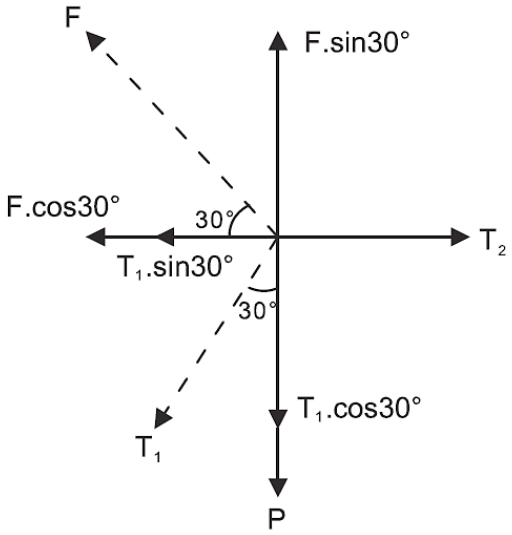
79-masala: Rasmdagi bir jinsli sharning og'irligi 2N va sistema muvozanatda. Shunga ko'ra, T_2 taranglik kuchi necha Nyuton?



Sharga ta’sir etuvchi barcha kuchlar chizmada ko’rsatilgan va bu kuchlar tarkibiy qismlarga ajratilgan.



yoki o’qlar bo’yicha sharga ta’sir etuvchi kuchlarni quyidagicha tasvirlab olamiz;



Birinchi arqonning taranglik kuchini quyidagi tenglikdan topamiz;

$$F \cdot sin30^0 = P + T_1 \cdot cos30^0 \quad \Rightarrow \quad 10\ N \cdot \frac{1}{2} = 2\ N + T_1 \cdot \frac{\sqrt{3}}{2} \quad \Rightarrow \quad T_1 = 2\sqrt{3}\ N$$

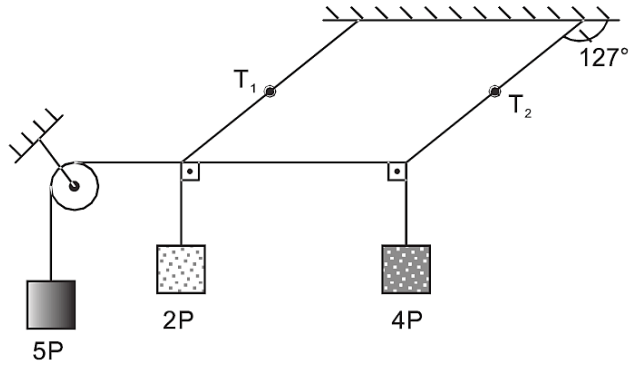
Ikkinchi arqonning taranglik kuchini esa quyidagicha hisoblaymiz;

$$F \cdot cos30^0 + T_1 \cdot sin30^0 = T_2 \quad \Rightarrow \quad 10\ N \cdot \frac{\sqrt{3}}{2} + 2\sqrt{3}\ N \cdot \frac{1}{2} = T_2$$

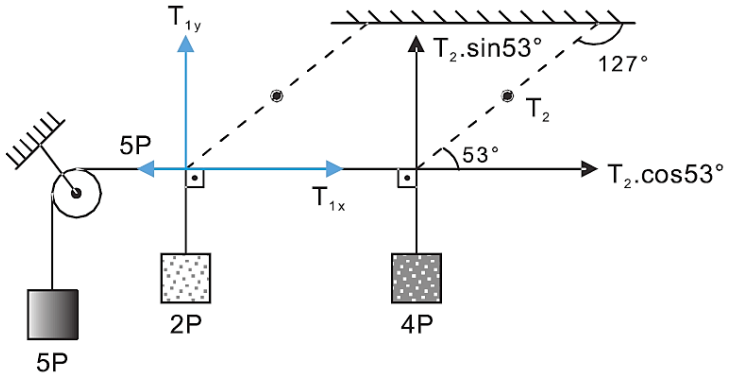
yoki;

$$T_2 = 6\sqrt{3}\ \ N\ .$$

80-masala: Rasmdagi tizim muvozanatda bo’lsa, birinchi ipdagi taranglik kuchi necha P ga teng? ($sin53^0 = 0{,}8\ ;\ cos53^0 = 06$).



Gorizontal va vertikal qismlarga ajratilgan va sistemaga ta’sir qiluvchi kuchlar tarkibiy qismlarga ajratilgandan keyin muvozanat tenglamasi yoziladi.



$$T_2 \cdot sin53^0 = 4P \quad \Rightarrow \quad T_2 \cdot 0{,}8 = 4P \quad \Rightarrow \quad T_2 = 5P\ ;$$

Ikkinchi tomondan;

$$T_{1y} = 2P\ ; \quad \Rightarrow \quad 5P = T_{1x} + T_2 cos53^0 \quad \Rightarrow \quad T_{1x} = 5P - 5P \cdot 0{,}6 = 2P\ ;$$

Birinchi ipdagi taranglik kuchini T_{1x} va T_{1y} orqali Pifagor teoremasidan hisoblaymiz;

$$T_1 = \sqrt{T_{1x}^2 + T_{1y}^2} = \sqrt{(2P)^2 + (2P)^2} = 2\sqrt{2}P\ ;$$

21. 36 km/h tezlik bilan harakatlanib kelgan 2 t massali avtomobil tormozlash boshidan 25 m yo’l o’tib to’xtadi. Tormozlovchi kuch miqdorini (kN da) aniqlang.

Javob: 4

22. Qandaydir kuch ta’sirida tinch holatidan harakatga kelgan aravacha 40 cm yo’l o’tdi. Aravachaga 2 kg yuk qo’yilganda u o’sha kuch ta’sirida, o’shancha vaqt ichida tinch holatidan boshlab 20 cm yo’l o’tdi. Aravachaning massasi qancha?

Javob: 2

23. Brusok vertikal devor bo’ylab yuqoriga ko’chirilmoqda. Unga vertikalga qandaydir burchak ostida yo’nalgan kuch qo’yilgan. Agar brusokning

devorga normal bosim kuchi unga qo'yilgan kuchdan ikki marta kichik bo'lsa, kuch qanday burchak ostida qo'yilganini (graduslarda) toping.

Javob: 30

24. 1 kg massali jism gorizontal tekislikda joylashgan. Jismga 2 N gorizontal kuch ta'sir qiladi. Ishqalanish koeffitsiyenti 0,3 bo'lsa, ishqalanish kuchini aniqlang.

Javob: 2

25. Yuk mashinasi o'zining kuzovidagi mahkamlanmagan yuk siljimasligi uchun qanday eng katta tezlanish bilan harakatlanishi kerak? Yukning kuzov tubiga ishqalanish koeffitsiyenti 0,2. $g=10m/s^2$.

Javob: 2

26. Jism qiya tekislik bo'ylab tekis sirpanmoqda. Agar jismning tekislikka ishqalanish koeffitsiyenti 0,2 bo'lsa, tekislikning gorizontga qiyalik burchagi kotangensi nimaga teng?

Javob: 5

27. Asosining uzunligi va balandligi 6 m bo'lgan qiya tekislik uchida og'ir jism joylashgan. Agar jism shu tekislikda tinch turadigan chegaraviy burchak balandlik 2,4 m va asos uzunligi oldingidek 6 m bo'lganda ro'y bersa, jism qiya tekislik asosigacha qancha vaqtda sirpanib tushadi? $g=10m/s^2$.

Javob: 2

28. 4 va 5 kg massali, ip orqali bog'langan ikki yuk ularning biriga qo'yilgan 27 N gorizontal kuch ta'sirida silliq stol ustida harakatlanmoqda. Yuklarning tezlanishini toping.

Javob: 3

29. Massalari 0,3 kg va 0,2 kg bo'lgan ikki jism ip orqali bog'langan va silliq gorizontal sirt ustida yotibdi. 6 N yuklanishga dosh bera oladigan ip uzilib ketmasligi uchun birinchi jismni gorizontal yo'nalgan qanday maksimal kuch bilan tortish kerak?

Javob: 15

30. Blok tros orqali shiftga osib qo'yilgan. Blok orqali uchlariga yuklar osilgan ip o'tkazilgan. Agar yuklarning harakat vaqtida trosning tarangligi og'irroq yukning og'irlik kuchiga teng bo'lsa, yuklarning massalari nisbati qanday?

Javob: 3

31. Neptun sayyorasi va Quyosh orasidagi masofa Yer va Quyosh orasidagi masofadan 30 marta katta, Neptunning massasi esa Yerning massasidan 15 marta katta. Quyoshning Yerga tortilish kuchi Quyoshning Neptunga tortilish kuchidan necha marta katta?

Javob: 60

32. Yer sirtidan qanday balandlikda (km da) erkin tushish tezlanishi Yer sirtidagiga qaraganda 16 marta kichik bo'ladi? Yerning radiusi 6400 km.

Javob: 19200

33. Agar Marsning radiusi Yer radiusining 0,5 qismini, Marsning massasi esa Yer massasining 0,1 qismini tashkil etsa, Mars sirtidagi erkin tushish tezlanishi Yerdagi erkin tushish tezlanishining necha foizini tashkil qiladi?

Javob: 40

34. Qandaydir sayyoraning radiusi Yer radiusidan 10 marta katta, sayyora moddasining o'rtacha zichligi esa Yerning o'rtacha zichligidan 2 marta kichik. Sayyora sirtidagi erkin tushish tezlanishi Yer sirtidagiga qaraganda necha marta katta?

Javob: 5

35. Qandaydir sayyoraning massasi Yer massasidan 4,5 marta katta, uning radiusi esa Yer radiusidan 2 marta katta. Shu sayyora uchun birinchi kosmik tezlik Yer uchun birinchi kosmik tezlikdan necha foizga ortiq?

Javob: 50

36. Yer sirtidan 21600 km masofada harakatlanadigan yo'ldoshning aylanish davri uning sirtidan 600 km masofada harakatlanadigan yo'ldoshning aylanish davridan necha marta katta. Yerning radiusi 6400 km.

Javob: 8

37. Yer sun'iy yo'ldoshining aylanish davri 27 marta oshirilsa, uning aylanma orbitasining radiusi necha marta ortadi?

Javob: 9

38. 1 va 2 kg massali sharchalar mos ravishda 4 m/s va 6 m/s tezliklar bilan bir-biriga parallel ravishda bir yo'nalish bo'ylab harakatlanadi. Bu ikki sharchaning natijaviy impulsi qanchaga teng?

Javob: 16

39. 3 kg massali bir xil sharchalar 3 m/s va 4 m/s tezliklar bilan o'zaro perpendikulyar yo'nalishda harakatlanadi. Bu sistemaning to'liq impulsi qiymati qanchaga teng?

Javob: 15

40. 0,2 kg massali sharcha tushish paytida 15 m/s tezlikka ega bo'lgan holda gorizontal maydonchaga erkin tushdi. Absolyut elastik urilishdagi sharcha impulsining o'zgarishini toping. Javobda olingan qiymatning modulini ko'psating.

Javob: 6

41. Massasi 2 kg bo'lgan jism aylana bo'ylab harakatlandi, va bunda u qaysidir nuqtada 4 m/s tezlikka ega bo'ldi. Aylananing to'rtdan birini o'tib, jism 3 m/s tezlikka erishdi. Jism impulsi o'zgarishining modulini aniqlang.

Javob: 10

42. Quroldan 600 m/s tezlik bilan snaryad uchib chiqadi. Agar porox gazlarining o'rtacha bosim kuchi 2700 kN ga teng bo'lsa va snaryad stvol ichida 0,002 s harakatlansa, snaryadning massasini aniqlang.

Javob: 9

43. Avtomat o'qining uchib chiqish paytidagi tezligi 300 m/s, massasi esa 10 g bo'lsa, o'q uzish paytida avtomatning yelkaga beradigan o'rtacha bosim kuchi qanday bo'ladi? Avtomat minutiga 300 ta o'q otadi.

Javob: 15

44. Ikki jismning har biri 3 m/s tezlik bilan bir-biriga qarab harakatlanib, o'zaro to'qnashgandan keyin 1,5 m/s tezlik bilan birga harakatlana boshladi. Ular massasining nisbatini toping.

Javob: 3

45. 5 kg massali miltiqdan o'q uziladi. Merganning yelkasiga tiralmagan miltiqning orqaga tisarilish tezligi mergan miltiqni yelkasiga qattiq tirab turgan holatdagi orqaga tisarilish tezligidan necha marta ortiq bo'ladi? Merganning massasi 75 kg.

Javob: 16

46. Aravacha silliq relslarda turibdi. Odam uning bir tomonidan ikkinchi tomoniga relslarga parallel holatda yurib o'tadi. Bunda aravacha yerga nisbatan qanday masofaga siljiydi? Odamning massasi 60 kg, aravachaning massasi 120 kg, uning uzunligi 6 m.

Javob: 2

47. Qandaydir balandlikdan 20 m/s tezlik bilan tosh gorizontal otildi. Otishdan 4 s o'tib toshning kinetik energiyasi 3000 J ga teng bo'ldi. Toshning massasi qanday? g=10 m/s^2.

Javob: 3

48. 4 kg massali erkin tushayotgan jismning tezligi qandaydir masofada 2 m/s dan 8 m/s gacha oshdi. Shu yo'ldagi og'irlik kuchining ishini toping.

Javob: 120

49. Ventilyator aylanishining tezligi ikki marta oshgan paytda uning foydali quvvati necha marta oshadi?

Javob: 8

50. 10 kN/m bikrlikli siqilgan prujina 50 J ga teng potensial energiya zahirasiga ega. Prujina necha santimetrga siqilgan?

Javob: 10

51. Prujinaga 100 g massali yuk osilgan. Prujinaning potensial energiyasi 9 marta ortishi uchun birinchi yukka qo'shimcha ravishda qanday massali (g da) yukni mahkamlash kerak?

Javob: 200

52. Prujinani 2 cm ga siqib 12 J ish bajarildi. Uni yana 3 cm ga siqish uchun qanday ish bajarish kerak?

Javob: 63

53. 0,5 kg massali jism yer yuzasidan 10 m balandlikdan 10 m/s tezlik bilan otildi. Jismning yerga tushish paytdagi kinetik energiyasi qanday bo'ladi? $g=10\ m/s^2$.

Javob: 75

54. Agar trayektoriyaning eng yuqori nuqtasida jismning kinetik energiyasi potensial energiyaga teng bo'lsa, u yer yuzasidan gorizontga qanday burchak ostida otilgan? Yer yuzasidagi potensial energiyani nolga teng deb qabul qiling.

Javob: 45

55. 12 N og'irlikdagi quvur yerda yotibdi. Uning bir uchidan ko'tarish qo'yish uchun qanday kuch qo'yish kerak?

Javob: 6

56. Bir jinsli yupqa plastina tomonlari 15, 20 va 25 cm bo'lgan uchburchak shakliga ega. Plastinaning og'irlik markazi katta tomondan qanday masofada (cm da) joylashgan?

Javob: 4

57. Bir jismning zichligi suvning zichligidan 1,25 marta katta. Shu jismning suvdagi og'irligi havodagi og'irligidan necha marta kichik bo'ladi?

Javob: 5

58. Jism havoda 3 N, suvda 1,8 N va noma'lum zichlikdagi suyuqlikda esa 2,04 N og'irlikka ega. Shu noma'lum suyuqlikning zichligi qanday?

Javob: 800

59. Yog'och bo'lagi hajmining 3/4 qismi suvga botgan holda suvda suzmoqda. Yog'och qanday zichlikka ega?

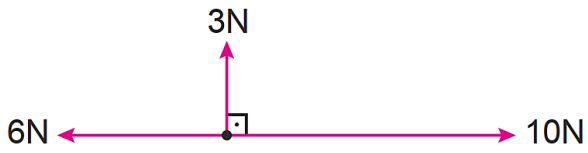
Javob: 750

60. 0,2 kg massali yuk bikrligi 125 N/m bo'lgan prujinada garmonik tebranmoqda. Tebranishlar amplitudasi 0,08 m bo'lsa, yukning eng katta tezlanishini aniqlang.

Javob: 50

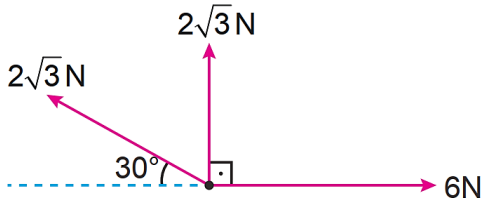
Qo'shimcha Test savollari.

1. Rasmdagi kuchlarning natijaviysi necha Nyutonga teng?



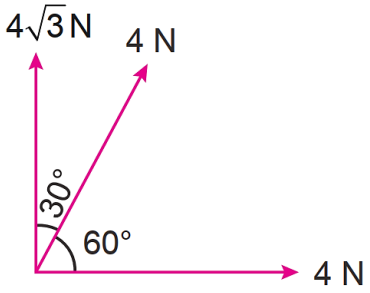
A) 3. B) 5. C) 6. D) 10.

2. Kuchlarning teng ta'sir etuvchisini hisoblang (N).



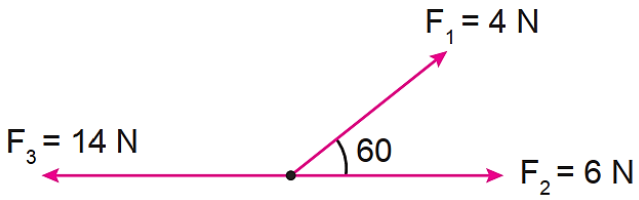
A) 3. B) $2\sqrt{3}$. C) 6. D) $4\sqrt{3}$.

3. Rasmda kuchlarning teng ta'sir etuvchisini hisoblang (N).



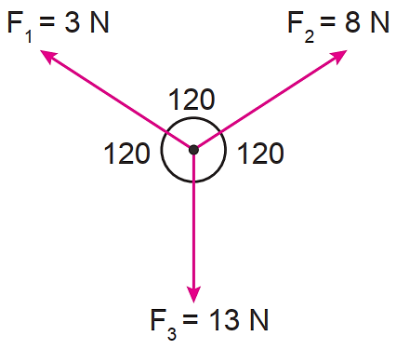
A) 4. B) 8. C) 10. D) 12.

4. Ishqalanishsiz sirtda jismga ta'sir etuvchi kuchlar rasmda tasvirlangan. Kuchlarning teng ta'sir etuvchisini hisoblang (N). $sin60^0 = \sqrt{3}/2;\ \ cos60^0 = 1/2$.



A) 4. B) $4\sqrt{3}$. C) 8. D) $8\sqrt{3}$.

5. Ishqalanishsiz sirtda jismga ta'sir etuvchi 3 ta kuch rasmda tasvirlangan. Bu kuchlarning ta'sir etuvchisini hisoblang (N).



A) $3\sqrt{3}$. B) 5. C) $5\sqrt{3}$. D) 8.

Javoblar:

1	2	3	4	5
B	C	D	B	C

6. Massasi 2 t bo'lgan avtomobil egrilik radiusi 100 m bo'lgan qavariq ko'prik ustida 72 km/h tezlik bilan harakatlanmoqda. Mashina ko'prik markazidan o'tayotib uni qanday kuch bilan bosadi (kN)? $g = 10\ m/s^2$.

A) 8. B) 10. C) 12. D) 20.

7. Agar 90 km/h tezlik bilan harakatlanayotgan avtomobilning bosimi aylana yoyi ko'rinishidagi mostning eng yuqori nuqtasida ikki marta kamaygani ma'lum bo'lsa (yo'lning gorizontal qismidagi bosim bilan solishtirganda), shu egri mostning radiusini aniqlang (m). $g = 10\ m/s^2$.

A) 125. B) 150. C) 225. D) 625.

8. Jismni qandaydir sayyoraning qutbidan ekvatoriga ko'chirishda uning vazni 20 % ga kamayadi. Sayyoraning aylanish burchak tezligi 0,001 rad/s, uning radiusi 3000 km. Shu sayyoradagi erkin tushish tezlanishi qanchaga teng? Sayyorani ideal shar deb hisoblang (m/s^2).

A) 5. B) 10. C) 12. D) 15.

9. Samolyot "o'lik sirtmoq" bajarmoqda. Trayektoriyaning quyi nuqtasida uchuvchining o'rindiqqa beradigan bosim kuchi og'irlik kuchidan 5 marta katta. Yuqori nuqtada uchuvchi vaznsizlik holatida bo'ladi. samolyotning quyi nuqtadagi tezligi yuqori nuqtadagidan necha marta katta?

A) 2. B) 3. C) 5. D) 6.

10. 65 kg massali chang'ichi yo'lning egrilik radiusi 20 m bo'lgan botiq qismi bo'ylab harakatlanmoqda. Agar chang'ichining tezligi 2 m/s bo'lsa, yo'lning shu qismining eng pastki nuqtasida chang'ilarning yo'lga beradigan bosim kuchini aniqlang (N). $g = 9{,}8\ m/s^2$.

A) 400. B) 650. C) 750. D) 800.

Javoblar:

6	7	8	9	10
C	A	C	A	B

11. Qandaydir sayyoraning massasi Yer massasidan 4,5 marta katta, uning radiusi esa Yer radiusidan 2 marta katta. Shu sayyora uchun birinchi kosmik tezlik Yer uchun birinchi kosmik tezlikdan necha % ga ortiq? Yer uchun birinchi kosmik tezlik 8 km/s.

A) 20. B) 30. C) 40. D) 50.

12. Yer sirtidan 3600 km balandlikda aylana orbitasi bo'ylab harakatlanishi uchun sun'iy yo'ldosh qanday tezlikka ega bo'lishi kerak (m/s)? Yerning radiusi 6400 km. Yer sirtida og'irlik kuchining tezlanishi 10 m/s^2.

A) 1850. B) 2500. C) 3200. D) 6400.

13. Yo'ldosh ekvator tekisligida sayyora sirtidan uning radiusiga teng balandlikda aylana orbita bo'ylab harakatlanadi. Yo'ldoshning chiziqli tezligini (km/s da) toping. sayyoraning radiusi 7200 km. Sayyora sirti yaqinida erkin tushish tezlanishi 10 m/s^2.

A) 2. B) 3. C) 6. D) 10.

14. Qandaydir sayyoraning Quyosh atrofida aylana orbita bo'ylab aylanish davri 27 yilga teng. Shu sayyoradan Quyoshgacha bo'lgan masofa Yerdan Quyoshgacha bo'lgan masofadan necha marta katta?

A) 3. B) 6. C) 9. D) 18.

15. Yer sun'iy yo'ldoshining aylanish davri 27 marta oshirilsa, uning aylanma orbitasining radiusi necha marta ortadi?

A) 3. B) 9. C) 6. D) 27.

Javoblar:

11	12	13	14	15
D	D	C	C	B

16. 2000 kg massali avtomobil egrilik radiusi 100 m bo'lgan va 18000 N dan ortiq bo'lmagan yuklanishga bardosh bera oladigan qavariq ko'prikdan muvaffaqiyatli o'tishi uchun u qanday minimal qiymatgacha tezligini oshirishi kerak (m/s)? g $= 10\ m/s^2$.

A) 10. B) 15. C) 20. D) 40.

17. Samolyot "o'lik sirtmoq" bajarmoqda. Trayektoriyaning quyi nuqtasida uchuvchining o'rindiqqa beradigan bosim kuchi og'irlik kuchidan 5 marta katta. Yuqori nuqtada uchuvchi vaznsizlik holatida bo'ladi. Samolyotning quyi nuqtadagi tezligi yuqori nuqtadagidan necha marta katta?

A) 2. B) 3. C) 4. D) 5.

18. Agar 90 km/h tezlik bilan harakatlanayotgan avtomibilning bosimi aylana yoyi ko'rinishidagi mostning eng yuqori nuqtasida ikki marta kamaygani ma'lum bo'lsa (yo'lning gorizontal qismida bosim bilan solishtirilganda), shu egri mostning radiusini aniqlang (m). $g = 10\ m/s^2$.

A) 125. B) 150. C) 200. D) 250.

19. Ipning uchiga bog'langan 250 g massali sharcha vertikal tekislikda tekis aylanadi. Ipning taranglik kuchi trayektoriyaning pastki nuqtasida yuqori nuqtasidagiga qaraganda qanchaga ortiq (N)? $g = 10\ m/s^2$.

A) 3. B) 4. C) 5. D) 6.

20*. 540 km/h tezlik bilan uchayotgan samolyot qayrilishida tangensi 0,3 ga teng bo'lgan burchakka og'adi. Qayrilishning radiusi qanchaga teng (m)? $g = 10\ m/s^2$.

A) 6250. B) 7500. C) 8400. D) 9600.

Javoblar:

16	17	18	19	20
A	A	A	C	B

21. 3 kg massali brusok gorizontal prujina yordamida gorizontal joylashgan doska bo'ylab tekis tortilmoqda. Agar prujina 5 cm ga uzaygan bo'lsa, uning bikrligi qanday (N/m)? brusok va doska orasidagi ishqalanish koeffitsiyenti 0,25. $g = 10\ m/s^2$.

A) 75. B) 100. C) 150. D) 200.

22. 2 kg massali jism gorizontal kuch ta'sirida gorizontal sirt bo'ylab 2 m/s^2 tezlanish bilan harakatlanmoqda. Agar jism va tekislik orasidagi ishqalanish koeffitsiyenti 0,2 bo'lsa, shu kuchning miqdorini toping. $g = 10\ m/s^2$.

A) 2. B) 4. C) 8. D) 12.

23. Yuk mashinasi o'zining kuzovidagi mahkamlanmagan yuk siljimasligi uchun qanday eng katta tezlanish bilan harakatlanishi kerak (m/s^2)? Yukning kuzov tubiga ishqalanish koeffitsiyenti 0,2. $g = 10\ m/s^2$.

A) 2. B) 3. C) 5. D) 10.

24. Qo'zg'almas o'qqa ega bo'lgan blok orqali o'tkazilgan ipning uchlariga massalari 7 va 11 kg bo'lgan yuklar osilgan. Harakat boshlanganidan necha millisekund o'tgach yengil yuk og'ir yukdan 20 cm yuqorida bo'ladi? $g = 10\ m/s^2$.

A) 120. B) 260. C) 300. D) 440.

25*. Qo'zg'almas o'qqa ega blok orqali o'tkazilgan ipning uchlariga har birining massasi 0,49 kg bo'lgan jismlar osilgan. Jismlarning har biri 4 s da 1,6 m yo'l o'tishi uchun ulardan birining ustiga qanday massali qo'shimcha yuk qo'yish kerak (g)? $g = 10\ m/s^2$.

A) 10. B) 20. C) 25. D) 30.

Javoblar:

21	22	23	24	25
C	C	A	C	B

26. Qo'zg'almas blokka ip yordamida $m_1 = 5$ kg va $m_2 = 3$ kg massali yuklar osilgan. Yuklar harakatlana boshlagan paytdan 12 s paytdagi blok aylanishining oniy chastotasi qanday (ayl/s) bo'ladi? Blok radiusi $R = 2$ cm. $\pi \approx 3$ deb hisoblang.

A) 125. B) 144. C) 180. D) 250.

27. Qo'zg'almas blok orqali o'tkazilgan chilvir uchlariga $m_1 = 3$ kg va $m_2 = 2$ kg yuklar osilganida tizim tinch holatdan harakatga kelsa va ishqalanish hisobga olinmasa 2 s dan so'ng yuklar tezligi qanday (m/s) bo'ladi?

A) 1. B) 2. C) 3. D) 4.

28. 540 km/h o'zgarmas tezlik bilan uchayotgan samolyot vertikal tekislikda radiusi 750 m bo'lgan "Nesterov sirtmog'i" nomli doiraviy figura yasadi. Uchuvchining sirtmoqning eng yuqori nuqtasidagi yuklanishini aniqlang.

A) 2. B) 3. C) 4. D) 5.

29. Massasi 70 kg bo'lgan parashutchi samolyotdan sakragandan so'ng ma'lum vaqt o'tgach, uning tezligi 55 m/s ga yetganda, parashut ochildi.

Parashut ochilgandan keyin, 2 s da uning tezligi 5 m/s gacha kamaydi. Tormozlanish paytida parashutchining og'irligi (vazni) qanday (N) bo'lgan?

A) 700. B) 1050. C) 1750. D) 2450.

30*. Massasi 1000 kg bo'lgan avtomobil egrilik radiusi 250 m bo'lgan qavariq ko'prik ustida 72 km/h tezlik bilan harakatlanmoqda. Ko'prikning egrilik markazidan unga tomon o'tkazilgan chiziq vertical bilan 30^0 burchak hosil qiluvchi nuqtada avtomobil ko'prikka qanday kuch bilan (kN da) bosadi? $\sqrt{3} \approx 1{,}72;\ g = 10\ m/s^2$.

A) 5. B) 7. C) 8. D) 11.

Javoblar:

26	27	28	29	30
D	D	A	D	B

31. Jism balandligi 5 m va uzunligi 13 m bo'lgan qiya tekislikdan sirpanib tushadi. Ishqalanish koeffitsiyenti 0,4. Jismning qiya tekislik bo'ylab harakat vaqtini toping (s). $g = 10\ m/s^2$.

A) 8. B) 10. C) 13. D) 15.

32. Jism qiya tekislik bo'ylab tekis sirpanmoqda. Agar jismning tekislikka ishqalanish koeffitsiyenti 0,2 bo'lsa, tekislikning gorizontga burchagi kotangensi nimaga teng?

A) 0,2. B) 0,8. C) 2,5. D) 5.

33. Jismga turtki bilan qiya tekislik bo'ylab yuqoriga yo'nalgan 3 m/s tezlik berildi. Agar tekislikning gorizontal qiyalik burchagining sinusi 0,6, va ishqalanish koeffitsiyenti 0,25 bo'lsa, jismning yuqoriga to'xtagunicha bo'lgan harakat vaqtini (ms da) toping. $g = 10\ m/s^2$.

A) 125. B) 375. C) 450. D) 525.

34. 5 kg massali jismni balandligi 3 m va uzunligi 5 m bo'lgan qiya tekislik bo'ylab tekis ko'tarishmoqda, va bunda unga qiya tekislikka parallel kuch qo'yilgan. Agar ishqalanish koeffitsiyenti 0,3 ga teng bo'lsa, shu kuchning miqdorini toping (N). $g = 10\ m/s^2$.

A) 42. B) 46. C) 52. D) 64.

35*. Jismga gorizontal kuch qo'ygan holda qiya tekislik bo'ylab yuqoriga ko'tarishmoqda. Bu kuchning miqdori jismga ta'sir qiluvchi og'irlik kuchidan ikki marta katta. Qiya tekislikning balandligi 3 m va uzunligi 5 m. Agar ishqalanish koeffitsiyenti 0,2 ga teng bo'lsa, jismning tezlanishini toping (m/s^2). $g = 10\ m/s^2$.

A) 2. B) 4. C) 6. D) 10.

Javoblar:

31	32	33	34	35
C	D	B	A	C

36. Qiyaligi 0,6 ga teng bo'lgan qiya tekislikning FIK ni (%) toping. ishqalanish koeffitsiyenti $\mu = 0{,}3$.

A) 93. B) 71. C) 62. D) 90.

37. FIK 60 % bo'lgan qurilmaning 30 kJ energiya sarflaganda bajaradigan ishini toping (J).

A) $2 \cdot 10^4$. B) $1{,}8 \cdot 10^4$. C) $1{,}8 \cdot 10^5$. D) $5 \cdot 10^3$.

38. Balandligi 10 m bo'lgan tepalikdan massasi 100 kg bo'lgan chana sirpanib tushmoqda. Tepalik ejagida uning tezligi 10 m/s ga yetgan bo'lsa, tushish vaqtida qancha (kJ) energiya issiqlikka aylangan?

A) 5. B) 10. C) 15. D) 0.

39. Qiyalik burchagi gorizontga 45^0 bo'lgan taxta bo'ylab 5 kg massali brusok ip yordamida 1 m balandlikka tortib chiqariladi. Ip taxtaga parallel joylashgan. Brusokning taxtaga ishqalanish koeffitsiyenti 0,3. Taxta va brusokni qizdirishga ketadigan energiyani toping (J). $g = 10\ m/s^2$.

A) 12. B) 15. C) 25. D) 32.

40. 4,2 kg massali jism gorizontal kuch ta'sirida 2 m/s^2 o'zgarmas tezlanish bilan gorizontal sirt bo'ylab sirpanadi. Jism va yuza orasidagi ishqalanish koeffitsiyenti 0,1. 5 s vaqt ichida issiqlik ajralishining o'rtacha quvvatini toping (W). $g = 10\ m/s^2$.

A) 21. B) 42. C) 66. D) 74.

Javoblar:

36	37	38	39	40
B	B	A	B	A

41. 36 km/h tezlik bilan harakatlanishda elektrovoz 60 kW quvvat sarflaydi. Agar elektrovozning FIK 80% ga teng bo'lsa, uning tortish kuchini aniqlang (N).

A) 4800. B) 6400. C) 7200. D) 8600.

42. Uzunligi 13 m va balandligi 5 m bo'lgan qiya tekislikda 26 kg massali yuk yotibdi. Ishqalanish koeffitsiyenti 0,5. Yukni pastga siljitish uchun, unga tekislik bo'ylab pastga yo'nalgan qanday minimal kuch qo'yish kerak (N)? $g = 10\ m/s^2$.

A) 12. B) 18. C) 20. D) 24.

43. Uzunligi 1 m va balandligi 0,8 m bo'lgan qiya tekislikda 2 kg massali yuk yotibdi. Ishqalanish koeffitsiyenti 0,5. Yuk pastga sirpanib ketmasligi uchun, unga tekislikka perpendikulyar yo'nalgan qanday minimal kuch qo'yish kerak (N)? $g = 10\ m/s^2$.

A) 8. B) 10. C) 16. D) 20.

44. Balandligi 40 cm va asosining uzunligi 100 cm bo'lgan qiya tekislikda 6 kg massali yuk yotibdi. Agar ishqalanish koeffitsiyenti 0,5 ga teng bo'lsa, jismni qiya tekislikdan tortib tushirish uchun, unga gorizontal yo'nalgan qanday minimal kuch qo'yish kerak (N)? $g = 10\ m/s^2$.

A) 3. B) 5. C) 8. D) 10.

45. Qiya tekislikda joylashgan 2,6 kg massali brusokni pastga sirpanib ketishdan saqlab qolish uchun, unga gorizontal yo'nalgan qanday minimal kuch qo'yish kerak (N)? Qiya tekislik uzunligi 50 cm, balandligi 30 cm, ishqalanish koeffitsiyenti 0,4. $g = 10\ m/s^2$.

A) 5. B) 7. C) 11. D) 12.

Javoblar:

41	42	43	44	45
A	C	D	B	B

46. Ishchi 16 kg massali taxtaning bir uchidan shunday ushlab turibdiki, bunda taxta boshqa uchi bilan yerga tiraladi va gorizont bilan 60^0 burchak hosil qiladi. Ishchi taxtani qanday kuch bilan ushlab turibdi (N)? Kuch taxtaga perpendikulyar yo'nalgan. g = 10 m/s^2.

A) 48. B) 40. C) 72. D) 80.

47. Radiusi 5 cm va massasi 6 kg bo'lganshar silliq vertical devorga 8 cm uzunlikdagi ip yordamida osib qo'yilgan. Sharning devorga bosim kuchini aniqlang (N). g = 10 m/s^2.

A) 10. B) 15. C) 20. D) 25.

48. Bir uchiga 1,2 kg massali yuk osilgan bir jinsli sterjen muvozanatda turishi uchun tayanch uning o'sha uchidan o'z uzunligining 1/5 qismiga teng masofada qo'yilgan. Sterjenning massasi qanchaga teng (g)?

A) 400. B) 600. C) 800. D) 900.

49. Jismni yelkalari teng bo'lmagan richagli tarozida o'lchashda uning bir palladagi og'irligi 36 N ga, boshqasida esa 49 N ga teng bo'ldi. Jismning haqiqiy og'irligini aniqlang (N).

A) 42. B) 21. C) 28. D) 44.

50. 30 kg massali narvon silliq devorga 45^0 burchak ostida tirab qo'yilgan. Narvonning devorga bosim kuchini toping (N). Narvonning og'irlik markazi uning o'rtasida joylashgan. g = 10 m/s^2.

A) 90. B) 120. C) 150. D) 180.

Javoblar:

46	47	48	49	50
B	D	C	A	C

51. 1 m uzunlikdagi va 200 kg massali bir jinsli bo'lmagan to'g'ri balka tarang tortilgan vertikal troslarda ikki uchidan osib qo'yilgan. Balka gorizontal vaziyatda turibdi. Agar balkaning og'irlik markazi uning chap

uchidan 0,3 m masofada joylashgan bo'lsa, o'ngdagi trosning tarangligini toping (N). g = 10 m/s^2.

A) 300. B) 400. C) 600. D) 800.

52. Ikki kishi ustida yuki bor taxtani yelkalariga qo'yib olib borishadi. Ulardan biriga yuk og'irligining 2/5 qismiga teng yuklanish to'g'ri keladi. Agar yuk taxtaning o'rtasidan 10 cm masofada joylashgan bo'lsa, uning uzunligi qancha (cm)? Taxtaning massasini hisobga olmang. g = 10 m/s^2.

A) 100. B) 150. C) 200. D) 250.

53. Bir jinsli yupqa plastina asosi 16 cm va yon tomoni 10 cm bo'lgan teng yonli uchburchak shakliga ega. Plastinaning og'irlik markazi asosdan qanday masofada joylashgan (cm)?

A) 1. B) 2. C) 3. D) 4.

54. Bir jinsli yupqa plastina tomonlari 15, 20 va 25 cm bo'lgan uchburchak shakliga ega. Plastinaning og'irlik markazi katta tomondan qanday masofada joylashgan (cm)?

A) 2. B) 3. C) 4. D) 5.

55. Radiusi 28 cm bo'lgan bir jinsli shar ichida sharning yuzasiga urinadigan, radiusi ikki marta kichik sharsimon kovak bor. Sistemaning og'irlik markazi katta sharning markazidan qanday masofada joylashgan (cm)?

A) 2. B) 3. C) 4. D) 5.

Javoblar:

51	52	53	54	55
C	A	B	C	A

56. Moddiy nuqta $x = 2sin(\pi t/3 + \pi/2)$ qonun bo'yicha garmonik tebranadi. Bunda barcha kattaliklar SI birliklarida berilgan. Tebranish davrini aniqlang (s).

A) 2. B) 3. C) 6. D) 8.

57. Garmonik tebranishlar $x = Asin\omega t$ qonun bo'yicha sodir bo'ladi. $\pi/6$ rad fazada siljish 4 cm ga teng. Tebranishlar amplitudasini aniqlang (cm).

A) 4. B) 6. C) 8. D) 16.

58. Torning nuqtasi 1 kHz chastota bilan tebranadi. Agar tebranishlar amplitudasi 1 mm bo'lsa, shu nuqta 1,2 s da qanday yo'lni bosib o'tadi (cm)?

A) 160. B) 240. C) 320. D) 480.

59. Garmonik tebranayotgan jism tezligi $\upsilon = 6\cos 3t$ (m/s) qonunga bo'ysunsa, tezlanish amplitudasi qanday (m/s^2)?

A) 2. B) 9. C) 18. D) 54.

60. Moddiy nuqtaning tebranma harakati $x = Asin\omega t$ qonuniyat bo'yicha ro'y bermoqda. Tebranishlar davrining qanday qismida u tebranish amplitudasining ikkinchi yarmini bosib o'tadi?

A) T/2. B) T/3. C) T/4. D) T/6.

Javoblar:

56	57	58	59	60
C	C	D	C	D

61. Agar matematik mayatnikning uzunligi 5 cm ga qisqartirilganda, tebranishlar chastotasi 1,5 marta ortsa, uning dastlabki uzunligini aniqlang (cm).

A) 3. B) 6. C) 9. D) 15.

62. Matematik mayatnik 0,36g (g-erkin tushish tezlanishi) tezlanish bilan tushayotgan tezyurar lift kabinasiga joylashtirilganda, uning tebranishlar davri necha % ga ortadi?

A) 15. B) 25. C) 30. D) 36.

63. Ikkita matematik mayatnikning biri 40 marta tebranganda, ikkinchisi 20 marta tebranadi. Ikkinchi mayatnikning uzunligi birinchisining uzunligidan necha marta katta?

A) 2. B) 4. C) 8. D) 10.

64*. Moddiy nuqta muvozanat vaziyatidan 4 cm ga siljiganida uning tezligi 6 cm/s ga, 3 cm ga siljiganida esa 8 cm/s ga teng. Tebranishlar amplitudasini toping (cm).

A) 2. B) 3. C) 5. D) 8.

65. 0,2 kg massali yuk bikrligi 125 N/m bo'lgan prujinada garmonik tebranmoqda. Tebranishlar amplitudasi 0,08 m bo'lsa, yukning eng katta tezlanishini aniqlang (m/s^2).

A) 10. B) 25. C) 40. D) 50.

Javoblar:

61	62	63	64	65
C	B	B	C	D

66. Tovushning havodagi tarqalish tezligi 340 m/s, qandaydir suyuqlikda esa 1360 m/s. Havodan suyuqlikka o'tishda tovush to'lqinining uzunligi necha marta ortadi?

A) 2. B) 3. C) 4. D) 8.

67. 200 Hz chastotali tovush to'lqinining uzunligi 750 MHz chastotali ultraqisqa to'lqinlar diapazonining radioto'lqini uzunligidan necha marta katta? Tovush tezligi 320 m/s.

A) 4. B) 6. C) 8. D) 10.

68. Davri 0,01 s bo'lgan tebranishlar 10 m uzunlikka ega bo'lgan tovush to'lqinini yuzaga keltiradigan materialda tovushning tarqalish tezligini toping (m/s).

A) 10. B) 100. C) 1000. D) 10000.

69. Tovushning suvdagi tezligi 1450 m/s. Agar tebranishlar chastotasi 725 Hz bo'lsa, qarama-qarshi fazalarda tebranuvchi qo'shni nuqtalar bir-biridan qanday masofada joylashgan (m)?

A) 1. B) 2. C) 4. D) 5.

70. Agar muhitning bir to'g'ri chiziqda yotgan, bir-biridan 0,5 m masofada joylashgan ikki nuqtasi $\pi/8$ fazalar farqi bilan tebransa, to'lqin uzunligini toping (m).

A) 2. B) 4. C) 8. D) 16.

Javoblar:

66	67	68	69	70
C	A	C	B	C

71. Dengiz chuqurligi exolot yordamida aniqlanadi. Agar exolotdan yuborilgan ultratovush impulslari 2 s dan so'ng qaytgan bo'lsa, dengiz chuqurligi qanday (m)? tovushning suvda tarqalish tezligi 1480 m/s.

A) 370. B) 740. C) 1480. D) 2960.

72. Dengiz tubiga jo'natilgan ultratovushni exolot 1,4 s dan so'ng qabul qilib oldi. Dengiz chuqurligi necha metr? Tovushning suvdagi tezligi 1530 m/s.

A) 1071. B) 2142. C) 2486. D) 3620.

73. Exolotdan yuborilgan signal 1,6 s dan keyin qabul qilingan bo'lsa, dengizning chuqurligi qanday (km)? Tovushning suvdagi tezligi 1500 m/s.

A) 1,2. B) 1,6. C) 1,8. D) 2,4.

74. Tovush to'lqinining uzunligi 8 m, davri 0,02 s bo'lsa, uning tarqalish tezligi qanday (m/s) bo'ladi?

A) 340. B) 400. C) 500. D) 600.

75. Tovush chastotasi 680 Hz, havoda tarqalish tezligi 340 m/s. Uning havodagi to'lqin uzunligi qanday (m)?

A) 0,5. B) 1. C) 2. D) 5.

Javoblar:

71	72	73	74	75
C	A	A	B	A

76*. Tubi pastga qaragan holda suv yuzida vertikal suzayotgan butilkaning vertikal garmonik tebranishlari davrini toping (ms). Butilkaning massasi 300 g, tubining yuzi 30 cm^2. Ishqalanishni hisobga olmang. $g = 10\ m/s^2, \pi = 3{,}14$.

A) 314. B) 628. C) 720. D) 840.

77*. Asosining yuzi 75 cm^2 bo'lgan 120 g massali silindr suv yuzida vertikal holatda suzmoqda. Agar silindr muvozanat holatidan biroz chiqarilsa, uning vertikal garmonik tebranishlari qanday davriy chastota bilan yuz beradi (Hz)? $g = 10\ m/s^2$.

A) 15. B) 20. C) 25. D) 30.

78*. Kesimi 10 cm^2 bo'lgan U-simon trubkaga 400 g suv quyildi. Ishqalanishni inobatga olmagan holda, trubkadagi suyuqlikning vertikal tebranishlari davriy chastotasini toping (Hz). $g = 9{,}8\ m/s^2$.

A) 5. B) 7. C) 8. D) 12.

79. Yo'lovchi 1020 m uzoqlikdagi radiodan berilgan aniq vaqt signalidan foydalanib, soatini to'g'riladi. Bunda uning soati necha sekund orqada bo'ladi? Tovushning havodagi tezligi 340 m/s.

A) 60. B) 30. C) 15. D) 3.

80. Chastotasi 165 Hz, bo'lgan to'lqin 330 m/s tezlik bilan tarqalmoqda. To'lqin uzunligi qanday (m)?

A) 6. B) 5. C) 4. D) 2.

Javoblar:

76	77	78	79	80
B	C	B	D	D

81. O'zgaruvchan kesimli quvurning kesimi 50 cm^2 bo'lgan qismida oqayotgan suvning tezligi 4 m/s. Kesimi 10 cm^2 bo'lgan qismidagi suvning tezligi qanday (m/s)?

A) 2. B) 4. C) 20. D) 50.

82. Buloqdan oqayotgan sharshara 12 litr hajmli chelakni 30 s da to'ldiradi. Buloqdan sekundiga necha litr suv oqib chiqadi?

A) 12. B) 0,6. C) 0,5. D) 0,4.

83. Quvurdagi suv oqimining tezligi 2 m/s. Quvurdan har soatda 7200 kg suv oqib o'tsa, uning ko'ndalang kesim yuzi qanday (cm^2)?

A) 1. B) 2. C) 6,28. D) 10.

84. Quvurdagi 5 mm^2 teshikdan suv yuqoriga tik otilib, 80 cm balandlikka ko'tarilmoqda. Teshikdan 10 soatda qancha (kg) suv oqib chiqadi?

A) 1000. B) 1200. C) 820. D) 720.

85. Samolyotning gorizontal uchish paytida qanotlari ostida havo bosimi 98 kPa, ustida -97 kPa. Agar qanotlarning yuzi 40 m^2 bo'lsa, ularning ko'tarish kuchi qanday (kN) bo'ladi?

A) 4. B) 20. C) 40. D) 200.

Javoblar:

81	82	83	84	85
C	D	D	D	C

MODDA TUZILISHINING MOLEKULYAR KINETIK NAZARIYA ASOSLARI.

Moddalarning tuzilishini va xossalarini uni tashkil qilgan molekulalarning harakatiga va molekulalar orasidagi o'zaro ta'sir kuchining mavjudligiga bog'lab o'rganuvchi nazariya molekulyar-kinetik nazariya (MKN) deb ataladi.

Bu nazariya qadimgi zamon faylasuflari tomonidan yaratilgan bo'lib, u faqat XVIII asrga kelibgina izchil nazariya shaklida rivojlana boshladi. Uning rivojlanishiga rus olimi M. V. Lomonosov, ingliz olimi D. Dalton, nemis fizigi R. Klauzius, ingliz fizigi J. Maksvell, Avstriya fizigi L. Bolsman, italyan olimi Avogadro va boshqalar o'z hissalarini qo'shishgan. Molekularikinetik nazariyaning tajribaviy asoslarini ingliz botanigi R. Broun, fransuz fizigi J. Perren va nemis fizigi O. Shtern yaratdilar.

Modda tuzilishining molekulyar kinetik nazariyasi quyidagi uchta qoidaga asoslangan.

1. *Barcha moddalar molekulalararo oraliqqa ega bo'lgan molekulalardan tashkil topgan; molekulalar o'z navbatida atomlardan tashkil topgan.*

2. *Molekulalar har doim uzluksiz tartibsiz (xaotik) harakatda bo'ladi.*

3. *Molekulalar orasida har doim tortishish va itarishish kuchlari mavjud bo'ladi. Bu kuchlar molekulalar oralig'iga keskin bog'liqdir.Molekulalar oraliqlari juda kichik bo'lganda itarishish kuchi juda katta bo'ladi; molekulalar bir-birlaridan uzoqlashganda esa bu kuchlar kamayib, ular orasida tortishish kuchi ortadi.mavjud bo'lgan bu kuchlar elektromagnit tabiatga ega.*

Kimyoviy elementning kimyoviy xossalarini o'zida saqlab qoladigan eng kichik zarrachasi ***atom*** *deyiladi.*

Molekula*-moddani tashkil etuvchi zarra bo'lib, u o'zida shu moddaning asosiy xossalarini saqlovchi mustaqil eng kichik bo'lakchadir.*

Molekulalarning uzluksiz xaotik harakati diffuziya va broun harakati hodisalarida yaqqol namoyon bo'ladi.

Bir-biri bilan chegaradosh bo'lgan jism zarralarining ularning issiqlik harakti tufayli bir-biriga kirib boorish hodisasi ***diffuziya*** *deyiladi.*

Diffuziya natijasida jismlar olingan fazoda modda molekulalarining konsentratsiyasi tenglashadi.(*Moddaning birlik hajmdagi molekulalari soni molekulalarning konsentratsiyasi deb ataladi.)*

Diffuziya hodisasi barcha jismlarda-qattiq, suyuq jismlarda va gazlarda kuzatiladi.

Lekin diffuziya tezligi qattiq jismlarda juda ham kichik, suyuqliklarda kichik, gazlarda esa juda ham katta bo'ladi.

❖ Molekula va atom o'lchamlari.

Kimyo kursidan ma'lumki, molekulalar turlicha atom birikmalaridan tashkil topishi mumkin. Bir atomli (geliy He, argon Ar, neon Ne kabi inert gazlar), ikki atomli (kislorod O_2, vodorod H_2, azot N_2) va ko'p atomli molekulalar bo'lishi mumkin. Turli modda atomlari birikib ko'p atomli molekulalarni hosil qiladi. Masalan, osh tuzining molekulasi bitta natriy Na atomi va bitta xlor Cl atomidan, suv molekulasi esa ikkita vodorod H atomi va bitta kislorod O atomidan iborat.

Aniq o'lchash va hisoblashlar atom va molekulalarning diametri $\sigma=2\div3\cdot10^{-10}$ m ekanini ko'rsatadi.

❖ Molekulalar massasi. Modda miqdori. Avogadro soni.

Moddaning M_N nisbiy molekulyar (yoki atom) massasi deb shu molekula (yoki atom) m_0 massasining uglerod atomi m_{0C} massasining 1/12 qismiga nisbatiga aytiladi.

$$M_N = \frac{m_0}{\frac{1}{12}m_{0C}} \quad (1)$$

M_N kattalikning o'lchovi yo'q. bundan ko'rinadiki, hisoblanishi zarur bo'lgan molekulaning massasi

$$m_0 = \frac{1}{12}M_N \cdot m_{0C} \quad (2)$$

bo'lar ekan.

Masalan, magniyning (Mg) atom massasi 24 ga teng. bu degan so'z, magniy atomining massasi uglerod (C) atomi massasining 1/12 qismidan 24 marta katta demakdir, shuningdak, vodorod atomining massasi 1 ga teng, demak, vodorod atomining massasi uglerod atomining massasidan 12 marta kichikdir.

Jismlarda atom yoki molekulalar nihoyatda ko'p bo'ladi. Shuning uchun aniq bir jismdagi atomlar sonini 0,012 kg uglerod massasidagi atomlar soni bilan taqqoslash qabul qilingan. Buning uchun ***modda miqdori***deb ataladigan maxsus fizik kattalik kiritiladi. Modda miqdori ν deb (grek harfi; "nyu" deb o'qiladi) ma'lum bir jismdagi molekulalar soni N ning 0,012 kg massali uglerodda mavjud bo'lgan atomlar soni (N_A) ga nisbatiga aytiladi:

$$\nu = \frac{N}{N_A} \quad (3)$$

SI da modda miqdori mol hisobida o'lchanadi va u asosiy birliklardan biridir. *Bir mol-moddaning shunday miqdoriki, unda mavjud bo'lgan molekulalar soni 0,012 kg ugleroddagi atomlar soniga teng.*

Mol bilan bir qatorda unga karrali birlik kilomol (kmol) ham qo'llaniladi: 1 kmol=10^3 mol.

Mol ta'rifiga asosan, har qanday moddaning bir mol miqdoridagi molekula yoki atomlar soni bir xil bo'ladi. Bu son ***Avogadro soni*** deb ataladi va u N_A bilan belgilanadi. Bu son bir mol modda (ya'ni 0,012 kg uglerod) dagi atomlar soniga teng bo'lib, quyidagi formula orqali ifodalanadi:

$$N_A = \frac{\mu_C}{m_{0C}} = \frac{\mu}{m_0} \quad (4)$$

bunda μ_C va μ kattaliklar (grek harfi: "myu" deb o'qiladi) bir mol uglerodning va ixtiyoriy olingan moddaning kilogramm hisobidagi massasi.

Bir mol miqdorida olingan modda massasi μ *molyar massa* deb ataladi.

$$\mu = \frac{m}{\nu} \quad (5)$$

$$m = m_0 N \quad (6)$$

ekanligini va (3) formulani e'tiborga olsak, u holda

$$\mu = m_0 \cdot N_A \quad (7)$$

bo'ladi. Demak, molyar massa molekulaning massasi bilan Avogadro soni ko'paytmasiga teng ekan. Molyar massani M_N nisbiy molekulyar massa orqali ifodalash mumkin. m_0 ning (2) dan qiymatini va N_A ning

$$N_A = \frac{0{,}012}{m_{0C}} \quad (8)$$

Qiymatini (7) ga qo'yamiz:

$$\mu = M_N \frac{m_{0C}}{12} \cdot \frac{0{,}012}{m_{0C}} = 10^{-3} \frac{kg}{mol} \quad (9)$$

Demak, molyar massa son jihatdan nisbiy molekulyar massaga teng ekan. Masalan, karbonat angidrid (CO_2) ning molyar massasi 0,044 kg/mol

ga, uglerodniki 0,012 kg/mol ga, kislorodniki 0,032 kg/mol ga teng. o'lchashlar natijasida uglerod atomining massasi $m_{0C} = 1{,}995 \cdot 10^{-26} kg$ ekani aniqlangan. (4) formuladagi kattaliklarning son qiymatini o'rniga qo'yib Avogadro sonini hisoblasak,

$$N_A = \frac{0{,}012\ \frac{kg}{mol}}{1{,}995 \cdot 10^{-26} kg} = 6{,}02 \cdot 10^{23} mol^{-1} \quad (10)$$

hosil bo'ladi. Avogadro soni molekulyar fizika va kimyoda muhim ahamiyatga ega bo'lib, universal doimiy hisoblanadi. Avogadro sonidan foydalanib, molekulalar sonini toppish mimkin. Turli gazlar bilan olib borilgan tajribalardan ko'rinadiki, *bir xil harorat va bosimda har qanday gazning bir mol massasi birday hajmni egallaydi.* Bunga *Avogadro qonuni deyiladi.*

Normal sharoitda (T=273 K tempertura va $1{,}013 \cdot 10^5$ Pa atmosfera bosimida) bir mol gaz massasining hajmi

$$V_\mu = 0{,}0224 \frac{m^3}{mol} \quad (11)$$

ekani aniqlangan. Bir mol (yoki kmol) moddaning hajmi *molyar hajm* deb ataladi.

Normal sharoitda N_A Avogadro sonini bir mol gazning V_μ m^3 hisobida hajmiga bo'lganimizda 1 m^3 hajmdagi molekulalar sonini toppish mumkin. Bu son ***Loshmidt*** soni deyiladi va n_0 bilan belgilanadi:

$$n_0 = \frac{N_A}{V_\mu} = \frac{6{,}02 \cdot 10^{23} mol^{-1}}{22{,}4 \cdot 10^{-3} \frac{m^3}{mol}} \approx 2{,}7 \cdot 10^{25}\ m^{-3} \quad (12)$$

ya'ni

$$n_0 = 2{,}7 \cdot 10^{25}\ m^{-3}. \quad (13)$$

❖ Moddaning agregat holatlari.

Modda asosan uch xil agregat holatda – gaz, suyuq va qattiq holatda bo‘lishi mumkin. Modda tuzilishining molekulyar kinetik nazariyasi uning gaz, suyuqlik va qattiq holatlar orasida asosiy farq quyidagilardan iborat ekanligini bildiradi:

- ❖ Gaz molekulalari orasidagi o‘rtacha masofa ularning diametrlariga nisbatan juda katta bo‘ladi. Shuning uchun gazlar osongina siqiladi, chunki gazni siqqanimizda molekulalar orasidagi o‘rtacha masofa kamayadi. Lekin siqilish jarayonida molekulalarning o‘lchamlari (diametri) o‘zgarmaydi. Gaz molekulalari fazoda sekundiga birnecha yuz metrga to‘g‘ri keladigan juda katta tezliklar bilan harakat qiladi. Bir-biri bilan to‘qnashganda ular bilyard soqqalari singari har tomonga sapchib ketadi. Gaz molekulalari o‘rtasidagi zaif tortishish kuchlari ularni bir-birining yaqinida tutib turolmaydi. Shuning uchun gazlar cheksiz kengaya oladi. Ularning shakli ham, hajmi ham o‘zgarmay qoladi. Molekulalarning idish devoriga beradigan son-sanoqsiz zarblari gaz bosimini hosil qiladi.

- ❖ Suyuqliklarda molekulalar bir-biriga deyarli taqalib turadi. Shuning uchun ular orasida kuchli o‘zaro ta’sir kuchlari mavjud. Bu kuchlar esa suyuqlik molekulalarining bir-biridan uzoqlashib ketishiga yo‘l qo‘y-maydi. Suyuqlik molekulasi muvozanat vaziyati atrofida tebranib turadi. Faqat u ahyon-ahyonda bir muvozanat holatidan boshqasiga sakrab o‘tib, boshqa molekulalarning qurshovida bo‘ladi. Molekulalarning biror muvozanat vaziyati atrofida tebranib turadigan holati «o‘troq» holat deyiladi. Uning «o‘troq» holatda bo‘lgan vaqti suyuqlikning temperaturasiga va turiga bog‘liq. Uy temperaturasida suv molekulasining «o‘troq» holatda bo‘lish vaqti 10^{-11} s ga teng. Molekulaningmuvozanat vaziyati atrofida tebranish davri (vaqti) yanada kichik bo‘lib, $10^{-12} \div 10^{-13}$ s ga yaqin. Suyuqlikning temperaturasi ko‘tarilishi bilan molekulaning «o‘troq» holatda bo‘lish vaqti kamayadi. Suyuqliklar kam siqiluvchandir. Suyuqliklarning oquvchanlik xususiyati tufayli o‘z shaklini saqlab qola olmaydi. Ammo u o‘z hajmini saqlab qoladi.
- ❖ Jismlarni tashkil etgan atom yoki molekulalar ilgarilanma harakat qilmasa bunday jismlar qattiq jism bo‘ladi. Qattiq jismlarning atom yoki molekulalari suyuqliklarnikidan farqli o‘laroq tayinli muvozanat vaziyatlari atrofida tebranib turadi. Ba’zan qattiq jism molekulalari muvozanat vaziyatini o‘zgartiradi, lekin bunday hollar kamdan-kam bo‘ladi. Ana shu sababdan qattiq jismlar hajmini va shaklini o‘zgartirmaydi. Agar qattiq jism atomlari yoki ionlarining muvozanat

vaziyatlari markazlari tutashtirilsa, kristall panjara deb ataladigan fazoviy muntazam panjara hosil bo‘ladi. Kristallar atomlarining joylashishidagi ichki tartib tufayli kristallarning tashqi ko‘rinishi ham muntazam geometrik shakl oladi.

❖ GAZLAR MOLEKULYAR-KINETIK NAZARIYASINING ASOSIY TENGLAMASI.

Modda gaz holatining, suyuqlik va qattiq holatlaridan farq qiladigan xususiyatlari shundan iboratki, birinchidan gaz suyuqlik va qattiq jismlarga nisbatan juda kichik zichlikka ega, ikkinchidan gaz egallashi mumkin bo‘lgan butun hajm bo‘ylab hamma vaqt bir tekisda taqsimlanadi. Gaz egallagan hajm deganda gaz solingan idishning hajmini tushunishimiz lozim.

Siyrak gazda molekulalar orasidagi masofalar ularning o‘lchamlaridan ko‘p marta ortiq. Bu holda molekulalar orasidagi o‘zaro ta’sir e’tiborga olinmaydigan darajada kichik bo‘lib, molekulalarning kinetik energiyasi o‘zaro ta’sirning potensial energiyasidan ancha katta.

Fizikada gaz xossalarini o‘rganishda **ideal gaz** tushunchasi kiritiladi. Ideal gazda:

1. Gazni tashkil qiluvchi molekulalar orasidagi masofa shu darajada kattaki, molekulalar orasidagi o‘zaro ta’sir kuchi hisobga olinmaydi.
2. Molekulalarning ta’sir kuchlari ular o‘zaro to‘qnashganda sodir bo‘ladi va bu to‘qnashish absolyut elastik to‘qnashish bo‘ladi.
3. Gaz molekulalarining hajmi hisobga olinmaydi va ular moddiy nuqta deb qaraladi.

Modda tuzilishining molekulyar – kinetik nazariyasi gazning bosimini gaz molekulalarining idish devorlariga urilishi natijasida unga impuls

$(m_0\upsilon)$ berishi tufayli hosil bo‘ladi deb tushuntiriladi. Tajribalar natijalariga ko‘ra, gazning bosimi (r) idish devorlariga urilayotgan molekulalar soni N ga, molekulaning massasi (m_0) va molekula harakatining o‘rtacha kvadratik tezligi $\bar{\upsilon}$ ga bog‘liq bo‘lar ekan, ya’ni

$$P = \frac{1}{3}\frac{N}{V}m_0\upsilon^2 = \frac{1}{3}n \cdot m_0\upsilon^2 \quad (1)$$

bu yerda - υgaz molekulalarining o‘rtacha kvadratik tezligi. **Gaz bosimi bilan gaz molekulalarining zichligi, massasi va tezligi orasidagi bog‘lanishni ifodalovchi tenglama gazlar – molekulyar kinetik nazariyasining asosiy tenglamasi deyiladi.**$m_0n$ko‘paytma gaz zichligini berganligi uchun (1) ifodani quyidagi ko‘rinishda yozish mumkin:

$$P = \frac{1}{3}\rho \cdot v^2 \quad (2)$$

(1) ifodaning o‘ng tomonining surat va maxrajini 2 ga ko‘paytirib,

$$E_k = \frac{m_0 v^2}{2}$$

ekanligini e’tiborga olsak, quyidagi ifodaga ega bo‘lamiz:

$$P = \frac{2}{3} n \cdot E_k \quad (3)$$

Demak, ideal gazning bosimi gaz molekulalarining konsentratsiyasi n ga va ularning o‘rtacha kinetik energiyasi E_k ga to‘g‘ri proporsional ekan. (1), (2) va (3) tengliklar **gazlar molekulyar–kinetik nazariyasining asosiy tenglamalaridir**.

❖ TEMPERATURA

Temperatura molekulyar fizika va termodinamikaning asosiy tushunchalaridan biridir. Temperatura makroskopik sistemaning issiqlik muvozanat holatini ifodalaydi. Issiqlik muvozanati holatida bo‘lgan sistemaning hamma qismlarida temperatura ayni bir qiymatga ega bo‘ladi. Ikki jismning temperaturasi bir xil bo‘lganda ular orasida issiqlik almashinmaydi. Agar jismlarning temperaturalari har xil bo‘lsa, ular bir – biriga tekkizilganda jismlar o‘rtasida energiya almashuvi bo‘ladi. Bunda temperaturasi yuqori bo‘lgan jism past temperaturali jismga energiya beradi. Energiya almashuvi ularning temperaturalari tenglashguncha davom etadi. Jismlarning temperaturalari farqi ular o‘rtasidagi issiqlik almashinish yo‘nalishini ko‘rsatadi. Temperaturani o‘lchovchi asbobga **termometr** deb ataladi.

Issiqlik muvozanati haolatida hamma gazlarning temperaturasi bir xil bo‘ladi, bu temperatura gazning turiga bog‘liq emas. Temperaturani aniqlash uchun molekulyar kinetik nazariyada qanday fizik kattalik temperaturaning mana shu xossasiga ega ekanligini aniqlaymiz.

Molekulalar qanchalik tez harakat qilsa, jism (gaz)ning harorati shunchalik yuqori bo‘ladi. Gaz yopiq idishda isitilganda, gazning bosimi ortadi. Molekulyar kinetik nazariyaning asosiy tenglamalariga ko‘ra bosim gaz molekulalarining ilgarilanma harakatining o‘rtacha kinetik energiyasiga to‘g‘ri proporsionaldir, ya’ni

$$P = \frac{2}{3} n \cdot E_k$$

Ma’lum bir massali gazning bosimi (*m=const*) va hajmi tayinli bir qiymatga ega bo‘lgan issiqlik muvozanati holatida gaz molekulalarining o‘rtacha kinetik energiyasi temperaturaga o‘xshab tayinli bir qiymatga ega bo‘lishi kerak. Bu xulosani tekshirish uchun quyidagi tajribaga murojat qilamiz. Turli xil gazlar, masalan vodorod, geliy va kislorod bilan to‘ldirilgan idishlarni olamiz. Idishlarning hajmi ma’lum bo‘lib, ularga manometrlar o‘rnatilgan. Manometrlar har bir idishdagi bosimni o‘lchaydi.Gazlarning massasi ma’lum, har bir idish ichidagi gaz molekulalarining sonini aniqlash mumkin.

Temperaturaning absolyut noli. Ideal gazning hajmi o‘zgarmas bo‘lganda bosimi nolga intiladigan holdagi yoki ideal gazning bosimi o‘zgarmas bo‘lganda hajm nolga intiladigan holdagi chegaraviy temperatura temperaturaning **absolyut noli** deyiladi. Absolyut nol temperaturada molekulalarning ilgarilanma harakati to‘xtaydi. Shuningdek, aytib o‘tish kerakki, tabiatda absolyut nol temperaturadan past temperatura bo‘lishi mumkin emas.

U.Kelvin temperaturaning absolyut shkalasini joriy etgan. Absolyut shkaladagi (Kelvin shkalasi) nol temperatura absolyut nolga mos keladi, bu shkalada temperaturaning har bir bir birligi Selsiy shkalasining gradusiga teng. Absolyut temperaturaning birligi XBS da Kelvin deb ataladi va K harfi bilan belgilanadi.

Kelvin shkalasi bo’yicha temperatura birligi qiymati Selsiy shkalasidagi qiymatga deyarli teng bo’lgani uchun kelvin shkalasida ifodalangan temperatura selsiy shkalasida ifodalangan temperatura bilan quyidagicha bog’lanishga ega:

$$T = t + 273$$

Angliya va Amerika qo’shma Shtatlarida ba’zida temperaturaning Farengeyt shkalasidan foydalaniladi. Polyak fizigi G. Farengeyt 1709-yili spirtli termometr, 1714-yili simobli termometr ixtiro qildi va temperaturalar shkalasini tavsiya etdi. Farengeyt shkalasida muzning erish temperaturasini 32^0 ga va suvning qaynash temperaturasini 212^0 ga teng qilib olinib, bu temperaturalar intervali 180 ta teng bo’lakka (gradusga) bo’lingan, Farengeyt termometrlari amalda birinchi ishlatilgan yaroqli termometrlardan hisoblangan.

Ideal gaz.

Biz ideal gaz holatini o’ganish uchun quyidagi soddalashtirishlarni kiritamiz .

1. Gazni tashkil etuvchi atom va molekulalar o’lchamlarini hisobga olmasa ham bo’ladigan darajada kichik bo’lgan elastik sharchalardir.

2 . Atom va molekulalar orasidagi o’zaro ta’sir kuchlari juda kichik (umuman yo’q desa ham bo’ladi) .

Bu shartlarni qanoatlantiruvchi gaz ideal gaz deyiladi.Gaz yuqoridagi shartlarning bajarilishi yoki bajarilmasligiga qarab ideal yoki real holatda bo'lishi mumkin . Berilgan massali gazning holati P bosim , V hajm va T temperaturalardan iborat uchta kattalikning qiymatlari bilan aniqlanadi. Bu kattaliklar holat kattaliklari deyiladi, ular bir-biriga qonuniy ravishda bog'langan bo'lib , ulardan birining o'zgarishi natijasida boshqalari ham o'zgaradi . Bu kattaliklarning o'zaro bog'lanishi analitik usulda

$$f(P, V, T) = 0$$

Funksiya ko'rinishida ifodalanishi mumkin . Biror jismning kattaliklari orasidagi bog'lanishni ifodalovchi munosabat shu jismning holat tenglamasi deb ataladi .Binobarin , yuqoridagi munosabat berilgan gaz massasining holat tenglamasidir . Kattaliklarning o'zgarishi bilan gaz holatining o'zgarishi gaz jarayoni deyiladi . Temperatura o'zgarmaganda gaz bosimining uning hajmiga bog'liq holda o'zgarishi izotermik jarayon , bosimi o'zmaganda gaz hajmining uning temperaturasiga bog'liq holda o'zgarishi izobarik jarayon , hajmi o'zgarmaganda gaz bosimining uning temperaturasiga bog'liq holda o'zgarishi izoxorik jarayon deyiladi .

1. MOLEKULYAR - KINETIK NAZARIYA ASOSLARI

Molekulyar fizikadan masalalar yechish namunalari.

Mavzu: Modda tuzilishining molekulyar-kinetik nazariyasi asoslari.

1-masala: Normal sharoitda 1) 0,001 kg azot va 2) 1 m^3 kislorod tarkibidagi molekulalar sonini hisoblang. Normal sharoitda kislorodning zichligi ρ_2=1,43 kg/m^3.

 Berilgan:	 Formula:
m_1=0,001 kg=10^{-3} kg V_2=1m^3 ρ_2=1,43 kg/m^3 μ_1=28·10^{-3} kg/mol μ_2=32·10^{-3} kg/mol _____ N=? n=?	1. Berilgan massadagi azot gazining molekulalar soni shu berilgan massani bitta azot molekulasining massasiga nisbatiga teng bo'lib, quyidagicha ifodalanadi: $$N = \frac{m_1}{m_0} \quad (1)$$ Bunda $$m_0 = \frac{\mu_1}{N_A} \quad (2)$$ ga teng bo'lib, μ_1-azot molekulasining molyar massasi, N_A=6,02·10^{23} mol^{-1}-Avogadro soni. Bu ikkala tenglikdan quyidagi ifodaga ega bo'lamiz. $$N = \frac{m_1 N_A}{\mu_1} \quad (3)$$ 2. Normal sharoitda hajm birligidagi kislorod molekulalarining soni quyidagicha topiladi. Kislorod massasi $m_2 = \rho_2 V_2$ ga, molekulalar soni $N = \frac{m_2}{m_0}$ ga tengligidan $$n = \frac{N}{V_2} = \frac{m_2}{m_0 V_2} = \frac{V_2 \rho_2}{\frac{\mu_2}{N_A} V_2} = \frac{N_A}{\mu_2}\rho_2 \quad (4)$$ bo'ladi.

Hisoblash:
$$N = \frac{m_1 N_A}{\mu_1} = \frac{10^{-3} kg \cdot 6{,}02 \cdot 10^{23} mol^{-1}}{28 \cdot 10^{-3} kg \cdot mol^{-1}} = 215 \cdot 10^{20} ta$$

$$n = \frac{6{,}02\cdot10^{23}mol^{-1}}{32\cdot10^{-3}kg\cdot mol^{-1}}\cdot 1{,}43\ \frac{kg}{m^3} \approx 2{,}7\cdot10^{25}m^{-3}$$

2-masala: Ozon (O_3), karbonat angidrid (CO_2), metan (CH_4) gazlarining bitta molekulasining massasini hisoblang.

Berilgan:	Formula:
$\mu_1=48\cdot10^{-3}$ kg/mol $\mu_2=44\cdot10^{-3}$ kg/mol $\mu_3=16\cdot10^{-3}$ kg/mol $N_A=6{,}02\cdot10^{23}$ mol^{-1} _____ m_{01}=? m_{02}=? m_{03}=?	Masala shartida berilgan har bir gaz molekulasining massasini quyidagi formulalar orqali topamiz: $m_{01}=\frac{\mu_1}{N_A}$ (1) $m_{02}=\frac{\mu_2}{N_A}$ (2) $m_{03}=\frac{\mu_3}{N_A}$ (3)
Hisoblash:	
$m_{01}=\frac{\mu_1}{N_A}=\frac{48\cdot10^{-3}\,kg/mol}{6{,}02\cdot10^{23}mol^{-1}}\approx 8\cdot10^{-26}\,kg$ (1). $m_{02}=\frac{\mu_2}{N_A}=\frac{44\cdot10^{-3}\,kg/mol}{6{,}02\cdot10^{23}mol^{-1}}\approx 7{,}3\cdot10^{-26}\,kg$ (2). $m_{03}=\frac{\mu_3}{N_A}=\frac{16\cdot10^{-3}\,kg/mol}{6{,}02\cdot10^{23}mol^{-1}}\approx 2{,}7\cdot10^{-26}\,kg$ (3).	

3-masala: Normal sharoitda 1 m^3 havoda $2{,}7\cdot10^{25}$ dona molekula bor. Agar molekulalar orasidagi masofa molekula diametridan 10 marta kattaligi ma'lum bo'lsa, molekulaning diametri qanchaga teng ekanligini aniqlang.

Berilgan:	Formula:
V= 1 m^3 $n_0=2{,}7\cdot10^{25}$ n=10 marta _____ σ=?	Agar kubning hajmini 1 m^3 deb olsak, u holda n_0 dona molekulalar uch o'lchamli fazoda OY, OZ, OX yo'nalishlar bo'ylab harakatlanadi. Har bir molekulaga kub hajmining a^3 ga teng qismi mos keladi, bunda a-molekulalar orasidagi masofa. Shunday ekan, kubning hajmi $V=n_0\cdot a^3$ deb hisoblash mumkin. Masalaning shartiga ko'ra n=10 edi. Bu ikki ifodadan molekulaning diametrini

	topsak, $$\sigma = \frac{1}{10}\sqrt[3]{\frac{V}{n_0}}.$$
Hisoblash:	
$$\sigma = \frac{1}{10}\sqrt[3]{\frac{1\ m^3}{2{,}7 \cdot 10^{25}}} = \frac{1\ m}{10 \cdot 3 \cdot 10^8} \approx 3 \cdot 10^{-10}\ m.$$	

4-masala: Diametri $3 \cdot 10^{-3}$ m bo'lgan suv tomchisidagi suv molekulalari sonini aniqlang.

Berilgan:	Formula:
$d=3 \cdot 10^{-3}$ m $\mu=18 \cdot 10^{-3}$ kg/mol $\rho=10^3$ kg/m^3 _____ N=?	Berilgan suv tomchisidagi molekulalar soni quyidagicha topiladi: $$N = \frac{m}{m_0}$$ bunda m-suv tomchisining massasi, m_0-bitta molekulaning massasi. Suv tomchisining massasini zichlik formulasidan foydalanib quyidagicha ifodalaymiz: $$m = \rho V$$ bunda V-berilgan suv tomchisining hajmi; tomchi shar shaklida bo'lgani uchun V ni quyidagicha ifodalaymiz; $$V = \frac{4}{3}\ \pi\ (\frac{d}{2})^3 = \frac{1}{6}\pi d^3$$ u vaqtda massa $$m = \frac{1}{6}\rho\pi d^3$$ bo'ladi. Bitta molekulaning massasi quyidagicha topiladi: $$m_0 = \frac{\mu}{N_A}$$ Aniqlangan m va m_0 ning ifodalarini tomchida molekulalar sonini aniqlash ifodasiga qo'ysak, $$N = \frac{1}{6\mu}\rho\pi d^3 N_A$$ Ifoda hosil bo'ladi.
Hisoblash:	

$$\mathrm{N} = \frac{3{,}14 \cdot 10^3 \frac{kg}{m^3}}{6 \cdot 18 \cdot 10^{-3} \frac{kg}{mol}} \cdot 27 \cdot 10^{-9}\, m^3 \cdot 6{,}02 \cdot 10^{23} mol^{-1} \approx 4{,}5 \cdot 10^{20} dona$$

5-masala: Massasi 20 g bo'lgan bir atomli gaz molekulalarining to'la kinetik energiyasi 3,2 kJ ga teng. Shu gaz molekulalarining o'rtacha kvadratik tezligini toping.

Berilgan:	Formula:
m=20 g=$2\cdot10^{-2}$ kg E=3,2 kJ=$3{,}2\cdot10^{3}$ J _____ υ=?	Molekulyar-kinetik nazariyaga asosan, molekulalarning o'rtacha kvadratik tezligi $$\upsilon = \sqrt{\frac{3kT}{m_0}}\ (1)$$ ga teng, bu yerda m_0-bitta molekulaning massasi, uning qiymati noma'lum. Agar berilgan gazdagi molekulalarning soni N bo'lsa, bitta molekulaning kinetik energiyasining $$\mathrm{E} = \frac{3}{2}kT\ (2)$$ ifodasini va $$\mathrm{N} = \frac{m}{m_0}\ (3)$$ ekanligini nazarga olsak, $$\mathrm{E} = \mathrm{N}E_0 = N\frac{3}{2}kT = \frac{m}{m_0}\frac{3}{2}kT\ (4)$$ bo'ladi, bundan bitta molekulaning massasi $$m_0 = \frac{3}{2E}kTm\ (5)$$ ga teng bo'ladi (5) dan m_0 ning qiymatini (1) ga keltirib qo'ysak, u holda molekulaning o'rtacha kvadratik tezligi uchun quyidagiga ega bo'lamiz: $$\upsilon = \sqrt{\frac{3kT \cdot 2E}{3kT \cdot m}} = \sqrt{\frac{2E}{m}}\ (6)$$
Hisoblash:	

$$\upsilon = \sqrt{\frac{2 \cdot 3{,}2 \cdot 10^3\, J}{2 \cdot 10^{-2} kg}} \approx 565 \frac{m}{s}$$

6-masala: 20 m chuqurlikdagi ko'lning tubidan havo pufakchasi suv sirtiga ko'tarilganda uning hajmi necha marta ortadi? atmosfera bosimi 100 kPa.

Berilgan:	Formula:
h=20 m $\rho=10^3$ kg/m^3 g=9,8 m/s^2 $P_0=10^5$ Pa _____ V_2/V_1=?	Ko'ldagi suvning istalgan qatlamidagi temperaturani doimiy desak, u holda Boyl-Mariott qonuniga ko'ra $P_1V_1 = P_2V_2$ (1) bo'ladi, bunda P_1-suv ostidagi pufakcha ichidagi havo bosimi, P_2-suv sirtiga ko'tarilgandagi pufakcha ichidagi havo bosimi, V_2-suv sirtidagi pufakcha hajmi, V_1-suv ostidagi pufakchaning hajmi. Suv sirtidagi pufakcha ichidagi havo bosimi tashqi atmosfera bosimiga teng bo'ladi, ya'ni $P_2 = P_0$, u holda yuqoridagi tenglik $P_1V_1 = P_0V_2$ (2) bo'ladi. Shuningdek, suv ostidagi pufakcha ichidagi havo bosimi $P_1 = P_0 + \rho gh$ (3) bu yerda ρgh gidrostatik, ya'ni suyuqlik ustunining bosimi. Bu bosim ifodasini (2) tenglikka qo'yib, quyidagi ifodaga ega bo'lamiz: $(P_0 + \rho gh)V_1 = P_0V_2$ (4) bundan $\frac{V_2}{V_1} = \frac{P_0 + \rho gh}{P_0} = 1 + \frac{\rho gh}{P_0}$ (5)
Hisoblash:	
$\frac{V_2}{V_1} = 1 + \frac{10^3 \frac{kg}{m^3} \cdot 9{,}8 \frac{m}{s^2} \cdot 20\ m}{10^5 Pa} \approx 3\ marta$	

7-masala: Temperaturasi 448 K bo'lgan 0,01 kg massali gazning hajmi $3 \cdot 10^3$ m^3 bo'lgan. Qanday temperaturada berilgan massali gazning zichligi $5 \cdot 10^{-6}$ kg/sm^3 ga teng bo'ladi. Gaz bosimi o'zgarmas.

Berilgan:	Formula:
T=448 K m=0,01 kg $V_1=3 \cdot 10^3$ m^3 $\rho_2=5 \cdot 10^{-6}$ $kg/sm^3=5$ kg/m^3 P=const _____ T_2=?	Berilgan gazning dastlabki zichligi $\rho_1 = \frac{m}{V_1}$ (1) ga teng bo'lib, turli temperaturalardagi zichliklarning nisbati hajmlar nisbatiga teskari proporsional bog'lanishdadir: $\frac{\rho_1}{\rho_2} = \frac{V_2}{V_1}$ (2) Gey-Lyussak qonuniga ko'ra P=const bo'lganda berilgan gazning turli temperaturalardagi hajmlari temperaturaga quyidagicha to'g'ri proporsional bog'langan: $\frac{V_2}{V_1} = \frac{T_2}{T_1}$ (3) (1) va (2) tengliklarni taqqoslab, quyidagi tenglikni yozish mumkin: $\frac{\rho_1}{\rho_2} = \frac{T_2}{T_1}$ (4) bundan $T_2 = \frac{\rho_1}{\rho_2} T_1 = \frac{T_1 m}{\rho_2 V_1}$ (5) ekani kelib chiqadi.
Hisoblash:	
$T_2 = 448\ K \cdot \frac{0{,}01\ kg}{3 \cdot 10^3 m^3 \cdot 5 \frac{kg}{m^3}} = 299\ K$	

8-masala: Bir xil massa va bir xil temperaturali karbonat angidrid (CO_2) va metan (CH_4) gazlari berilgan. Ularning zichliklari teng bo'lishi uchun bosimlari qanday nisbatda bo'lishi kerak?

Berilgan:	Formula:
$m_1=m_2$	CO_2 va CH_4 gazlari uchun Klapeyron-

$T_1=T_2$ $\mu_1=44\cdot10^{-3}$ kg/mol $\rho_1=\rho_2$ $\mu_2=16\cdot10^{-3}$ kg/mol _____ $P_1/P_2=?$	Mendeleyev tenglamalarini quyidagi ko'rinishda yozaylik: $$P_1V_1=\frac{m_1}{\mu_1}RT_1 \quad (1)$$ va $$P_2V_2=\frac{m_2}{\mu_2}RT_2 \quad (2)$$ Bu ifodalarni zichliklar orqali quyidagicha yozish mumkin: $$P_1=\frac{\rho_1}{\mu_1}RT_1 \quad (3)$$ $$P_2=\frac{\rho_2}{\mu_1}RT_2 \quad (4)$$ Tengliklarning har ikki tomonini hadma-had bo'lib, quyidagi natijaga erishamiz: $$\frac{P_1}{P_2}=\frac{\rho_1RT_1}{\mu_1}\cdot\frac{\mu_2}{\rho_2RT_2} \quad (5)$$ yoki masalaning shartiga ko'ra $$\frac{P_1}{P_2}=\frac{\mu_2}{\mu_1} \quad (6)$$
Hisoblash:	
$$\frac{P_1}{P_2}=\frac{16\cdot10^{-3}kg/mol}{44\cdot10^{-3}kg/mol}=\frac{4}{11}\approx\frac{1}{3} \;\; yoki\; P_1:P_2\approx1:3$$	

9-masala: Ballonda 2 mPa bosim ostida 400 K temperaturada turgan azotning zichligi hisoblansin.

Berilgan:	Formula:
P=2 mPa=$2\cdot10^{-3}$ Pa T=400 K $\mu=28\cdot10^{-3}$ kg/mol R=8,31 J/mol·K _____ $\rho=?$	Ideal gaz holat tenglamasini yozamiz: $$PV=\frac{m}{\mu}RT \quad (1)$$ Bu ifodalarni zichliklar orqali quyidagicha yozish mumkin: $$P=\frac{\rho}{\mu}RT \quad (2)$$ $$\rho=\frac{PM}{RT} \quad (3)$$
Hisoblash:	

$$\rho = \frac{PM}{RT} = \frac{2 \cdot 10^{-3} Pa \cdot 28 \cdot 10^{-3} kg/mol}{8{,}31 \frac{J}{mol} \cdot K \cdot 400K} = 1{,}68 \cdot 10^{-3} \frac{kg}{m^3}$$

10-masala: Normal atmosfera bosimida xonaning temperaturasi yoz kunlari 35 ^{0}C, qish kunlari esa 0 ^{0}C gacha pasayadi. Bunda havo massasining farqi 8,5 kg ni tashkil etsa, xonaning hajmi qancha?

Berilgan:	Formula:
$P_0=10^5$ Pa $t_1=35^0$C $T_1=t_1+273=308$ K $t_2=0^0$C $T_2=t_2+273=273$ K $\mu=29\cdot10^{-3}$ kg/mol R=8,31 J/mol·K Δm=8,5 kg _____ V=?	Masalaning mazmunidan xonaning hajmi V=const. Shunga binoan, Klapeyron-Mendeleyev tenglamasini T_1 va T_2temperaturalar uchun quyidagicha yozaylik: $$P_0V = \frac{m_1}{\mu} RT_1 \quad (1)$$ yoki $$P_0V = \frac{m_2}{\mu} RT_2 \quad (2)$$ Bu tenglamalarning chap tomonlari teng bo'lgani uchun o'ng tomonlari ham tengdir, ya'ni: $$\frac{m_1}{\mu} RT_1 = \frac{m_2}{\mu} RT_2 \quad yoki \quad \frac{m_1}{m_2} = \frac{T_2}{T_1} \quad (3)$$ bunda $m_1<m_2$, chunki $T_1>T_2$, ya'ni temperature yuqori bo'lganda gaz molekulalarining harakat tezligi ortadi, tortishish kuchi kamayadi, binobarin, molekulalar orasidagi masofa ham ortadi. xonada o'zgarmas bosim saqlanishi uchun gazning bir qismi xonadan chiqadi, gaz massasi kamayadi. Shuning uchun massalar farqi $\Delta m = m_2 - m_1$ bo'ladi. Bundan $m_2 = \Delta m + m_1$ bo'ladi. Bu hosil bo'lgan ifodani yuqoridagi tenglamaga qo'yib, havo massasi m_1 ni topaylik: $$\frac{m_1}{m_1 + \Delta m} = \frac{T_2}{T_1}, bundan\ m_1 = \frac{\Delta m T_2}{T_1 - T_2} \quad (4)$$ m_1 ning bu qiymatini Klapeyron-Mendeleyev tenglamasiga qo'ysak,

	$$P_0V = \frac{\Delta m T_2}{\mu(T_1 - T_2)} RT_1 \quad (5)$$ bundan $$V = \frac{\Delta m T_2}{\mu(T_1 - T_2)P_0} RT_1 \quad (6)$$
Hisoblash:	
$$V = \frac{8{,}5\ kg \cdot 273\ K \cdot 8{,}31 \frac{J}{mol} \cdot K \cdot 308K}{29 \cdot 10^{-3} \frac{kg}{mol} \cdot 35K \cdot 10^5 Pa} \approx 5853 \cdot 10^{-2} m^3 \approx 58{,}5\ m^3$$	

11-masala: Agar kislorod molekulalarining o'rtacha kvadratik tezligi 400 m/s va konsentratsiyasi $2{,}7 \cdot 10^{25}$ m^{-3} bo'lsa, kislorodning idish devorlariga beradigan bosimini toping.

Berilgan:	Formula:
υ_{kv}=400 m/s n=$2{,}7 \cdot 10^{25}$ m^{-3} μ=0,032 kg/mol _____ P=?	Molekulyar kinetik nazariyaning asosiy tenglamasiga binoan: $$P = \frac{1}{3} m_0 n v^2 \ (1)$$ bu yerda v_{kv}^2-tezlik kvadratining o'rtacha qiymati, $$m_0 = \frac{\mu}{N_A} \ (2)$$ m_0-kislorod molekulasining massasi. m_0 ning bu ifodasini (1) formulaga qo'yib, bosimni topamiz: $$P = \frac{1}{3} \frac{\mu}{N_A} n v^2 \ (3)$$
Hisoblash:	
$$P = \frac{1}{3} \frac{\mu}{N_A} n v^2 = \frac{0{,}032 \cdot 2{,}7 \cdot 10^{25} \cdot (400 \frac{m}{s})^2}{3 \cdot 6{,}02 \cdot 10^{23} mol^{-1}} = 7{,}65 \cdot 10^4 Pa = 76{,}5\ kPa$$	

12-masala: Ideal gazning harorati 87 ^{0}C va konsentratsiyasi $1{,}0 \cdot 10^{12}$ m^{-3} bo'lsa, shu gazning bosimini va molekulalari ilgarilanma harakatining o'rtacha kinetik energiyasini toping.

Berilgan:	Formula:
T=(87+273) K=360 K n=$1{,}0 \cdot 10^{12}$ m^{-3}	Gaz molekulalari xaotik ilgarilanma harakatining o'rtacha kinetik energiyasi

k=1,38·10^{-23} J/K _____ P=? E=?	gazning absolyut haroratiga to'g'ri proporsional: $$E = \frac{3}{2}kT \quad (1)$$ Gazning bosimi molekulalar konsentratsiyasiga va haroratga to'g'ri proporsional: $$P = nkT \quad (2)$$ Bosimning bu qiymatini molekulyar-kinetik nazariyaning asosiy tenglamasi $$P = \frac{2}{3}nE \quad (3)$$ dan foydalanib topsa ham bo'lar edi.
Hisoblash:	
$$E = \frac{3}{2} \cdot 1{,}38 \cdot 10^{-23} J/K \cdot 360\ K = 7{,}45 \cdot 10^{-21} J$$ $$P = \mathrm{n}kT = 1{,}0 \cdot 10^{12} m^{-3} \cdot 1{,}38 \cdot 10^{-23} J/K \cdot 360K \approx 5\ nPa$$	

13-masala: Idishdagi gazning harorati 127 ^{0}C va bosimi 200 kPa edi. Gazning yarmi idishdan chiqarilib yuborilgandan so'ng harorati 50 ^{0}C pasaygan bo'lsa, bosimi qancha bo'lgan?

Berilgan:	Formula:
T_1=(127+273) K=400 K P_1=200 kPa=2·10^5 Pa ΔT=-50 K $m_2=m_1/2$ _____ P_2=?	Mendeleyev-Klapeyron tenglamasini gazning boshlang'ich va oxirgi holatlariga qo'llaymiz: $$P_1V_1 = \frac{m_1}{\mu}RT_1; P_2V_2 = \frac{m_2}{\mu}RT_2 \quad (1)$$ Bu tenglamalardan ikkinchisini birinchisiga hadma-had bo'lib, quyidagi tenglamaga kelamiz: $$\frac{P_2V_2}{P_1V_1} = \frac{m_2T_2}{m_1T_1} \quad (2)$$ Bundan $V_1=V_2$, $m_2/m_1=1/2$ va $T_2=T_1+\Delta T$ ekanini hisobga olgan holda $$P_2 = P_1\frac{T_{1+}\Delta T}{2T_1} \quad (3)$$ Ifodani topamiz.

Hisoblash:
$P_2 = 200\ \frac{400-50}{2\cdot 400}\ kPa = 87{,}5\ kPa$

14-masala:Gaz aralashmasi 32 g kislorod va 22 g karbonat angidrid gazidan iborat. Shu aralashmaning normal sharoitdagi zichligini toping.

Berilgan:	Formula:
m_1=32 g μ_1=32 g/mol m_2=22 g μ_1=44 g/mol T=273 K P=101,3 kPa _____ ρ=?	Zichlikning ta'rifiga ko'ra: $\rho = \frac{m}{V}$ (1) bu yerda: m=m_1+m_2-gaz aralashmasining massasi, V-hajmi. Dalton qonuniga binoan gaz aralashmasining bosimi unga kirgan gazlarning parsial bosimlari yig'indisiga teng: $P = P_1 + P_2$ (2) Parsial bosimlarni gaz holati tenglamasi (Mendeleyev-Klapeyron tenglamasi) dan foydalanib topish mumkin: $P_1V = \frac{m_1}{\mu_1}RT_1;\ P_2V = \frac{m_1}{\mu_2}RT_2$ (3) (3) ifodalarni (2) formulaga qo'yib, quyidagini olamiz: $P = \left(\frac{m_1}{\mu_1} + \frac{m_2}{\mu_2}\right)\frac{RT}{V}.$ (4) bundan, $V = \left(\frac{m_1}{\mu_1} + \frac{m_2}{\mu_2}\right)\frac{RT}{P}.$ (5) Bu ifodani (1) ga qo'yib, aralashmaning zichligini topamiz: $\rho = \frac{m_1+m_2}{V} = \frac{m_1+m_2}{\frac{m_1}{\mu_1}+\frac{m_2}{\mu_2}}\frac{P}{RT}$ (6)
Hisoblash:
$\rho = \frac{m_1+m_2}{\frac{m_1}{\mu_1}+\frac{m_2}{\mu_2}}\frac{P}{RT} = \frac{(32+22)\cdot 10^{-3}}{\frac{32}{32}+\frac{22}{44}}\cdot\frac{101{,}3\cdot 10^3}{8{,}31\cdot 273}\frac{kg}{m^3} = 1{,}61\ \frac{kg}{m^3}.$

15-masala:Shtern tajribasida atomlarning o'rtacha tezligi 300 m/s va asbobning aylanish chastotasi 20 ayl/s bo'lsa, metall polosaning siljishini toping. katta silindrning radiusi 10 sm, kichik silindrning radiusini e'tiborga olmang.

Berilgan:	Formula:
υ=300 m/s ν=20 ayl/s R=0,1 m r=0 _____ S=?	Shtern tajribasida polosaning siljish masofasi: $S = \frac{2\pi\nu(R-r)R}{\upsilon}$ (1) formuladan topiladi. Bu formulada r=0 ekanini hisobga olib va son qiymatlarni qo'yib, quidagini topamiz: $S = \frac{2\pi\nu R^2}{\upsilon}$ (2)
Hisoblash:	
$S = \frac{2\pi\nu R^2}{\upsilon} = \frac{2 \cdot 3{,}14 \cdot 20 \cdot 0{,}1^2}{300} m \approx 4{,}2\ mm.$	

16-masala. Erish temperaturasida turgan 3 kg muzni suvga aylantirish uchun qancha issiqlik miqdori berish kerak?

Berilgan: m=3 kg λ=336 kJ/kg _____ **Topish kerak:** Q=?	**Formula:** $Q = \lambda \cdot m$ (1) $[Q] = \frac{J}{kg} \cdot kg = J$
Hisoblash: $Q = \lambda \cdot m = 336 \cdot 10^3 \cdot 3 = 1008 \cdot 10^3\ J = 1008\ kJ$	

17-masala. Erish temperaturasida turgan m massali qalayni to'liq eritishga 10 kJ issiqlik miqdori sarflanadi. Eritilgan qalayni massasini toping.

Berilgan: Q=10 kJ=10·10³ J λ=60 kJ/kg=60·10³ J/kg _____	**Formula:** $Q = \lambda \cdot m$ (1) $m = \frac{Q}{\lambda}$ (2)

Topish kerak: m=?	$[m] = \dfrac{J}{\dfrac{J}{kg}} = kg$
Hisoblash: $m = \dfrac{Q}{\lambda} = \dfrac{10 \cdot 10^3}{60 \cdot 10^3} kg \approx 0{,}17\ kg$	

18-masala. Muzlatkichga qo'yilgan 0^0C dagi 0,5 litr suv batamom muzlaguncha undan qancha issiqlik ajralib chiqadi?

Berilgan:	**Formula:**
t=0^0C V=0,5 l=0,5·10^{-3} m^3 ρ=10^3 kg/m^3 λ=334 kJ/kg=334·10^3 J/kg _____ Topish kerak: Q=?	$Q = \lambda \cdot m$ (1) $m = \rho \cdot V$ (2) $Q = \lambda \cdot \rho \cdot V$ (3) $[Q] = \dfrac{J}{kg} \cdot \dfrac{kg}{m^3} \cdot m^3 = J$
Hisoblash: $Q = 334 \cdot 10^3 \cdot 10^3 \cdot 0{,}5 \cdot 10^{-3} = 167 \cdot 10^3\ J = 167\ kJ$	

19-masala. Erish temperaturasida turgan 5 kg jismni batamom eritguncha 420 kJ issiqlik miqdori safrlandi. Bu jism qaysi moddadan tayyorlangan?

Berilgan:	**Formula:**
m=5 kg Q=420 kJ=420·10^3 J _____ Topish kerak: λ=?	$Q = \lambda \cdot m$ (1) $\lambda = \dfrac{Q}{m}$ (2) $[\lambda] = \dfrac{J}{kg} = \dfrac{J}{kg}$
Hisoblash: $\lambda = \dfrac{Q}{m} = \dfrac{420 \cdot 10^3}{5}\ \dfrac{J}{kg} = 84 \cdot 10^3\ \dfrac{J}{kg} = 84\ \dfrac{kJ}{kg}$ $\lambda = 84\ \dfrac{kJ}{kg}$ $Po'lat$	

20-masala. Temperaturasi 0 ^{0}C bo'lgan 1 litr suvni qaynatish uchun sarflanadigan energiya shunday temperaturadagi qancha muzni eritishi mumkin?

Berilgan:	**Formula:**
t_1=0 ^{0}C t_2=100 ^{0}C c=4200 J/kg V=1 l =1·10^{-3} m^3 ρ=1·10^3 kg/m^3 λ=334 kJ/kg=334·10^3 J/kg _____ Topish kerak: m_m=?	$Q_1 = \lambda \cdot m_m$ (1) $Q_2 = c \cdot m_s \cdot \Delta t$ (2) $\Delta t = t_2 - t_1$ (3) $m_s = \rho \cdot V$ (4) $Q_1 = Q_2$ (5) $\lambda \cdot m_m = c \cdot \rho \cdot V \cdot (t_2 - t_1)$ (6) $m_m = \frac{c \cdot \rho \cdot V \cdot (t_2 - t_1)}{\lambda}$ (7) $[m] = \frac{kg}{J} \cdot \frac{J}{kg \cdot K} \cdot \frac{kg}{m^3} \cdot m^3 \cdot K = kg$

Hisoblash:

$$m_m = \frac{c \cdot \rho \cdot V \cdot (t_2 - t_1)}{\lambda} = \frac{4200 \cdot 10^3 \cdot 1 \cdot 10^{-3} \cdot 100}{334 \cdot 10^3} = 1{,}25\ kg$$

21-masala. Sirtining yuzasi 250 m^2 bo'lgan hovuz suvi 0 ^{0}C temperaturada 1 mm qalinlikdagi muz bilan qoplandi. Bunda atrofga qancha issiqlik miqdori ajralgan? Muzning zichligini 900 kg/m^3 ga teng deb oling.

Berilgan:	**Formula:**
S=250 m^2 t_1=0 ^{0}C d=1 mm=1·10^{-3} m ρ=900 kg/m^3= 0,9·10^3 kg/m^3 λ=334 kJ/kg=334·10^3 J/kg _____ Topish kerak: Q=?	$Q = \lambda \cdot m$ (1) $m = \rho \cdot V$ (2) $V = S \cdot d$ (3) $Q = \lambda \cdot \rho \cdot V$ (4) $Q = \lambda \cdot \rho \cdot S \cdot d$ (5) $[Q] = \frac{J}{kg} \cdot \frac{kg}{m^3} \cdot m^2 \cdot m = J$

Hisoblash:

$$Q = \lambda \cdot \rho \cdot S \cdot d = 334 \cdot 10^3 \cdot 0{,}9 \cdot 10^3 \cdot 250 \cdot 1 \cdot 10^{-3} = 75{,}150 \cdot 10^6\ J$$
$$Q \approx 75\ MJ$$

22-masala. O'choqda 60 kg po'latni 1400 ^{0}C ga isitish uchun 4,6 kg maxsus yoqilg'I sarf bo'ladi. Agar po'latning solishtirma issiqlik sig'imi 460 J/kg·K,

maxsus yoqilg'ining yonish issiqligi 30 MJ/kg bo'lsa, o'choqning issiqlik berishi (FIK) qanday?

1. Berilgan:	Formula:
m_1=60 kg Δt =1400^{0}C m_2=4,6 kg c =460 J/kg·K q =30 MJ/kg=3·10^7 J/kg _____ η =?	$\eta = \frac{A_f}{A_t} \cdot 100\%$ (1) $A_f = Q_1 = cm_1\Delta t$ (2) $A_t = Q_2 = qm_2$ (3) $\eta = \frac{cm_1\Delta t}{qm_2} \cdot 100\%$ (4)

Hisoblash:

$$\eta = \frac{cm_1\Delta t}{qm_2} \cdot 100\% = \frac{460\ \frac{J}{kg \cdot K} \cdot 60\ kg \cdot 1400^0 C}{3 \cdot 10^7\ \frac{J}{kg} \cdot 4{,}6\ kg} 100\% = 28\%$$

23-masala. Minutiga 4 g kerosin sarflaydigan isitkichda temperaturasi 31 ^{0}C bo'lgan 2 litr suv qancha vaqtdan so'ng qaynagan? Qurilmaning FIK 35 % q_k=46 MJ/kg ga teng deb oling.

2. Berilgan:	Formula:
t =1 min=60 s m=4 g t_1 =31^{0}C t_2 =100 ^{0}C $\Delta t = t_2 - t_1 = 69\ ^0C$ $V = 2\ l = 2 \cdot 10^{-3}\ m^3$ $\rho = 1000\ \frac{kg}{m^3}$ $\eta = 35\ \%$ q_k =46 MJ/kg=46·10^6 J/kg $c = 4200$ J/kg·K _____ t_0=?	$\eta = \frac{A_f}{A_t} \cdot 100\%$ (1) $A_f = Q_1 = cm_1\Delta t = cm_1(t_2 - t_1)$ (2) $A_t = Q_2 = q_k m_2$ (3) $\eta = \frac{cm_1\Delta t}{q_k m_2} \cdot 100\% = \frac{cm_1(t_2 - t_1)}{q_k m_2} \cdot 100\%$ (4) $m_1 = \rho \cdot V$ (5) $\eta = \frac{c \cdot \rho \cdot V(t_2 - t_1)}{q_k \cdot m_2} \cdot 100\%$ (6)

Hisoblash:

$$\eta = \frac{c \cdot \rho \cdot V(t_2 - t_1)}{q_k \cdot m_2} \cdot 100\%$$

$$\eta = \frac{4200\ \frac{J}{kg \cdot K} \cdot 10^3 \frac{kg}{m^3} \cdot 2 \cdot 10^{-3}\ m^3 \cdot 69\,^0C}{46 \cdot 10^6\ \text{J/kg} \cdot m_2} \cdot 100\%$$

$$m_2 = 36\ g$$

4 g --------- 1 min

36 g --------- t_0

$$t_0 = \frac{36g \cdot 1\ min}{4g} = 9\ min$$

24-masala. Suv tomchisining massasi 10^{-10} g. U nechta molekuladan tashkil topgan?

Berilgan:	***Formula***:
$m = 10^{-10}\ g$ $\mu = 18\ \ g/mol$ _____ $Topish\ kerak$: $N =$?	Molekulalar soni N ni 1 moldagi molekulalar soni $N_A = 6{,}022 \cdot 10^{23}\ mol^{-1}$ (1) ni (ya'ni Avogardo sonini) tomchidagi modda miqdori (mollar soni) $\nu = \frac{m}{\mu}$ (2) ga ko'paytirib topish mumkin: $N = \nu \cdot N_A = \frac{m}{\mu} \cdot N_A$ (3)

Hisoblash:

$$N = \nu \cdot N_A = \frac{m}{\mu} \cdot N_A = \frac{10^{-10}\ g}{18\ \ g/mol} \cdot 6{,}022 \cdot 10^{23} mol^{-1} \approx 3{,}3 \cdot 10^{12}.$$

*Olimpiada masalalari.

1-masala: Havosi so'rib olingan va ikkala uchi kavsharlangan L=1 m uzunlikdagi nayning o'rtasida uzunligi h=20 sm bo'lgan simob ustunchasi bor. agar nayni vertikal qo'yilsa, uning ichidagi simob ustunchasi *l*=10 sm bo'ladi. Nay qancha P_1 bosimgacha so'rilgan? Simobning zichligi ρ=13,6 g/sm³.

Berilgan:	Formula:
L=1 m h=20 sm=0,2 m *l*=10 sm= 0,1 m ρ=13,6 g/sm³ _____ P_1=?	Nayning har ikkala uchida havo dastlab $V_1 = \frac{L-h}{2} \cdot S$ (1) hajmni egallaydi (bunda S-nayning ko'ndalang kesim yuzi) va P_1 bosimga ega bo'lgan. Nayni vertikal qo'yilganda yuqorigi qismda havoning hajmi $V_2 = (\frac{L-h}{2} + l) \cdot S$ (2) bosimi P_2 bo'lgan. Nayning pastki qismida esa hajm $V_3 = (\frac{L-h}{2} - l) \cdot S$ (3) Bosimi P_3 bo'lgan. Boyl-Mariott qonuniga ko'ra nayning yuqorigi qismi uchun $P_1V_1 = P_2V_2$ (4) bundan. $(L-h)P_1 = (L-h+2l)P_2$ (5) pastki qism uchun $P_1V_1 = P_3V_3$ (6) bundan $(L-h)P_1 = (L-h-2l)P_3$ (7) Boshqa tomondan nayning pastki qismidagi havo bosimi nayning yuqorigi qismidagi havo bosimi bilan simob ustunchasining bosimi yig'indisiga teng bo'lganda simob ustunchasi muvozanatda bo'ladi, ya'ni $P_3 = P_2 + \rho gh$ (8)

	(5), (7) va (8) dan P_2 va P_3 larni yo'qotib, quyidagini topamiz: $$P_1 = \frac{\rho g h[(L-h)^2 - 4l^2]}{4l(L-h)} \quad (9)$$
Hisoblash:	
$$P_1 = \frac{\rho g h[(L-h)^2 - 4l^2]}{4l(L-h)} = 50\ kPa$$	

2-masala: Chuqurligi H ga teng bo'lgan suv havzasi tubidan havo pufakchasi chiqmoqda. Pufakchaning radiusi r va vaqtning berilgan momentida u turgan h chuqurlik orasidagi bog'lanishni toping. pufakchaning havza tubida bo'lgan paytdagi hajmi V_0 ga teng. Sirt taranglik kuchini hisobga olmang.

Berilgan:	Formula:
H, r, h, V_0 _____ r(h)=?	Suv havzasining tubidagi havo bosimi $$P_1 = P_0 + \rho g H \quad (1)$$ ga teng. h chuqurlikdagi havo bosimi esa $$P_2 = P_0 + \rho g h \quad (2)$$ bo'ladi. Xuddi shu h chuqurlikda havo pufakchasining hajmi $$V = \frac{4}{3}\pi r^3 \quad (3)$$ ga teng. Boyl-Mariott qonuniga ko'ra $$P_1 V_0 = P_2 V \quad (4)$$ yoki $$(P_0 + \rho g H)V_0 = (P_0 + \rho g h)\frac{4}{3}\pi r^3 \quad (5)$$ (5) ifodadan$r$ ni topamiz.
Hisoblash:	
$$r = \sqrt[3]{\frac{3(P_0 + \rho g H)V_0}{4\pi(P_0 + \rho g h)}}.$$	

3-masala: Nasosning so'rish kamerasi V_0 hajmga ega. V hajmdagi havoni P_0 bosimdan P_n bosimgacha so'rib olish uchun nasos necha sikl ish bajaradi?Temperaturani o'zgarmas deb hisoblang.

Berilgan:	Formula:
V_0, V, P_0, P_n	So'rishdan oldin havoning hajmi balonning V

_____ n =?	hajmiga va bosimi esa P_0 ga teng bo'lgan. Birinchi so'rishning oxirida havoning hajmi balonning V hajmi bilan so'ruvchi kameraning V_0 hajmlari yig'indisiga teng, bosimi esa P_1 ga teng bo'ladi. Boyl-Mariott qonuniga ko'ra $$P_0V = P_1(V + V_0) \quad (1)$$ bundan $$P_1 = P_0\frac{V}{V + V_0} \quad (2)$$ Ikkinchi siklda boshlang'ich bosim sifatida P_1 xizmat qiladi. Shuning uchun $$P_2 = P_1\frac{V}{V + V_0} = P_0(\frac{V}{V + V_0})^2 \quad (3)$$ Uchinchi sikilda boshlang'ich bosim P_2 bo'ladi. Binobarin, $$P_3 = P_2\frac{V}{V + V_0} = P_0(\frac{V}{V + V_0})^3 \quad (4)$$ va h. k. ravshanki, n sikldan so'ng bosim $$P_n = P_0(\frac{V}{V + V_0})^n \quad (5)$$ bo'ladi; bundan $$\frac{P_n}{P_0} = (\frac{V}{V + V_0})^n \quad (6)$$
Hisoblash:	
(6) ifodani logarifmlab, quyidagini topamiz: $$l\,g\left(\frac{P_n}{P_0}\right) = n\lg\frac{V}{V + V_0}\ yoki\ n = \frac{\lg\left(\frac{P_n}{P_0}\right)}{lg\frac{V}{V + V_0}}.$$	

4-masala: Avtomobil shinasidagi kamera dvigatel yordamida ishlaydigan nasos bilan damlanadi. Agar nasos har bir yurishda atmosferadan balandligi 10 sm va diametri 10 sm bo'lgan silindrik havo ustuni olsa va agar bir yurish vaqti 1,5 sekund bo'lsa, 6 litr hajmli kamerani 0,5 MPa bosimgacha damlash uchun qancha vaqt kerak bo'ladi? Kameradagi boshlang'ich bosim 100 kPa ga teng.

Berilgan:	Formula:

h=10 sm=0,1 m d=10 sm=0,1 m t_1=1,5 s V=6 *l*=6·10^{-3} m^3 _____ t =?	Havoning parsial bosimini Boyl-Mariott qonuni yordamida topish mumkin. $$P_0V_0 = PV \quad (1)$$ bunda $$V_0 = S \cdot h = \frac{\pi d^2}{4} \cdot h \quad (2)$$ nasosning har bir yurishida so'riladigan havoning hajmi. Nasos n ta yurishida kameraga kiritgan barcha havo parsial bosimlarining yig'indisi $$Pn = \frac{\pi d^2 hnP_0}{4V} \quad (3)$$ ga teng bo'ladi. Bu kattalikni kameradagi P_0 boshlang'ich bosimga qo'shib, quyidagini topamiz. $$P_1 = \frac{\pi d^2 hnP_0}{4V} + P_0 \quad (4)$$ bundan kamerada P_1 bosim hosil qilish uchun zarur bo'lgan nasos yurishlari soni $$n = \frac{4V(P_1 - P_0)}{\pi d^2 hP_0} \quad (5)$$ ga teng. Kamerani damlash uchun ketadigan vaqt: $$t = nt_1 = \frac{4V(P_1 - P_0)}{\pi d^2 hP_0} \cdot t_1 \quad (6)$$ ga teng.
Hisoblash:	
$$t = \frac{4V(P_1 - P_0)}{\pi d^2 hP_0} \cdot t_1 \approx 46\ s$$	

5-masala: Silindrik idishdagi gaz yengil qo'zg'ala oladigan, massasi m va yuzi S ga teng bo'lgan porshen bilan ikki qismga ajratilgan. Silindrni gorizontal qo'yilganda idishning ikkala qismidagi bosim birday va P ga teng. silindrni vertikal qo'yilganda porshen ustidagi P_1 bosim qancha bo'lishini aniqlang. Temperatura o'zgarmaydi deb hisoblang.

Berilgan:	Formula:
m; S; P;	Silindr gorizontal turganda har ikki yarmining

_____ P_1 =?	hajmi V bo'lsin. Uni vertikal holatga o'tkazilganda yuqorigi yarmining hajmi V+ΔV va bosimi P_1 ga teng bo'ladi, pastki yarmining hajmi V-ΔV va bosimi P_1+(mg/S) ga teng bo'ladi. Boyl-Mariott qonuniga muvofiq silindrning yuqorigi va pastki yarmi uchun: $$PV = P_1(V + \Delta V) \quad (1)$$ va $$PV = (P_1 + \frac{mg}{S})(V - \Delta V) \quad (2)$$ tenglamalarni V ga bo'lsa, $$P = P_1(1 + \frac{\Delta V}{V}) \quad (3)$$ va $$P = (P_1 + \frac{mg}{S})(1 - \frac{\Delta V}{V}) \quad (4)$$ ni olamiz. Bu tenglamalardan $\Delta V/V$ noma'lum kattalikni yo'qotib, ushbu kvadrat tenglamani olamiz: $$P_1^2 - \left(P - \frac{mg}{S}\right) P_1 - \frac{mgP}{2S} \quad (5)$$
Hisoblash:	
(5) kvadrat tenglamaning yechimi: $$P_1 = \frac{1}{2}\left[P - \frac{mg}{S} + \sqrt{P^2 + \left(\frac{mg}{S}\right)^2}\right]$$ Ikkinchi ildiz tashlab yuboriladi, chunki u P_1 uchun manfiy qiymatlar beradi.	

6-masala: Og'ir porshenli vertikal silindr 10 kg massali kislorod bilan to'ldirilgan. Temperatura 50 K ortgandan so'ng kesim yuzi 100 sm^2 bo'lgan porshen 7 m balandlikka ko'tarildi. Porshenning og'irligini aniqlang.porshen ustidagi normal bosim 100 kPa ga teng. porshenning silindr devorlariga ishqalanishini hisobga olmang.

Berilgan:	Formula:
m=10 kg ΔT=50 K S=100 sm^2=10^{-2} m^2 h=7 m P_0=10^5 Pa	Holat tenglamasi silindr qizdirilgunga qadar $$PV = \frac{m}{M} RT \quad (1)$$ qizdirilgandan keyin esa

M=32·10^{-3} kg/mol _____ $F_{og'}$ =?	$$P(V+Sh)=\frac{m}{M}R(T+\Delta T) \quad (2)$$ ko'rinishda bo'ladi, bunda P, V va T-gazning qizdirilgunga qadar bosimi, hajmi va temperaturasi. Ikkinchi tenglamani birinchi tenglamadan ayirib va $$P=P_0+\frac{F_{og'}}{S} \quad (3)$$ Ekanligini nazarda tutgan holda quyidagini olamiz: $$F_{og'}=\frac{mR\Delta T}{\mu h}-P_0S \quad (4)$$
Hisoblash:	
$$F_{og'}=\frac{mR\Delta T}{\mu h}-P_0S=855\ kg$$	

7-masala: Ikkala tomoni berkitilgan silindr 100 kPa bosimda va 30 ^{0}C temperaturada gaz bilan to'ldirilib, yengil qo'zg'aluvchan porshen bilan 50 sm uzunlikda teng ikki qismga bo'lingan. Porshen 20 sm siljishi uchun silindrning bir qismidagi gaz temperaturasini qanday kattalikka orttirish kerak?Ikkinchi qismida temperatura o'zgarmaydi.Porshen siljigandan so'ng gaz bosimi qancha bo'lishini aniqlang.

Berilgan:	Formula:
$P_0=10^5$ Pa t=30^{0}C; T=(30+273)K=303K L=50 sm=0,5 m *l*=20 sm=0,2 m T=const _____ P=?	Silindrning ikkala qismidagi gazning holat tenglamasi uni qizdirmasdan oldin $$PSL=\frac{m}{M}\,RT \quad (1)$$ bo'ladi, bunda $$V=SL \quad (2)$$ (2) silindr yarmining hajmi, S-uning ko'ndalang kesim yuzi. Qizdirilgan yarmining hajmi $$V_1=S(L+l) \quad (3)$$ ga teng bo'lib qoladi va undagi gazning holat tenglamasi:

	$$P_1S(L+l)=\frac{m}{M}R(T+\Delta T) \quad (4)$$ ikkinchi yarmining hajmi esa $$V_2=S(L-l) \quad (5)$$ va undagi gaz uchun holat tenglamasi $$P_1S(L-l)=\frac{m}{M}RT \quad (6)$$ bo'ladi, bundan P_1-porshen siljigandan keyingi gaz bosim, bu bosim porshen muvozanatda bo'lganligidan silindrning ikkala yarmi birday, $T+\Delta T$ –qizdirilgan yarmidagi temperatura. Oxirgi ikki tenglamani bir-biriga bo'lib, quyidagini olamiz: $$T+\Delta T=T\frac{L+l}{L-l} \quad (7)$$ bundan $$\Delta T=\frac{2Tl}{L-l} \quad (8)$$ (1) va (6) tenglamalarning o'ng tomonlari o'zaro teng, shuning uchun $$P_1S(L-l)=PSL \quad (9)$$ (bu tenglama silindrning temperatura o'zgarmagan qismi uchun Boyl-Mariott qonunini ifodalaydi). Bu tenglamadan: $$P_1=\frac{PL}{(L-l)} \quad (10)$$ ga teng.
Hisoblash:	
$\Delta T=\frac{2Tl}{L-l}=404\ K, \qquad P_1=\frac{PL}{(L-l)}=167\ kPa.$	

8-masala: V=100 litr hajmli idisg yarim o'tkazuvchan to'siq bilan teng ikkiga bo'lingan. Idishning birinchi yarmida m_1=2 g massali vodorod, ikkinchi yarmida bir mol azot bor. Agar to'siq faqat vodorodni o'tkazishi mumkin bo'lsa, to'siqning ikki tomonida qaror topgan bosimni aniqlang. ikkala tomondagi temperatura birday t=127 ^{0}C va o'zgarmas.

Berilgan:	Formula:
V=100 litr=$100\cdot10^{-3}$ m^3=10^{-1} m^3	Vodorod to'siq orqali erkin o'ta olganligidan, idishning butun V hajmi bo'yicha tarqaladi va

m_1=2 g=2·10^{-3} kg
t=127^{0}C; T=(127+273) K=400 K
μ_1=2·10^{-3} kg/mol
μ_2=28·10^{-3} kg/mol
T=const

_____

P=?

uning uchun holat tenglamasi

$$P_1V = \frac{m_1}{\mu_1}\,RT \quad (1)$$

bo'ladi, bunda μ_1=2·10^{-3} kg/mol – vodorodning molyar massasi. Idishning faqat vodorodning o'zi bo'lgan qismida bundan keyin ham faqat vodorod qoladi, shu sababli idishning bu qismidagi bosim

$$P_1 = \frac{m_1}{\mu_1 V}\,RT \quad (2)$$

ga teng bo'ladi. Azot uchun holat tenglamasi

$$P_2\frac{V}{2} = \frac{m_2}{\mu_2}\,RT \quad (3)$$

bunda μ_2=28·10^{-3} kg/mol –azotning molyar massasi. idishning bu qismida ham vodorod, ham azot bo'lgani uchun to'la bosim P_1 va P_2 parsial bosimlar yig'indisidan iborat bo'ladi. Shunday qilib,

$$P = P_1 + P_2 = \left(\frac{m_1}{\mu_1} + \frac{2m_2}{\mu_2}\right)\frac{RT}{V} \quad (4)$$

(4) ifodadan umumiy bosimni topamiz.

Hisoblash:

$$P_1 = \frac{m_1}{\mu_1 V}\,RT = \frac{2\cdot 10^{-3}\ kg}{2\cdot 10^{-3}\frac{kg}{mol}\cdot 10^{-1}m^3}\,8{,}31\ \frac{J}{mol\cdot K}\cdot 400\ K \approx 33\ kPa$$

$$m_2 = \nu\cdot\mu_2 = 1\ mol\cdot 28\cdot 10^{-3}\frac{kg}{mol} = 28\cdot 10^{-3}\ kg.$$

$$P = P_1 + P_2 = \left(\frac{m_1}{\mu_1} + \frac{2m_2}{\mu_2}\right)\frac{RT}{V}$$

$$= \left(\frac{2\cdot 10^{-3}kg}{2\cdot 10^{-3}\frac{kg}{mol}} + \frac{2\cdot 28\cdot 10^{-3}\ kg}{28\cdot 10^{-3}\frac{kg}{mol}}\right)\frac{8{,}31\frac{J}{mol\cdot K}\cdot 400\ K}{10^{-1}m^3}$$

$$\approx 0{,}1\ MPa$$

Mustaqil yechish uchun saralangan masalalar:

Molekulyar fizika. Gaz qonunlari.

1. $1{,}204\cdot10^{24}$ ta molekuladan tashkil topgan jismning modda miqdori qanday (mol)? Avogadro soni $6{,}02\cdot10^{23}$ mol^{-1}.

(Javob: 2).

2. $3\cdot10^{23}$ ta azot molekulasi qanday massaga (g da) ega? Azotning molyar massasi 28 g/mol. Avogadro soni $6\cdot10^{23}$ mol^{-1}.

(Javob: 14).

3. 50 mol kislorodning massasi (g da) qanday? Kislorodning molyar massasi 32 g/mol.

(Javob: 1600).

4. 3 g vodoroddagi molekulalar soni 9 g suvdagiga qaraganda necha marta ko'p? Vodorodning molyar massasi 2 g/mol, suvniki esa 18 g/mol.

(Javob: 3).

5. Atmosferali havo faqat kislorod va azotdan tashkil topgan hamda havoning molyar massasi 29,12 g/mol deb hisoblab, aralashmadagi kislorod molekulalarining foizli ulushini aniqlang. Kislorodning molyar massasi 32 g/mol, azotniki 28 g/mol.

(Javob: 28).

6. $3\cdot10^{-5}$ m^3 hajmli simobli lampa ballonida 10^{12} ta molekula bo'lsa, undagi simob bug'lari 300 K temperaturada qanday bosim (μPa) hosil qiladi? Bolsman doimiysi $1{,}38\cdot10^{-23}$ J/K.

(Javob: 138).

7. $5\cdot10^{24}$ ta gaz molekulasi 300 K temperature va 414 Pa bosimda qanday hajmni egallaydi (m^3)? Bolsman doimiysi $1{,}38\cdot10^{-23}$ J/K.

(Javob: 50).

8. Agar idishdagi havo 0,83 μPa bosimgacha so'rib olingan bo'lsa, 27 ^{0}C temperaturada idishning 1 mm^3 hajmida necha ming havo molekulasi bo'ladi? Universal gaz doimiysi 8,3 J/(mol·K). Avogadro soni $6\cdot10^{23}$ mol^{-1}.

(Javob: 200000).

9. 0,01 m^3 hajmli ballonda 27 ^{0}C temperaturali gaz bor. Gaz chiqib ketishi oqibatida ballondagi bosim 4140 Pa ga kamaydi. Agar temperatura

o’zgarmagan bo’lsa, ballondan qancha molekula chiqib ketgan? Bolsman doimiysi 1,38 ·10^{-23} J/K. Javobda natijani 10^{20} ga ko’paytirgan holda bering.

(Javob: 100).

10. Xonada elektrokamin yoqilganidan so’ng o’zgarmas bosim holatida havo temperaturasi 18 ^{0}C dan 27 ^{0}C gacha ko’tarildi. Xona ichidagi havo molekulalarining soni necha foizga kamaygan?

(Javob: 3).

11. 2 mol ideal gazning 27 ^{0}C temperaturadagi to’liq ilgarilanma harakat kinetik energiyasi qanday bo’ladi(J)? Universal gaz doimiysi 8,31 J/(mol·K).

(Javob: 7479).

12. 5 litr sig’imli ballonda 800 kPa bosim ostida bo’lgan gaz molekulalarining to’liq ilgarilanma harakat kinetik energiyasi (kJ da) qanday bo’ladi?

(Javob: 6).

13. Agar gaz -73 ^{0}C gacha sovutilganda uning molekulalarining o’rtacha kvadratik tezligi 2 marta kamaygan bo’lsa, gaz qanday temperatura ostida (^{0}C) bo’lgan?

(Javob: 527).

14. Gazning bosimi 30 kPa, uning zichligi 1 kg/m^3. Gaz molekulalarining o’rtacha kvadratik tezligi qanchaga teng (m/s)?

(Javob: 300).

15. 400 kPa bosim ostidagi gazning zichligi 1,6 kg/m^3. 2 kg massali boshqa gaz 200 kPa bosim ostida 10 m^3 hajmni egallaydi. Ikkinchi gaz molekulalarining o’rtacha kvadratik tezligi birinchinikiga qaraganda necha marta katta?

(Javob: 2).

16. Gaz molekulalarining o’rtacha kvadratik tezligi 1000 m/s ga teng. Gazning bosimi va hajmi 1,2 marta oshirilgandan so’ng o’rtacha kvadratik tezlik qanchaga teng bo’ladi(m/s)?

(Javob: 1200).

17. Gaz temperaturasini 100 K ga oshirganda uning molekulalarining o'rtacha kvadratik tezligi 300 m/s dan 500 m/s gacha oshdi. O'rtacha kvadratik tezlik 700 m/s gacha ortishi uchun temperaturani yana necha gradusga ko'tarish kerak?

(Javob: 150).

Ideal gaz holatining o'zgarishi.

a) Izobarik jarayon.

18. Ideal gazning temperaturasi 67 ^{0}C va hajmi 25 litr. Bosim o'zgarmaganda, hajm 10 litrga teng bo'lishi uchun gazni qancha sovutish kerak (K)?

(Javob: 204).

19. Temperaturasi 27 ^{0}C bo'lgan ideal gazning hajmi 10 litr edi. Gaz izobarik ravishda 327 ^{0}C gacha isitilganda hajmi qanchaga ortadi (litr)?

(Javob: 10).

20. Ideal gazning temperaturasi 51 ^{0}C va hajmi 0,9 litr. Bosim o'zgarmaganda, hajm 0,3 litrga teng bo'lishi uchun gazni qanchaga sovutish kerak (K)?

(Javob: 216).

21. Gaz 27 ^{0}C temperaturada 3 litr hajmga ega. Bu gaz izobarik 100 ^{0}C da qizdirilsa, u qanday hajmni egallaydi (litr)?

(Javob: 4).

22. Ideal gaz 47 ^{0}C da 3 litr hajmni egallaydi. Bosimni o'zgartirmasdan, hajmni 1,2 litrga orttirish uchun gazning temperaturasini qanchagacha ko'tarish kerak (K)?

(Javob: 128).

23. Massasi 2,6 kg bo'lgan ideal gaz 27 ^{0}C temperaturada porshen ostida 1,3 m^3 hajmni egallab turibdi. Gaz izobarik kengayib, uning zichligi 1,2 kg/m^3 ga teng bo'lganda, porshen ichida qanday temperatura bo'ladi (K)?

(Javob: 500).

24. Gazni izobarik ravishda temperaturasini 10 K ga oshirilganda, gaz hajmi dastlabki qiymatining 1/20 qismi qadar oshdi. Gazning dastlabki temperaturasi qanday bo'lgan (K)?

(Javob: 200).

25. Massasi 3 kg bo'lgan ideal gaz 127 ^{0}C temperaturada erkin siljiydigan porshen ostida 2,5 m^3 hajmni egallab turibdi. Qanday temperaturada (K) porshen ostidagi gazning zichligi 2 kg/m^3 bo'ladi?

(Javob: 240).

26. Dastlabki temperaturasi 27 ^{0}C bo'lgan ideal gaz izobarik kengayib, uning hajmi 24 % ga ortdi. Uning keyingi temperaturasi qanday bo'lgan (^{0}C)?

(Javob: 99).

27. Ideal gaz o'zgarmas bosim ostida 1 K ga qizdirilganda uning hajmi dastlabki hajmining 1/350 qismiga ortdi. Gazning boshlang'ich harorati topilsin (K).

(Javob: 350).

28. Qo'zg'aluvchan porshenli silindr ichida joylashgan gaz 300 K temperaturada 250 cm^3 hajmni egallaydi. Agar temperatura 270 K gacha pasaysa, gaz qanday hajmni (cm^3) egallaydi?

(Javob: 225).

29. Gazning hajmi uning 0 ^{0}C dagi hajmidan ikki marta katta bo'lishi uchun uni o'zgarmas bosimda necha gradusga qizdirish kerak?

(Javob: 273).

30. Agar havo 3 K ga qizdirilganda uning hajmi 1 % ga ortgan bo'lsa, havoning boshlang'ich temperaturasi (K da) qanday bo'lgan?

(Javob: 300).

31. Gaz 27 ^{0}C dan 39 ^{0}C gacha qizdirildi. Agar gazning bosimi o'zgarmagan bo'lsa, uning hajmi necha % ga ortgan?

(Javob: 4).

32. Massasi 0,012 ka va temperaturasi 177 ^{0}C bo'lgan gaz 0,004 m^3 hajmda turibdi. Agar gazning bosimi o'zgarmas saqlansa, qanday temperaturada (K da) uning zichligi 6 kg/m^3 bo'ladi?

(Javob: 225).

33. Gaz doimiy hajmda 127 ^{0}C dan 27 ^{0}C gacha sovutildi. Shundan so'ng gazning hajmi izotermik jarayonda necha % ga kamaytirilganda uning bosimi avvalgisiga teng bo'ladi?

(Javob: 25).

b) Izoxorik jarayon.

34. Gaz 280 K dan 540 K gacha izoxorik qizdirilganda uning bosimi 39 kPa ga ortdi. Gaz dastlab qanday bosimda bo'lgan (kPa)?

(Javob: 42).

35. Ballondagi gaz 17 ^{0}C temperaturada $1{,}45\cdot10^5$ Pa bosimga ega bo'lsa, qanday temperaturada (K) uning bosimi $2\cdot10^5$ Pa bo'ladi?

(Javob: 400).

36. Agar chog'lanma lampochka yonganda, temperaturasi 17 ^{0}C dan 360 ^{0}C gacha ko'tarilsa, uning ichidagi gaz bosimi qanday o'zgaradi?

(Javob: ≈2,2 marta ortadi).

37. Gaz 300 K dan 420 K gacha izoxorik qizdirilganda uning bosimi 50 kPa ga ortdi. Gaz dastlab qanday bosimda bo'lgan (kPa)?

(Javob: 125).

38. Gazning temperaturasini izoxorik ravishda 12 ^{0}C ga qizdirilganda gaz bosimi dastlabki qiymatning 1/75 qismiga ortdi. Gazning dastlabki temperaturasi qanday bo'lgan (K)?

(Javob: 900).

39. Ballonda 100 ^{0}C haroratli gaz bor. Gazning bosimi ikki marta ortishi uchun uni qanday haroratgacha qizdirish kerak (^{0}C)?

(Javob: 473).

40. Gaz temperaturasi 286 K dan 326 K gacha o'zgarganda bosim 20 kPa ga ortdi. Gazning dastlabki bosimini toping (kPa). Jarayon izoxorik.

(Javob: 143).

41. Havo harorati ertalab 7 ^{0}C bo'lganda rezinali qayiqqa puflab dam berildi. Agar qayiq kunduzi quyosh nurlari ostida 21 ^{0}C gacha qizigan bo'lsa, undagi havo bosimi necha % ga ortgan? Qayiqning hajmi o'zgarmagan?

(Javob: 5).

42. Gaz o'zgarmas hajmda 1 K ga qizdirilganda bosim 0,2 % ga ortdi. Gaz qanday boshlang'ich temperaturada (^{0}C) bo'lgan?

(Javob: 227).

43. Ochiq idishdagi havo sekinlik bilan 400 K gacha qizdirildi, so'ngra idish germetik bekitilib, 280 K gacha sovutildi. Bunda idishdagi bosim necha % ga o'zgargan?

(Javob: 30).

44. Silindr ichida, porshen ostida gaz bor. Gazning absolyut temperaturasi 2 marta oshirilganda porshen o'zgarmas holatda qolishi uchun uning ustiga 10 kg yuk qo'yish lozim. Porshenning yuzasi 10 cm^2. Gazning boshlang'ich bosimini (kPa da) toping. g=10 m/s^2.

(Javob: 100).

45. Vertikal silindr ichidagi 5 kg massali porshen ostida gaz bor. Gazning absolyut temperaturasi ikki marta oshirilganda porshen o'zgarmas holatda qolishi uchun uning ustiga qanday massali yuk qo'yish kerak (kg)? Atmosfera bosimi 100 kPa, porshenning yuzasi 0,001 m^2.

(Javob: 15).

46. Zich berkitilgan shisha idishning ichidagi havo bosimi 7 ^{0}C temperaturada 150 kPa ga teng. Agar idishni qizdirmay turib, tiqinni tortib olish uchun 45 N minimal kuch talab etilsa, u shisha
og'zidan otilib chiqishi uchun idishni qanday temperaturagacha (^{0}C da) qizdirish kerak bo'ladi? Tiqinning ko'ndalang kesim yuzasi 4 cm^2.

(Javob: 217).

47. Gaz dastlab 400 K dan 600 K gacha izoxorik ravishda, keyin esa T temperaturagacha izobarik ravishda qizdirildi. Shundan so'ng bosim gazning hajmiga to'g'ri proporsional ravishda kamayadigan jarayonda gaz boshlang'ich holatga keltirildi. T temperaturani (K da) toping.

(Javob: 900).

d) Izotermik jarayon.

48. Normal atmosfera bosimi sharoitida ideal gaz 6 litr hajmni egallaydi. Agar gaz bosimi 20 kPa ga ortsa, gaz qanday hajmni egallaydi (litr)? T=const.

(Javob: 5).

49. Gazning dastlabki hajmi 0,2 litr, bosimi esa 300 kPa bo'lgan. Gaz izotermik kengayib, bosimi 120 kPa ga erishdi. Gazning keying hajmini toping (litr).

(Javob: 0,5).

50. Porshenli silindr ichiga qamalgan gazning dastlabki hajmi 24 cm^3, bosimi 0,8 MPa bo'lgan. Gaz izotermik siqilib, gazning hajmi 16 cm^3 ga keltirilganda uning bosimi qanday qiymatga erishadi (MPa)?

(Javob: 1,2).

51. Normal atmosfera bosimi sharoitida ideal gaz 50 litr hajmni egallaydi. Agar bosim 4 marta ortsa, gaz qancha hajmni egallaydi (litr)? T=const.

(Javob: 12,5).

52. Ideal gaz 1,2 litr hajmdan 0,8 litr hajmgacha izotermik siqildi. Bunda gazning bosimi 40 kPa ga ortdi. Gazning dastlabki bosimi qanday bo'lgan (kPa)?

(Javob: 80).

53. Ideal gaz 6 litr hajmdan 4 litr hajmgacha izotermik siqildi. Bunda gazning bosimi 0,6 normal atmosfera bosimiga ortdi. Gazning dastlabki bosimi qanday bo'lgan (kPa)? Atmosfera bosimi 100 kPa deb oling.

(Javob: 120).

54. Chuqurligi 30 m bo'lgan ko'lning tubidan havo pufakchasi suv sirtiga ko'tarilganda, uning hajmi necha marta ortadi? Suvning ustki va pastki qismlarida temperatura bir xil deb hisoblang. Atmosfera bosimi 100 kPa, $g=10\ m/s^2$.

(Javob: 4).

55. Gaz $5\cdot10^6$ Pa bosimda $2\cdot10^{-2}$ m^3 hajmni egallaydi. xuddi shu temperaturada, lekin 1 m^3 hajmda gaz qanday bosim ostida bo'ladi? Javobni atmosferada ifodalang (1 atm=10^5 Pa).

(Javob: 1).

56. 10 litr sig'imli ballonni 30 litr sig'imli, 100 kPa bosim ostida havosi bo'lgan ballon bilan tutashtirilganda 200 kPa umumiy bosim yuzaga kelishi uchun uni qanday bosimgacha havo bilan to'ldirish kerak (kPa)? Temperatura o'zgarmas.

(Javob: 500).

57. Ikki idish kranli, yupqa trubka bilan ulangan. 15 dm^3 hajmli birinchi idishda 2 atm bosim ostida gaz bor, ikkinchisida esa 10 atm bosim ostida xuddi shunday gaz bor. Agar kran ochilsa, ikkala idishda ham 4 atm bosim yuzaga keladi. Ikkinchi idishning hajmini (dm^3 da) toping. Temperatura o'zgarmas.

(Javob: 5).

58. Agar 3 litr sig'imli futbol to'piga dam solishda porshenli nasos 40 marta bosib tortilgan bo'lsa, to'pga qanday bosimgacha (kPa da) dam berilgan? Har bir dam solishda nasos atmosferadan 150 cm^3 havoni so'rib oladi. Atmosfera bosimi 100 kPa. Dam urish paytigacha to'p ichida bo'lgan havo miqdori inobatga olinmasin. Temperatura o'zgarmas.

(Javob: 200).

59. Idishdagi havo bosimi 10^5 Pa gat eng edi. Havo so'ruvchi nasos porshenining uch yurishidan so'ng havo bosimi 800 Pa ga tushdi. Nasos silindrining hajmi idish hajmidan necha marta kattaligini aniqlang. Temperatura o'zgarmas.

(Javob: 4).

60. Porshenli nasos silindrining hajmi havosi tortib olinayotgan idishning hajmiga teng. Nasos porshenining 5 yurishidan keyin idishdagi bosim qanchaga teng bo'ladi (Pa)? Idishning boshlang'ich bosimi 10^5 Pa ga teng bo'lgan. Temperatura o'zgarmas.

(Javob: 3125).

61. Silindrning porsheni ostidagi gaz 10^5 Pa bosimda 240 cm^3 hajmni egallaydi. Gaz hajmini kamaytirib, porshenni 2 cm ga siljitish uchun unga o'z tekisligiga perpendikulyar ravishda qanday kuch qo'yish kerak (N)? porshenning yuzasi 24 cm^2.

(Javob: 60).

62. Baland silindr ichida, ishqalanishsiz ko'cha oladigan og'ir porshen ostida gaz joylashgan. Porshenning yuzasi 30 cm. Silindrni ochiq tomoni bilan pastga qaratib qo'yilganda, gazning hajmi 3 marta ortdi. Porshenning massasi qanchaga teng (kg)? Atmosfera bosimi 100 kPa, g=10 m/s^2.

(Javob: 15).

63. Vertikal silindr ichida, massasi 20,2 kg va kesimi 20 cm^2 bo'lgan porshen ostida havo bor. Silindr 5 m/s^2 tezlanish bilan vertikal yuqoriga ko'chira

boshlangandan so’ng havo ustunining balandligi 20 % ga kamaydi. Temperaturani o’zgarmas hisoblab, atmosfera bosimini (kPa da) toping. g=10 m/s^2.

(Javob: 101).

64. Og’zi probka bilan berkitilgan idishda $0{,}5\cdot10^5$ Pa bosim ostida havo joylashgan. Agar idish suv ichiga ochiq tomoni bilan 10 m chuqurlikka tushirilsa va probka ochilsa, idishga qanday hajmda suv (litr da) kiradi? Idishning hajmi 4 litr, atmosfera bosimi 100 kPa, g=10 m/s^2. Suv qatlami ichida va uning sirtida temperatura bir xil.

(Javob: 3).

65. Suv havzasining tubidan ko’tarilayotgan havo pufakchasining hajmi qanday chuqurlikda suv sirtidagidan 3 marta kichik bo’ladi (m)? Atmosfera bosimi 100 kPa. Suv qatlami ichida va uning sirtida temperatura bir xil.

(Javob: 20).

66. Havo pufakchasi 35 m chuqurlikdagi suv havzasi tubidan ko’tarilmoqda. 5 m chuqurlikda pufakchaning hajmi havza tubidagiga qaraganda necha marta katta bo’ladi. Atmosfera bosimi 100 kPa, g=10 m/s^2. Suv qatlami ichida va uning sirtida temperatura bir xil.

(Javob: 3).

67. Suv havzasi tubidan ko’tarilayotgan havo pufakchasining radiusi qanday chuqurlikda sirtidagiga qaraganda 2 marta kichik bo’ladi(m)? Atmosfera bosimi 100 kPa, g=10 m/s^2. Suv qatlami ichida va uning sirtida temperatura bir xil.

(Javob: 70).

68. Gorizontal holatdagi probirka ichida 150 mm uzunlikdagi simob ustuni bilan atmosferadan ajratilgan 240 cm^3 havo bor. Agar probirkani ochiq tomoni bilan yuqoriga qaratib qo’yilsa, havoning hajmi 200 cm^3 bo’lib qoladi. Atmosfera bosimini (kPa da) toping. Simobning zichligi 13600 kg/m^3, g=10 m/s^2.

(Javob: 102).

69. Gazning hajmi 2 marta kamaytirilganda bosim 120 kPa ga o’zgardi, absolyut temperatura esa 10 % ga oshdi. Gazning dastlabki bosimi (kPa da) qanday bo’lgan?

(Javob: 100).

70. Gazning hajmi 7 marta oshirilganda bosimi 10 marta kamayishi uchun uning absolyut temperaturasini necha % ga kamaytirish kerak?

(Javob: 30).

71. Ikki idish kranli, yupqa trubka bilan ulangan. 3 litr hajmli birinchi idish 10 kPa bosim ostida turgan gaz bilan to'ldirilgan, 6 litr hajmli boshqa idishda bosim hisobga olmas darajada kam. Birinchi idishdagi gazning temperaturasi 27 ^{0}C. Agar kranni ochib gazning temperaturasini 177 ^{0}C gacha ko'tarilsa, idishlarda qanday bosim (kPa) qaror topadi?

(Javob: 5).

72. 127 ^{0}C temperatura va 200 kPa bosimda 3 litr hajmni egallaydigan gaz izotermik siqiladi, keyin -73 ^{0}C temperaturagacha izobarik sovutiladi, undan so'ng hajm 1 litr gacha izotermik o'zgartiriladi. Gazning oxirgi bosimini (kPa da) toping.

(Javob: 300).

73. Havo bilan to'ldirilgan yupqa rezinali shar suv ichiga 65,2 m chuqurlikka tushirilganda uning radiusi necha marta kamayadi? Suv sirtidagi bosim 100 kPa. Sirtdagi suvning temperaturasi 27 ^{0}C, chuqurlikdagisi 9 ^{0}C.

(Javob: 2).

Mendeleyev- Klapeyron tenglamasi.

74. Hajmi 20 litr bo'lgan idishga kislorod solingan. Idishdagi gazning temperaturasi 127 ^{0}C va bosimi 160 kPa ga teng bo'lsa, idishdagi gaz massasini aniqlang (g). R=8,31 J/(mol·K).

(Javob: 30,8).

75. Bosimi 0,45 MPa va temperaturasi 52 ^{0}C bo'lganda 500 mol gaz qanday hajmni egallaydi (m^3)? R=8,31 J/(mol·K).

(Javob: 3).

76. Hajmi 0,05 m^3 va temperaturasi 500 K bo'lgan gazning bosimi 250 kPa. Modda miqdorini aniqlang (mol). R=8,31 J/(mol·K).

(Javob: 3).

77. Massasi 8 g bo'lgan gaz 27 ^{0}C temperaturada va 150 kPa bosimda 4,15 litr hajmni egallaydi? Bu qanday gaz? R=8,31 J/(mol·K).

(Javob: Kislorod).

78. Temperaturasi 367 ^{0}C va bosimi 415 kPa bo'lgan kislorod gazining zichligi qanday (kg/m^3) ? M=32 g/mol. R=8,31 J/(mol·K).

(Javob: 2,5).

79. 24 litr hajmli ballonda 1,2 kg karbonat angidrid gazi bor. Ballon $3\cdot10^6$ Pa bosimgacha chidaydi. Qanday temperaturada portlash xavfi tug'iladi (K)? M=44 g/mol. R=8,31 J/(mol·K).

(Javob: ≈318).

80. Hajmi 40 litr bo'lgan idishga gaz solingan bo'lib, uning temparaturasi 400 K va bosimi 200 kPa ga teng. idishdagi gazning miqdorini aniqlang (mol). R=8,31 J/(mol·K).

(Javob: 2,4).

81. Temperaturasi 17 ^{0}C bo'lgan 4x5x3 m^3 o'lchamli xonadagi havo miqdorini aniqlang (mol). Atmosfera bosimi 10^5 Pa ga teng deb oling. R=8,31 J/(mol·K).

(Javob: ≈2490).

82. Hajmi 16,6 litr bo'lgan idishda 280 g azot gazi 3,5 MPa bosim ostida bo'lsa, uning temperaturasi nimaga teng (K)? M=28 g/mol. R=8,3 J/(mol·K).

(Javob: 700).

83. Ichida vodorod bo'lgan ballon 1172 K temperaturada portlagan bo'lsa va u o'n marta mustahkamlik zahirasi bilan 293 K temperaturali 7 kg massali azotni saqlashga mo'ljallangan bo'lsa, ballonda qanday massali (g da) vodorod bo'lgan? Vodorodning molyar massasi 2 kg/kmol, azotniki esa 28 kg/kmol.

(Javob: 1250).

84. 0,02 kg miqdordagi gaz 10^6 Pa bosim va 47 ^{0}C temperaturada 1660 cm^3 hajmni egallaydi. Shu berilganlar bo'yicha gazning molyar massasini (kg/kmol da) aniqlang. Universal gaz doimiysi 8300 J/(kmol·K).

(Javob: 32).

85. 0,06 m^3 sig'imli ballon ichida 27 ^{0}C temperaturada $8,3\cdot10^5$ Pa bosim ostida joylashgan vodorodning massasini (g da) aniqlang. Vodorodning molyar massasi 2 kg/kmol, universal gaz doimiysi 8300 J/(kmol·K).

(Javob: 40).

86. Sig'imi 83 litr bo'lgan ballonda 2,2 kg karbonat angidrid gazi bor. Ballon $4 \cdot 10^6$ Pa dan ortiq bo'lmagan bosimga bardosh beradi. qanday temperaturada (K da) ballon portlab ketishi mumkin? Karbonat angidrid gazining molyar massasi 44 kg/kmol, universal gaz doimiysi 8300 J/(kmol·K).

(Javob: 800).

87. Uzunligi 1,6 m bo'lgan, normal atmosfera bosimida havo bilan to'ldirilgan silindr ichiga yuzasi 200 cm^2 bo'lgan porshenni sekin kirita boshladilar. Agar poshen silindr tubidan 10 cm masofada to'xtatilsa, unga ta'sir etuvchi kuch aniqlansin (kN).

(Javob: 32).

88. Sig'imi 300 cm^3 bo'lgan jo'mrakli tiqin bilan berkitilgan kolbada siyraklashgan havo bor. Kolbadagi bosimni o'lchash uchun kolbaning bog'zini biroz suvga botirdilar va jo'mrakni ochdilar. Natijada kolbaga massasi 292 g ga teng suv kirdi. Agar atmosfera bosimi 100 kPa bo'lsa, kolbadagi dastlabki bosim aniqlansin (kPa). ρ_{suv}=1 g/cm^3.

(Javob: ≈2,67).

89. 573 K haroratli havo bilan to'ldirilgan, sig'imi 10 cm^3 bo'lgan g'ovak shrni trubka yordamida simob bilan to'ldirilgan kosaga tutashtirdilar. Ichidagi havoning harorati 293 K gacha soviganda sharga kiradigan simobning massasi aniqlansin (g). Shar sig'imining o'zgarishi inobatga olinmasin. ρ_{sim}=13,6 g/cm^3.

(Javob: ≈66,5).

90. Gaz harorat o'lchagichi shardan va unga payvandlangan gorizontal shisha trubkadan iborat. Trubkada joylashtirilgan simob tomchisi shar hajmini tashqi muhitdan ajratib turadi. Trubkaning ko'ndalang kesim yuzasi 0,1 cm^2. 273 K haroratda tomchi shar sirtidan 30 cm masofada turadi. 278 K da esa 50 cm masofada turadi. Sharning sig'imi topilsin (cm^3).

(Javob: 106,2).

91. 12 litr sig'imli ballonda karbonat angidrid gazi bor. Gazning bosimi 1 MPa da, harorati 300 K. ballondagi gaz massasi aniqlansin (g). M=44 g/mol, R=8,31 J/(mol·K).

(Javob: 212).

92. Modda miqdori 1 kmol bo'lgan 1 MPa bosimdagi 400 K haroratli ideal gaz qanday hajmni egallaydi (m^3)?

(Javob: 3,32).

93. 2 m^3 sig'imli qozonda 500 K haroratli 10 kg massali o'ta qizdirilgan suv bug'lari bor. Qozondagi bug'ning bosimi aniqlansin (MPa). M=18 g/mol, R=8,31 J/(mol·K).

(Javob: 1,15).

94. Sig'imi 20 litr bo'lgan ballonda 1,3 MPa bosim ostida 500 g massali karbonat angidrid bor. Gazning harorati aniqlansin. M=44 g/mol, R=8,31 J/(mol·K).

(Javob: ≈275).

95. Harorati 309 K va bosimi 0,7 MPa bo'lgan gaz 12 kg/m^3 zichlikka ega. Gazning nisbiy molekulyar massasi aniqlansin.

(Javob: 44).

96. Vodorod va kislorodlarning massa ulushlari mos ravishda 1/9 va 8/9 ga teng bo'lgan aralashmasining zichligi topilsin (g/m^3). Aralashmaning bosimi 100 kPa, harorati 300 K.

(Javob: 481).

97. Ballondagi gazning bosimi 16 kPa dan 10 kPa gacha kamayganida uning harorati 127 ^{0}C dan 27 ^{0}C gacha kamaydi. Ballondan gazning qanchasi chiqib ketgan (%)?

(Javob: ≈17).

98. Ideal gazning holati P/T^2=const qonuniyat bo'yicha o'zgarmoqda. Agar gazning harorati 2 marta kamaysa, uning hajmi qanday o'zgaradi?

(Javob: 2-marta ortadi).

99. Ideal gazning absolyut harorati V^2T=const qonuniyatga ko'ra 4 marta orttirilsa, uning bosimi qanday o'zgaradi?

(Javob: 8-marta ortadi).

100. Ballonda geliy (He) va kislorod (O_2) aralashmasi bor. Agar geliyning massasi 24 g va aralashmaning modda miqdori 10 mol bo'lsa, kislorodning massasini toping (g).

(Javob: 128).

Yechimlar:

1. $1{,}204 \cdot 10^{24}$ ta molekuladan tashkil topgan jismning modda miqdori qanday (mol)? Avogadro soni $6{,}02 \cdot 10^{23}$ mol^{-1}.

(Javob: 2).

 Berilgan:	 Formula:
$N = 1{,}204 \cdot 10^{24}$ $N_A = 6{,}02 \cdot 10^{23}\ mol^{-1}$ _____ $Topish\ kerak: \nu = ?$	Molekulalar soni $N = \nu \cdot N_A \quad (1)$ (1) ifodadan modda miqdori: $\nu = \frac{N}{N_A} \quad (2)$

Hisoblash:
 $\nu = \frac{N}{N_A} = \frac{1{,}204 \cdot 10^{24}}{6{,}02 \cdot 10^{23}\ mol^{-1}} = 2\ mol.$

2. $3 \cdot 10^{23}$ ta azot molekulasi qanday massaga (g da) ega? Azotning molyar massasi 28 g/mol. Avogadro soni $6 \cdot 10^{23}$ mol^{-1}.

(Javob: 14).

 Berilgan:	 Formula:
$N = 3 \cdot 10^{23}$ $M = 28\ \frac{g}{mol}$ $N_A = 6 \cdot 10^{23}\ mol^{-1}$ _____ $Topish\ kerak: m = ?$	Molekulalar soni $N = \nu \cdot N_A \quad (1)$ (1) ifodaga ν modda miqdorining $\nu = \frac{m}{M} \quad (2)$ ifodasini qo'ysak: $N = \frac{m}{M} \cdot N_A \quad (3)$ ifodaga ega bo'lamiz. (3) ifodadan molekula

	massasi $$m = \frac{N \cdot M}{N_A} \quad (4)$$ ga teng.

Hisoblash:
 $$m = \frac{N \cdot M}{N_A} = \frac{3 \cdot 10^{23} \cdot 28\ \frac{g}{mol}}{6 \cdot 10^{23}\ mol^{-1}} = 14\ g.$$

3. 50 mol kislorodning massasi (g da) qanday? Kislorodning molyar massasi 32 g/mol.

(Javob: 1600).

 Berilgan:	 Formula:
$v = 50\ mol$ $M = 32\ \frac{g}{mol}$ $Topish\ kerak: m = ?$	Modda miqdori $$v = \frac{m}{M} \quad (1)$$ (1) modda miqdori ifodasidan kislorod (O_2) molekulasining massasini: $$m = v \cdot M \quad (2)$$ ifodadan topamiz.

Hisoblash:
 $$m = v \cdot M = 50\ mol \cdot 32\ \frac{g}{mol} = 1600\ g.$$

4. 3 g vodoroddagi molekulalar soni 9 g suvdagiga qaraganda necha marta ko'p? Vodorodning molyar massasi 2 g/mol, suvniki esa 18 g/mol.

(Javob: 3).

 Berilgan:	 Formula:
$m_V = 3\ g$ $m_S = 9\ g$ $M_V = 2\ \frac{g}{mol}$ $M_S = 18\ \frac{g}{mol}$ $N_A = 6{,}02 \cdot 10^{23}\ mol^{-1}$ ——————— $Topish\ kerak: \frac{N_V}{N_s} = ?$	Molekular soni $N = \frac{m}{M} \cdot N_A \quad (1)$ ifodani vodorod va suv uchun yozib olsak: $N_V = \frac{m_V}{M_V} \cdot N_A \quad (2)$ va $N_S = \frac{m_S}{M_S} \cdot N_A \quad (3)$ ifodaga ega bo'lamiz. Molekulalar sonining nisbati, quyidagiga teng: $\frac{N_V}{N_S} = \frac{\frac{m_V}{M_V} \cdot N_A}{\frac{m_S}{M_S} \cdot N_A} \quad (4)$ Avogadro sonini qisqartirib, quyidagi nisbatga ega bo'lamiz. $\frac{N_V}{N_S} = \frac{m_V M_S}{m_S M_V} \quad (5)$

Hisoblash:
 $\frac{N_V}{N_S} = \frac{m_V M_S}{m_S M_V} = \frac{3\ g \cdot 18\ \frac{g}{mol}}{9\ g \cdot 2\ \frac{g}{mol}} = 3.$

5. Atmosferali havo faqat kislorod va azotdan tashkil topgan hamda havoning molyar massasi 29,12 g/mol deb hisoblab, aralashmadagi kislorod molekulalarining foizli ulushini aniqlang. Kislorodning molyar massasi 32 g/mol, azotniki 28 g/mol.

(Javob: 28).

 Berilgan:	 Formula:
$M = 29{,}12\ \frac{g}{mol}$ $M_k = 32\ \frac{g}{mol}$ $M_a = 28\ \frac{g}{mol}$ ——————— $Topish\ kerak$: $\frac{N_k}{N} = ?$	Aralashma modda miqdori: $\nu = \nu_k + \nu_a$ (1) kislorodning modda miqdori: $\nu_k = \frac{m_k}{M_k}$ (2) azotniki esa: $\nu_a = \frac{m_a}{M_a}$ (3) (2) va (3) ifodalarni (1) ifodaga qo'yamiz va aralashma massasi: $m = m_k + m_a$ (4) e'tiborga olib quyudagi ifodaga ega bo'lamiz: $\frac{m}{M} = \frac{m_k}{M_k} + \frac{m_a}{M_a}$ (5) (4) ifodadan aralashma massasi $m_a = m - m_k$ (6) ga teng: Aralashma massasini (5) ifodaga qo'yamiz $\frac{m}{M} = \frac{m_k}{M_k} + \frac{m - m_k}{M_a}$ (7) yoki: $\frac{m}{M} = \frac{m_k}{M_k} + \frac{m}{M_a} - \frac{m_k}{M_a}$ (8) (8) ifodadan: $\frac{m}{M} - \frac{m}{M_a} = \frac{m_k}{M_k} - \frac{m_k}{M_a}$ (9) (9) ifodadan aralashma massasi m va kislorod massasi m_k ni qavs belgisidan chiqarib hisoblaymiz: $m\left(\frac{1}{M} - \frac{1}{M_a}\right) = m_k\left(\frac{1}{M_k} - \frac{1}{M_a}\right)$ (10) (10) ifodadan

	$$\frac{m_k}{m} = \frac{\left(\frac{1}{M} - \frac{1}{M_a}\right)}{\left(\frac{1}{M_k} - \frac{1}{M_a}\right)} \quad (11)$$ (11) ifodadan kislorod va azot molekulalarining % li ulushlarini molekulalar soni bo'yicha quyidagicha yozib olamiz: $$\frac{N_k}{N} = \frac{\frac{m_k}{M_k} \cdot N_A}{\frac{m}{M} \cdot N_A} \quad (12)$$ (12) ifodadan, aralashmadagi kislorod molekulalarining % li ulushi; $$\frac{N_k}{N} = \frac{m_k \cdot M}{M_k \cdot m} \quad (13)$$ (13) ifodadan, aralashmadagi azot molekulalari % li ulushi; $$\frac{N_a}{N} = \frac{m_a \cdot M}{M_a \cdot m} \quad (14)$$ ga teng.

Hisoblash:
 $\frac{m_k}{m} = \frac{\left(\frac{1}{29,12} - \frac{1}{28}\right)}{\left(\frac{1}{32} - \frac{1}{28}\right)} = \frac{(-1,12) \cdot 32 \cdot 28}{(-4) \cdot 29,12 \cdot 28} = \frac{8}{26} = \frac{4}{13}$
 $\frac{N_k}{N} = \frac{m_k \cdot M}{M_k \cdot m} \cdot 100\% = \frac{\frac{4}{13} m \cdot 29,12 \ \frac{g}{mol}}{32 \ \frac{g}{mol} \cdot m} \cdot 100\% = 28\%.$

$$\frac{N_a}{N} = \frac{(m - m_k) \cdot M}{M_a \cdot m} \cdot 100\% = \frac{(m - \frac{4}{13}m) \cdot 29{,}12\ \frac{g}{mol}}{28\ \frac{g}{mol} \cdot m} \cdot 100\%$$

$$= 72\%.$$

6. $3 \cdot 10^{-5}$ m^3 hajmli simobli lampa ballonida 10^{12} ta molekula bo'lsa, undagi simob bug'lari 300 K temperaturada qanday bosim (μPa) hosil qiladi? Bolsman doimiysi $1{,}38 \cdot 10^{-23}$ J/K.

(Javob: 138).

 Berilgan:	 Formula:
$V = 3 \cdot 10^{-5}$ m^3 $N = 10^{12}$ $T = 300\ K$ $k = 1{,}38\ \cdot 10^{-23}\ \frac{J}{K}$ $Topish\ kerak: P = ?$	Simob bug'larining bosimi: $P = n \cdot k \cdot T$ (1) konsentratsiyasi esa: $n = \frac{N}{V}$ (2) (2) ifodani (1) ifodadagi konsentratsiya ifodasiga qo'ysak; $P = \frac{N}{V} \cdot k \cdot T$ (3) (3) ifodaga ega bo'lamiz:

Hisoblash:
 $P = \frac{N}{V} \cdot k \cdot T = \frac{10^{12}}{3 \cdot 10^{-5} m^3} \cdot 1{,}38 \cdot 10^{-23}\ \frac{J}{K} \cdot 300K\ = 138\ \mu Pa.$

7. $5 \cdot 10^{24}$ ta gaz molekulasi 300 K temperatura va 414 Pa bosimda qanday hajmni egallaydi (m^3)? Bolsman doimiysi $1{,}38 \cdot 10^{-23}$ J/K.

(Javob: 50).

 Berilgan:	 Formula:
$N = 5 \cdot 10^{24}$ $T = 300\ K$ $P = 414\ Pa$ $k = 1{,}38 \cdot 10^{-23}\ \frac{J}{K}$ $Topish\ kerak: V = ?$	Gaz molekulasi bosimi: $P = n \cdot k \cdot T \quad (1)$ konsentratsiyasi esa: $n = \frac{N}{V} \quad (2)$ (2) ifodani (1) ifodadagi konsentratsiya ifodasiga qo'ysak; $P = \frac{N}{V} \cdot k \cdot T \quad (3)$ (3) ifodadan gaz egallagan hajmni topamiz: $V = \frac{N}{P} \cdot k \cdot T \quad (4)$

Hisoblash:
 $V = \frac{N}{P} \cdot k \cdot T = \frac{5 \cdot 10^{24}}{414\ Pa} \cdot 1{,}38 \cdot 10^{-23}\ \frac{J}{K} \cdot 300K\ = 50\ m^3.$

8. Agar idishdagi havo 0,83 μPa bosimgacha so'rib olingan bo'lsa, 27 ^{0}C temperaturada idishning 1 mm^3 hajmida necha ming havo molekulasi bo'ladi? Universal gaz doimiysi 8,3 J/(mol·K). Avogadro soni $6 \cdot 10^{23}$ mol^{-1}.

(Javob: 200000).

 Berilgan:	 Formula:

$P = 0{,}83 \cdot 10^{-6}$ Pa $t = 27\ ^0C$ $T = (t + 273)K = 300$ K $V = 1\ mm^3 = 1 \cdot 10^{-6}\ m^3$ $R = 8{,}3\ \frac{J}{(mol \cdot K)}$ $N_A = 6 \cdot 10^{23}\ mol^{-1}$ ——————— $Topish\ kerak: N = ?$	Idishdagi havoning bosimi: $$P = n \cdot k \cdot T \quad (1)$$ konsentratsiyasi esa: $$n = \frac{N}{V} \quad (2)$$ (2) ifodani (1) ifodadagi konsentratsiya ifodasiga qo'ysak; $$P = \frac{N}{V} \cdot k \cdot T \quad (3)$$ (3) ifodadan havo molekulalari sonini topamiz: $$N = \frac{P \cdot V}{k \cdot T} \quad (4)$$ Bolsman doimiysi: $$k = \frac{R}{N_A} \quad (5)$$ (5) ifodadagi Bolsman doimiysini qiymatini (4) ifodaga qo'yib, quyidagiga ega bo'lamiz: $$N = \frac{P \cdot V \cdot N_A}{R \cdot T} \quad (6)$$

Hisoblash:
 $N = \frac{P \cdot V \cdot N_A}{R \cdot T} = \frac{0{,}83 \cdot 10^{-6} Pa \cdot 1 \cdot 10^{-6}\ m^3 \cdot 6 \cdot 10^{23} mol^{-1}}{8{,}3\ \frac{J}{(mol \cdot K)} \cdot 300\ K} =$ $= 20000$.

9. 0,01 m^3 hajmli ballonda 27 ^0C temperaturali gaz bor. Gaz chiqib ketishi oqibatida ballondagi bosim 4140 Pa ga kamaydi. Agar temperatura o'zgarmagan bo'lsa, ballondan qancha molekula chiqib ketgan? Bolsman doimiysi $1{,}38 \cdot 10^{-23}$ J/K. Javobda natijani 10^{20} ga ko'paytirgan holda bering.

(Javob: 100).

 Berilgan:	 Formula:
$V = 0{,}01\ \text{m}^3$ $\text{t} = 27\ ^0\text{C}$ $\text{T} = (\text{t} + 273)\text{K} = 300\ \text{K}$ $\Delta\text{P} = 4140\ \text{Pa}$ $\text{T} = \text{const}$ $k = 1{,}38\ \cdot 10^{-23}\ \frac{J}{K}$ $\_\_\_\_\_$ $Topish\ kerak: \Delta N = ?$	Ballondagi gaz bosimining o'zgarishi: $\Delta P = \Delta n \cdot k \cdot T \quad (1)$ Konsentratsiya o'zgarishi esa: $\Delta n = \frac{\Delta N}{V} \quad (2)$ (2) ifodani (1) ifodadagi konsentratsiya o'zgarishini ifodasiga qo'ysak; $\Delta P = \frac{\Delta N}{V} \cdot k \cdot T \quad (3)$ (3) ifodadan ballondan chiqib ketgan gaz molekulalari sonini topamiz: $\Delta N = \frac{\Delta P \cdot V}{k \cdot T} \quad (4)$

Hisoblash:
 $\Delta N = \frac{\Delta P \cdot V}{k \cdot T} = \frac{4140\ Pa \cdot 0{,}01\ m^3}{1{,}38\ \cdot 10^{-23}\ \frac{J}{K}\ \cdot 300\ K} = 0{,}1 \cdot 10^{23} =$ $= 100 \cdot 10^{20}$.

10. Xonada elektrokamin yoqilganidan so'ng o'zgarmas bosim holatida havo temperaturasi 18 ^{0}C dan 27 ^{0}C gacha ko'tarildi. Xona ichidagi havo molekulalarining soni necha foizga kamaygan?

(Javob: 3).

 Berilgan:	 Formula:

$P = const$ $t_1 = 18\ ^0C$ $T_1 = (t + 273)\ K = 291\ K$ $t_2 = 27\ ^0C$ $T_2 = (t + 273)\ K = 300\ K$ _____ $Topish\ kerak$: $\frac{\Delta N}{N_1} = ?$	Idishdagi havoning bosimi: $P = n \cdot k \cdot T$ (1) konsentratsiyasi esa: $n = \frac{N}{V}$ (2) (2) ifodani (1) ifodadagi konsentratsiya ifodasiga qo'ysak; $P = \frac{N}{V} \cdot k \cdot T$ (3) (3) ifodadan 18 ^{0}C da havo molekulalari soni: $N_1 = \frac{P \cdot V}{k \cdot T_1}$ (4) (4) ifodadan 27 ^{0}C da havo molekulalari soni: $N_2 = \frac{P \cdot V}{k \cdot T_2}$ (5) (5) ifodadan o'zgarmas kattaliklarni qisqartirib quyidagi nisbatga ega bo'lamiz: $\frac{N_2}{N_1} = \frac{T_1}{T_2}$ (6) (6) ifodadan xonadagi molekulalar sonini nech % kamayganini topamiz: $\Delta N = (N_1 - N_2) \cdot 100\ \%$ (7) (6) ifodadan 300 K temperaturadagi molekulalar sonini topib (7) ifodaga keltirib qo'yamiz: $\Delta N = (N_1 - \frac{N_1 \cdot T_1}{T_2}) \cdot 100\ \%$ (8) (8) ifodadan N_1 ni qavsdan chiqarib: $\frac{\Delta N}{N_1} = (1 - \frac{T_1}{T_2}) \cdot 100\ \%$ (9) ifodaga ega bo'lamiz:

Hisoblash:

$$\frac{\Delta N}{N_1} = \left(1 - \frac{291\ K}{300\ K}\right) \cdot 100\ \% = 3\%\ .$$

11. 2 mol ideal gazning 27 ^{0}C temperaturadagi to'liq ilgarilanma harakat kinetik energiyasi qanday bo'ladi(J)? Universal gaz doimiysi 8,31 J/(mol·K).

(Javob: 7479).

 Berilgan:	 Formula:
$\nu = 2$ mol $t = 27\ ^0C$ $T = (t + 273)K = 300$ K $R = 8{,}31\ \frac{J}{(mol \cdot K)}$ $Topish\ kerak: E_k = ?$	Bir atomli ideal gazning ichki energiyasi: $U = \frac{3}{2}\frac{m}{M} \cdot R \cdot T$ (1) Ideal gazning modda miqdori: $\nu = \frac{m}{M}$ (2) (2) ifodadagi modda miqdori ifodasini (1) ifodaga qo'yib: $U = \frac{3}{2}\nu \cdot R \cdot T$ (3) (3) ifodaga ega bo'lamiz: Ideal gaz molekulalarining to'liq ilgarilanma harakatdagi kinetik energiyasi,ichki energiyaga teng: $E_k = U = \frac{3}{2}\nu \cdot R \cdot T$ (4)

Hisoblash:

$$E_k = U = \frac{3}{2}\,\nu \cdot R \cdot T\ = \frac{3}{2} \cdot 2\,mol \cdot 8{,}31\ \frac{\text{J}}{(\text{mol} \cdot \text{K})} \cdot 300\ \text{K} = 7479\ \text{J}.$$

12. 5 litr sig'imli ballonda 800 kPa bosim ostida bo'lgan gaz molekulalarining to'liq ilgarilanma harakat kinetik energiyasi (kJ da) qanday bo'ladi?

(Javob: 6).

 Berilgan:	 Formula:
$V = 5$ litr $= 5 \cdot 10^{-3}$ m^3 $P = 800$ kPa $= 8 \cdot 10^5$ Pa _____ $Topish\ kerak$: E_k =?	Bir atomli ideal gazning ichki energiyasi: $$U = \frac{3}{2}\,\frac{m}{M} \cdot R \cdot T \quad (1)$$ Ideal gaz holat tenglamasi: $$P \cdot V = \frac{m}{M} \cdot R \cdot T \quad (2)$$ (2) ifodani (1) ifodaga qo'yib: $$U = \frac{3}{2}\,P \cdot V \quad (3)$$ (3) ifodaga ega bo'lamiz: Ideal gaz molekulalarining to'liq ilgarilanma harakatdagi kinetik energiyasi,ichki energiyaga teng: $$E_k = U = \frac{3}{2}\,P \cdot V \quad (4)$$

Hisoblash:

$$E_k = U = \frac{3}{2}\, P \cdot V = \frac{3}{2} \cdot 8 \cdot 10^5\ \text{Pa} \cdot 5 \cdot 10^{-3}\text{m}^3 = 6 \cdot 10^3\ \text{J} = 6\ \text{kJ}.$$

13. Agar gaz -73 ^{0}C gacha sovutilganda uning molekulalarining o'rtacha kvadratik tezligi 2 marta kamaygan bo'lsa, gaz qanday temperatura ostida (^{0}C) bo'lgan?

(Javob: 527).

 Berilgan:	 Formula:
$t_2 = -73\,^0\text{C}$ $T_2 = (t + 273)\ \text{K} = 200\ \text{K}$ $\frac{\upsilon_1}{\upsilon_2} = 2$ $\_\_\_\_\_$ $Topish\ kerak: t_1 = ?$	Molekulalarning o'rtacha kvadratik tezligi: $$\upsilon = \sqrt{\frac{3 \cdot R \cdot T}{M}} \quad (1)$$ (1) ifodani T_1 harorat uchun: $$\upsilon_1 = \sqrt{\frac{3 \cdot R \cdot T_1}{M}} \quad (2)$$ va T_2 harorat uchun: $$\upsilon_2 = \sqrt{\frac{3 \cdot R \cdot T_2}{M}} \quad (3)$$ yozib olamiz va (2) va (3) ifodalardan tenglikning ikkala tomonini kvadratga oshirib, quyidagi tenglikka ega bo'lamiz: $$\upsilon_1^2 = \frac{3 \cdot R \cdot T_1}{M} \quad (4)$$ va $$\upsilon_2^2 = \frac{3 \cdot R \cdot T_2}{M} \quad (5)$$ (4) va (5) ifodalardan o'zgarmas kattaliklarni qisqartirib, quyidagi nisbatga ega bo'lamiz: $$\frac{T_2}{T_1} = \frac{\upsilon_2^2}{\upsilon_1^2} \quad (6)$$

	(6) ifodadan T_1 harorat quyidagiga teng: $$T_1 = \frac{v_1^2}{v_2^2} \cdot T_2 = \left(\frac{v_1}{v_2}\right)^2 \cdot T_2 \quad (6)$$

Hisoblash:
 $T_1 = \left(\frac{v_1}{v_2}\right)^2 \cdot T_2 = (2)^2 \cdot 200\ K = 800\ K.$ $t_1 = (T_1 - 273)\ ^0C = (800 - 273)\ ^0C = 527\ ^0C$

14. Gazning bosimi 30 kPa, uning zichligi 1 kg/m^3. Gaz molekulalarining o'rtacha kvadratik tezligi qanchaga teng (m/s)?

(Javob: 300).

 Berilgan:	 Formula:
$P = 30\ \text{kPa} = 3 \cdot 10^4\ \text{Pa}$ $\rho = 1\ \frac{\text{kg}}{\text{m}^3}$ $Topish\ kerak: v = ?$	Molekulyar kinetik nazariyaning asosiy tenglamasidan gazning bosimi: $$P = \frac{1}{3}\rho \cdot v^2 \quad (1)$$ (1) ifodadan gaz molekulalarining o'rtacha kvadratik tezligi: $$v = \sqrt{\frac{3P}{\rho}} \quad (2)$$ ga teng:

Hisoblash:
 $v = \sqrt{\frac{3P}{\rho}} = \sqrt{\frac{3 \cdot 3 \cdot 10^4\ \text{Pa}}{1\ \frac{\text{kg}}{\text{m}^3}}} = 300\frac{m}{s}.$

15. 400 kPa bosim ostidagi gazning zichligi 1,6 kg/m^3. 2 kg massali boshqa gaz 200 kPa bosim ostida 10 m^3 hajmni egallaydi. Ikkinchi gaz molekulalarining o'rtacha kvadratik tezligi birinchinikiga qaraganda necha marta katta?

(Javob: 2).

 Berilgan:	 Formula:
$P_1 = 400\ \text{kPa} = 4 \cdot 10^5\ \text{Pa}$ $\rho_1 = 1{,}6\ \frac{\text{kg}}{\text{m}^3}$ $m_2 = 2\ \text{kg}$ $P_2 = 200\ \text{kPa} = 2 \cdot 10^5\ \text{Pa}$ $V_2 = 10\ \text{m}^3$ ——————— $Topish\ kerak: \frac{v_2}{v_1} = ?$	Molekulyar kinetik nazariyaning asosiy tenglamasidan gazning bosimi: $$P = \frac{1}{3}\rho \cdot v^2 \quad (1)$$ (1) ifodadan birinchi gaz molekulalarining o'rtacha kvadratik tezligi: $$v_1 = \sqrt{\frac{3 \cdot P_1}{\rho_1}} \quad (2)$$ ga teng, ikkinchi gaz molekulalarining o'rtacha kvadratik tezligi esa: $$v_2 = \sqrt{\frac{3 \cdot P_2}{\rho_2}} \quad (3)$$ (3) ifodadagi ikkinchi gaz zichligi o'rniga; $$\rho_2 = \frac{m_2}{V_2} \quad (4)$$ ifodani qo'yib: $$\frac{v_2}{v_1} = \sqrt{\frac{P_2 \cdot V_2 \cdot \rho_1}{m_2 \cdot P_1}} \quad (5)$$

Hisoblash:
 $\frac{v_2}{v_1} = \sqrt{\frac{P_2 \cdot V_2 \cdot \rho_1}{m_2 \cdot P_1}} = \sqrt{\frac{2 \cdot 10^5\ \text{Pa} \cdot 10\ \text{m}^3 \cdot 1{,}6\ \frac{\text{kg}}{\text{m}^3}}{2\ \text{kg} \cdot 4 \cdot 10^5\ \text{Pa}}} = 2.$

16. Gaz molekulalarining o'rtacha kvadratik tezligi 1000 m/s ga teng. Gazning bosimi va hajmi 1,2 marta oshirilgandan so'ng o'rtacha kvadratik tezlik qanchaga teng bo'ladi(m/s)?

(Javob: 1200).

 Berilgan:	 Formula:
$\upsilon_1 = 1000$ m/s $P_2 = 1{,}2P_1$ $V_2 = 1{,}2V_1$ _____ $Topish\ kerak$: $\upsilon_2 = ?$	Bitta molekula yoki atomga to'g'ri keluvchi o'rtacha kinetik energiya : $$E_k = \frac{m_0 \cdot \upsilon^2}{2} \quad (1)$$ O'rtacha kinetik energiyaning bosim va hajmga bog'liqlik ifodasi: $$E_k = \frac{3}{2} P \cdot V \quad (2)$$ (1) ifoda bilan (2) ifodani tenglashtirib: $$\frac{3}{2} P \cdot V = \frac{m_0 \cdot \upsilon^2}{2} \quad (3)$$ (3) ifodaga ega bo'lamiz: Bu ifodadan birinchi va ikkinchi hol uchun tezlikni topib: $$\upsilon_1 = \sqrt{\frac{3 \cdot P_1 \cdot V_1}{m_0}} \quad (4)$$ va $$\upsilon_2 = \sqrt{\frac{3 \cdot P_2 \cdot V_2}{m_0}} \quad (5)$$ (4) va (5) ifodalarning nisbatidan; $$\frac{\upsilon_2}{\upsilon_1} = \sqrt{\frac{P_2 \cdot V_2}{P_1 \cdot V_1}} \quad (6)$$ (6) ifodadan: $$\upsilon_2 = \sqrt{\frac{P_2 \cdot V_2}{P_1 \cdot V_1}} \cdot \upsilon_1 \quad (7)$$ Ifodaga ega bo'lamiz.

Hisoblash:
 $\upsilon_2 = \sqrt{\frac{P_2 \cdot V_2}{P_1 \cdot V_1}} \cdot \upsilon_1 = \sqrt{\frac{1{,}2P_1 \cdot 1{,}2V_1}{P_1 \cdot V_1}} \cdot 1000\ \frac{m}{s} = 1200\frac{m}{s}.$

17. Gaz temperaturasini 100 K ga oshirganda uning molekulalarining o'rtacha kvadratik tezligi 300 m/s dan 500 m/s gacha oshdi. O'rtacha kvadratik tezlik 700 m/s gacha ortishi uchun temperaturani yana necha gradusga ko'tarish kerak?

(Javob: 150).

 Berilgan:	 Formula:
$\Delta T_1 = 100\ K$ $\upsilon_1 = 300\frac{m}{s}$ $\upsilon_2 = 500\frac{m}{s}$ $\upsilon_3 = 700\frac{m}{s}$ $Topish\ kerak: \Delta T_2 = ?$	Gaz molekulalarining berilgan haroratda kinetik energiyasining o'zgarishi : $\Delta E_{k1} = \frac{m_0 \cdot \upsilon_2^2}{2} - \frac{m_0 \cdot \upsilon_1^2}{2}$ (1) Harorat o'zgarishi bo'yicha; $\Delta E_{k1} = \frac{3}{2} \cdot k \cdot \Delta T_1$ (2) (1) va (2) ifodalarni tenglashtirib; $\frac{3}{2} \cdot k \cdot \Delta T_1 = \frac{m_0 \cdot \upsilon_2^2}{2} - \frac{m_0 \cdot \upsilon_1^2}{2}$ (3) ΔT_2 harorat o'zgarishi bo'yicha; $\frac{3}{2} \cdot k \cdot \Delta T_2 = \frac{m_0 \cdot \upsilon_3^2}{2} - \frac{m_0 \cdot \upsilon_2^2}{2}$ (4) (3) va (4) ifodalardan o'zgarmas kattaliklarni qisqartirib quyidagi nisbatga ega bo'lamiz; $\frac{\Delta T_2}{\Delta T_1} = \frac{\upsilon_3^2 - \upsilon_2^2}{\upsilon_2^2 - \upsilon_1^2}$ (5) (5) ifodadan; $\Delta T_2 = \frac{\upsilon_3^2 - \upsilon_2^2}{\upsilon_2^2 - \upsilon_1^2} \cdot \Delta T_1$ (6)

Hisoblash:
 $\Delta T_2 = \frac{v_3^2 - v_2^2}{v_2^2 - v_1^2} \cdot \Delta T_1 = \frac{(700\frac{m}{s})^2 - (500\frac{m}{s})^2}{(500\frac{m}{s})^2 - (300\frac{m}{s})^2} \cdot 100\ K = 150\ K.$

18. Ideal gazning temperaturasi 67 ^{0}C va hajmi 25 litr. Bosim o'zgarmaganda, hajm 10 litrga teng bo'lishi uchun gazni qancha sovutish kerak (K)?

(Javob: 204).

 Berilgan:	 Formula:
$T_1 = 67\ ^0C$ $T_1 = (273 + 67)\ K = 340\ K$ $V_1 = 25\ l$ $V_2 = 10\ l$ $P = const$ _____ $Topish\ kerak: \Delta T = ?$	Izobarik jarayon tenglamasi: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (1) (1) ifodadan; $T_2 = \frac{V_2 \cdot T_1}{V_1}$ (2) (2) ifodadan harorat o'zgarishi; $\Delta T = T_1 - T_2$ (3) (2) ifodani (3) ifodaga qo'ysak; $\Delta T = T_1 - \frac{V_2 \cdot T_1}{V_1} = T_1 \cdot (1 - \frac{V_2}{V_1})$ (4)

Hisoblash:
 $\Delta T = T_1 \cdot \left(1 - \frac{V_2}{V_1}\right) = 340\ K \cdot \left(1 - \frac{10\ l}{25\ l}\right) = 340\ K \cdot 0{,}6 = 204\ K.$

19. Temperaturasi 27 ^{0}C bo'lgan ideal gazning hajmi 10 litr edi. Gaz izobarik ravishda 327 ^{0}C gacha isitilganda, hajmi qanchaga ortadi (litr)?

(Javob: 10).

 Berilgan:	 Formula:
$t_1 = 27\,^0C$ $T_1 = (273 + 27)\ K = 300\ K$ $V_1 = 10\ l$ $t_2 = 327\,^0C$ $T_2 = (273 + 327)\ K = 600\ K$ $P = const$ _____ $Topish\ kerak: \Delta V = ?$	Izobarik jarayon tenglamasi: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (1) (1) ifodadan; $V_2 = \frac{V_1 \cdot T_2}{T_1}$ (2) (2) ifodadan hajm o'zgarishi; $\Delta V = V_2 - V_1$ (3) (2) ifodani (3) ifodaga qo'ysak; $\Delta V = \frac{V_1 \cdot T_2}{T_1} - V_1 = V_1 \cdot (\frac{T_2}{T_1} - 1)$ (4)

Hisoblash:
 $\Delta V = V_1 \cdot \left(\frac{T_2}{T_1} - 1\right) = 10l \cdot \left(\frac{600\ K}{300\ K} - 1\right) = 10\ l.$

20. Ideal gazning temperaturasi 51 ^{0}C va hajmi 0,9 litr. Bosim o'zgarmaganda, hajm 0,3 litrga teng bo'lishi uchun gazni qanchaga sovutish kerak (K)?

(Javob: 216).

 Berilgan:	 Formula:
$t_1 = 51\,^0C$ $T_1 = (273 + 51)\ K = 324\ K$ $V_1 = 0{,}9\ l$ $V_2 = 0{,}3\ l$ $P = const$ $Topish\ kerak: \Delta T = ?$	Izobarik jarayon tenglamasi: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (1) (1) ifodadan; $T_2 = \frac{V_2 \cdot T_1}{V_1}$ (2) (2) ifodadan harorat o'zgarishi; $\Delta T = T_1 - T_2$ (3) (2) ifodani (3) ifodaga qo'ysak; $\Delta T = T_1 - \frac{V_2 \cdot T_1}{V_1} = T_1 \cdot (1 - \frac{V_2}{V_1})$ (4)

Hisoblash:
 $\Delta T = T_1 \cdot \left(1 - \frac{V_2}{V_1}\right) = 324\ K \cdot \left(1 - \frac{0{,}3\ l}{0{,}9\ l}\right) = 216\ K.$

21. Gaz 27 ^{0}C temperaturada 3 litr hajmga ega. Bu gaz izobarik 100 ^{0}C da qizdirilsa, u qanday hajmni egallaydi (litr)?

(Javob: 4).

 Berilgan:	 Formula:

$t_1 = 27\,^0C$ $T_1 = (273 + 27)\ K = 300\ K$ $V_1 = 3\ l$ $\Delta t = 100\,^0C$ $\Delta T = 100\ K$ $P = const$ _____ $Topish\ kerak$: $V_2 = ?$	Izobarik jarayon tenglamasi: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (1) (1) ifodadan; $V_2 = \frac{V_1 \cdot T_2}{T_1}$ (2) Harorat o'zgarishi; $\Delta T = T_2 - T_1$ (3) (3) ifodadan; $T_2 = \Delta T + T_1$ (4) (4) ifodani (2) ifodaga qo'ysak; $V_2 = \frac{V_1 \cdot (\Delta T + T_1)}{T_1}$ (5) ifodaga ega bo'lamiz.

Hisoblash:
 $V_2 = \frac{V_1 \cdot (\Delta T + T_1)}{T_1} = \frac{3\ l \cdot (100 + 300)K}{300\ K} = 4\ l.$

22. Ideal gaz 47 ^{0}C da 3 litr hajmni egallaydi. Bosimni o'zgartirmasdan, hajmni 1,2 litrga orttirish uchun gazning temperaturasini qanchagacha ko'tarish kerak (K)?

(Javob: 128).

 Berilgan:	 Formula:
$t_1 = 47\,^0C$ $T_1 = (273 + 47)\ K = 320\ K$ $V_1 = 3\ l$ $V_2 = 1{,}2\ l$ $P = const$ _____ $Topish\ kerak$: $T_2 = ?$	Izobarik jarayon tenglamasi: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (1) (1) ifodadan; $T_2 = \frac{V_2 \cdot T_1}{V_1}$ (2)

Hisoblash:
 $T_2 = \frac{V_2 \cdot T_1}{V_1} = \frac{1{,}2\ l \cdot 320\ K}{3\ l} =$ 128 K.

23. Massasi 2,6 kg bo'lgan ideal gaz 27 ^{0}C temperaturada porshen ostida 1,3 m^3 hajmni egallab turibdi. Gaz izobarik kengayib, uning zichligi 1,2 kg/m^3 ga teng bo'lganda, porshen ichida qanday temperatura bo'ladi (K)?

(Javob: 500).

 Berilgan:	 Formula:
$m = 2{,}6$ kg $T_1 = 27\ ^0C$ $T_1 = (273 + 27)$ K $= 300$ K $V_1 = 1{,}3$ m^3 $\rho = 1{,}2 \frac{kg}{m^3}$ P = const _____ *Topish kerak*: $T_2 =$?	Izobarik jarayon tenglamasi: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (1) Gaz massasi; $m = \rho \cdot V_2$ (2) (2) ifodadan V_2 hajmni topib, (1) ifodaga qo'yamiz; $V_2 = \frac{m}{\rho}$ (3) (3) ifodani (1) ifodaga qo'yib,quyidagi tenglikka ega bo'lamiz; $\frac{V_1}{T_1} = \frac{m}{T_2 \cdot \rho}$ (4) (4) ifodadan T_2 haroratni topsak; $T_2 = \frac{m \cdot T_1}{\rho \cdot V_1}$ (5) ifodaga ega bo'lamiz.

Hisoblash:
 $T_2 = \frac{m \cdot T_1}{\rho \cdot V_1} = \frac{2{,}6\ kg \cdot 300\ K}{1{,}2\ \frac{\text{kg}}{\text{m}^3} \cdot 1{,}3\ \text{m}^3} =$ 500 K.

24. Gazni izobarik ravishda temperaturasini 10 K ga oshirilganda, gaz hajmi dastlabki qiymatining 1/20 qismi qadar oshdi. Gazning dastlabki temperaturasi qanday bo'lgan (K)?

(Javob: 200).

 Berilgan:	 Formula:
$\text{P} = \text{const}$ $\Delta\text{T} = 10\ \text{K}$ $\text{V}_1 = \text{V}$ $\text{V}_2 = \text{V} + \frac{1}{20}\text{V} = \frac{21}{20}\text{V}$ $Topish\ kerak$: $\text{T}_1 =$?	Izobarik jarayon tenglamasi: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (1) (1) ifodadan; $T_2 = \frac{V_2 \cdot T_1}{V_1}$ (2) Harorat o'zgarishi; $\Delta\text{T} = \text{T}_2 - \text{T}_1$ (3) (3) ifodadan; $\text{T}_2 = \Delta\text{T} + \text{T}_1$ (4) (4) ifodani (2) ifodaga qo'ysak; $\Delta\text{T} + \text{T}_1 = \frac{V_2 \cdot T_1}{V_1}$ (5) (5) ifodadan; $\Delta\text{T} = \frac{V_2 \cdot T_1}{V_1} - \text{T}_1$ (6) (6) ifodadan T_1 haroratni qavsdan chiqarsak; $\Delta\text{T} = (\frac{V_2}{V_1} - 1) \cdot \text{T}_1$ (7) (7) ifodadan;

	$$T_1 = \frac{\Delta T}{(\frac{V_2}{V_1} - 1)} \quad (8)$$ ifodaga ega bo'lamiz.

Hisoblash:
 $T_1 = \frac{\Delta T}{(\frac{V_2}{V_1} - 1)} = \frac{10\ K}{(\frac{\frac{21}{20}V}{V} - 1)} = \frac{10\ K}{(\frac{21}{20} - 1)} = 200$ K.

25. Massasi 3 kg bo'lgan ideal gaz 127 ^{0}C temperaturada erkin siljiydigan porshen ostida 2,5 m^3 hajmni egallab turibdi. Qanday temperaturada (K) porshen ostidagi gazning zichligi 2 kg/m^3 bo'ladi?

(Javob: 240).

 Berilgan:	 Formula:
$m = 3$ kg $t_1 = 127^0$C $T_1 = (127 + 273)$ K $= 400$ K $V_1 = 2{,}5$ m^3 $\rho = 2\frac{\text{kg}}{\text{m}^3}$ $P = \text{const}$ _____ $Topish\ kerak$: $T_2 =$?	Izobarik jarayon tenglamasi: $$\frac{V_1}{T_1} = \frac{V_2}{T_2} \quad (1)$$ Gaz massasi; $$m = \rho \cdot V_2 \quad (2)$$ (2) ifodadan V_2 hajmni topib, (1) ifodaga qo'yamiz; $$V_2 = \frac{m}{\rho} \quad (3)$$ (3) ifodani (1) ifodaga qo'yib,quyidagi tenglikka ega bo'lamiz; $$\frac{V_1}{T_1} = \frac{m}{T_2 \cdot \rho} \quad (4)$$ (4) ifodadan T_2 haroratni topsak; $$T_2 = \frac{m \cdot T_1}{\rho \cdot V_1} \quad (5)$$ ifodaga ega bo'lamiz.

Hisoblash:
 $T_2 = \frac{m \cdot T_1}{\rho \cdot V_1} = \frac{3\ kg \cdot 400\ K}{2\frac{\text{kg}}{\text{m}^3} \cdot 2{,}5\ \text{m}^3} = 240\ \text{K}.$

26. Dastlabki temperaturasi 27 ^{0}C bo'lgan ideal gaz izobarik kengayib, uning hajmi 24 % ga ortdi. Uning keyingi temperaturasi qanday bo'lgan (^{0}C)?

(Javob: 99).

 Berilgan:	 Formula:
$t_1 = 27^0\text{C}$ $T_1 = (27 + 273)\ \text{K} = 300\ \text{K}$ $V_1 = V$ $V_2 = V + \frac{24\%}{100\%}V = 1{,}24\ V$ $P = \text{const}$ $Topish\ kerak: t_2 = ?$	Izobarik jarayon tenglamasi: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (1) (1) ifodadan; $T_2 = \frac{V_2 \cdot T_1}{V_1}$ (2) ifodaga ega bo'lamiz. $t_2 = T_2 - 273$ (3) (3) ifodadan; $t_2 = \left(\frac{V_2 \cdot T_1}{V_1} - 273\right)^0\text{C}$ (4)
Hisoblash:	
 $t_2 = \left(\frac{V_2 \cdot T_1}{V_1} - 273\right)^0\text{C} = \left(\frac{1{,}24\ V \cdot 300\ K}{V} - 273\right)^0\text{C} = 99^0\text{C}.$	

27. Ideal gaz o'zgarmas bosim ostida 1 K ga qizdirilganda uning hajmi dastlabki hajmining 1/350 qismiga ortdi. Gazning boshlang'ich harorati topilsin (K).

(Javob: 350).

 Berilgan:	 Formula:
$P = const$ $\Delta T = 1\ K$ $T_2 = T_1 + \Delta T$ $V_1 = V$ $V_2 = V + \frac{1}{350}V = \frac{351}{350}\ V$ _____ $Topish\ kerak$: $T_1 = ?$	Izobarik jarayon tenglamasi: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (1) (1) ifodadan; $T_1 = \frac{V_1 \cdot T_2}{V_2}$ (2) ifodaga ega bo'lamiz. $T_2 =$ ekanligidan; $T_1 = \frac{V_1 \cdot (T_1 + \Delta T)}{V_2}$ (3) (3) ifodadan; $T_1 \cdot V_2 = V_1 \cdot (T_1 + \Delta T)$ (4) (4) ifodadan; $T_1 \cdot V_2 = V_1 \cdot T_1 + V_1 \cdot \Delta T$ (5) (5) ifodadan; $T_1 \cdot V_2 - V_1 \cdot T_1 = V_1 \cdot \Delta T$ (6) (6) ifodadan T_1 haroratni qavsdan chiqarib; $T_1 \cdot (V_2 - V_1) = V_1 \cdot \Delta T$ (7) quyidagi tenglikka ega bo'lamiz; $T_1 = \frac{V_1 \cdot \Delta T}{(V_2 - V_1)}$ (8)
Hisoblash:	
 $T_1 = \frac{V_1 \cdot \Delta T}{(V_2 - V_1)} = \frac{V \cdot 1\ K}{\left(\frac{351}{350}\ V - V\right)} = 350\ K.$	

28. Qo'zg'aluvchan porshenli silindr ichida joylashgan gaz 300 K temperaturada 250 cm^3 hajmni egallaydi. Agar temperatura 270 K gacha pasaysa, gaz qanday hajmni (cm^3) egallaydi?

(Javob: 225).

 Berilgan:	 Formula:
$P = const$ $T_1 = 300\ K$ $V_1 = 250\ cm^3$ $T_2 = 270\ K$ _____ $Topish\ kerak: V_2 = ?$	Izobarik jarayon tenglamasi: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (1) (1) ifodadan; $V_2 = \frac{V_1 \cdot T_2}{T_1}$ (2)
Hisoblash:	
 $V_2 = \frac{V_1 \cdot T_2}{T_1} = \frac{250\ cm^3 \cdot 270\ K}{300\ K} = 225\ cm^3$.	

29. Gazning hajmi uning 0 ^{0}C dagi hajmidan ikki marta katta bo'lishi uchun uni o'zgarmas bosimda necha gradusga qizdirish kerak?

(Javob: 273).

 Berilgan:	 Formula:
$P = const$ $t_1 = 0^0C$ $T_1 = (0 + 273)\ K = 273\ K$ $V_2 = 2V_1$ _____ $Topish\ kerak: \Delta T = ?$	Izobarik jarayon tenglamasi: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (1) (1) ifodadan; $T_2 = \frac{V_2 T_1}{V_1}$ (2) (2) ifodani $\Delta T = T_2 - T_1$ (3) (3) ifodaga qo'yamiz; $\Delta T = \frac{V_2 T_1}{V_1} - T_1$ (4) (4) ifodadan T_1 haroratni qavsdan chiqarib;

	$$\Delta T = T_1 \cdot \left(\frac{V_2}{V_1} - 1\right) \quad (5)$$ ifodaga ega bo'lamiz.
Hisoblash:	
 $\Delta T = T_1 \cdot \left(\frac{V_2}{V_1} - 1\right) = 273\ \text{K} \cdot \left(\frac{2V_1}{V_1} - 1\right) = 273\ K$.	

30. Agar havo 3 K ga qizdirilganda uning hajmi 1 % ga ortgan bo'lsa, havoning boshlang'ich temperaturasi (K da) qanday bo'lgan?

(Javob: 300).

 Berilgan:	 Formula:
$P = \text{const}$ $\Delta T = 3\ \text{K}$ $V_2 = 1{,}01V_1$ _____ *Topish kerak*: $T_1 = ?$	Izobarik jarayon tenglamasi: $$\frac{V_1}{T_1} = \frac{V_2}{T_2} \quad (1)$$ (1) ifodadan; $$T_2 = \frac{V_2 T_1}{V_1} \quad (2)$$ (2) ifodani $$\Delta T = T_2 - T_1 \quad (3)$$ (3) ifodaga qo'yamiz; $$\Delta T = \frac{V_2 T_1}{V_1} - T_1 \quad (4)$$ (4) ifodadan T_1 haroratni qavsdan chiqarib; $$\Delta T = T_1 \cdot \left(\frac{V_2}{V_1} - 1\right) \quad (5)$$ ifodaga ega bo'lamiz. (5) ifodadan;

	$T_1 = \dfrac{\Delta T}{\left(\dfrac{V_2}{V_1} - 1\right)}$ (6) ifodaga ega bo'lamiz.
Hisoblash:	
 $T_1 = \dfrac{\Delta T}{\left(\dfrac{V_2}{V_1} - 1\right)} = \dfrac{3\ K}{\left(\dfrac{1{,}01 \cdot V_1}{V_1} - 1\right)} = 300\ K$.	

31. Gaz 27 ^{0}C dan 39 ^{0}C gacha qizdirildi. Agar gazning bosimi o'zgarmagan bo'lsa, uning hajmi necha % ga ortgan?

(Javob: 4).

 Berilgan:	 Formula:
$P = const$ $\Delta T = 3\ K$ $t_1 = 27^0C$ $T_1 = (27 + 273)\ K = 300\ K$ $t_2 = 39^0C$ $T_2 = (39 + 273)\ K = 312\ K$ ——————————— $Topish\ kerak$: $\dfrac{\Delta V}{V_1} = ?$	Izobarik jarayon tenglamasi: $\dfrac{V_1}{T_1} = \dfrac{V_2}{T_2}$ (1) (1) ifodadan; $V_2 = \dfrac{V_1 \cdot T_2}{T_1}$ (2) (2) ifodani $\Delta V = V_2 - V_1$ (3) (3) ifodaga qo'yib; $\Delta V = \dfrac{V_1 \cdot T_2}{T_1} - V_1$ (4) (4) ifodaga ega bo'lamiz. Bu ifodadan V_1 hajmni qavsdan chiqarib; $\Delta V = V_1\left(\dfrac{T_2}{T_1} - 1\right)$ (5) (5) ifodadan; $\dfrac{\Delta V}{V_1} = \left(\dfrac{T_2}{T_1} - 1\right) \cdot 100\%$ (6)

Hisoblash:
 $\frac{\Delta V}{V_1} = \left(\frac{T_2}{T_1} - 1\right) \cdot 100\% = \left(\frac{312\ K}{300\ K} - 1\right) \cdot 100\% = 4\ \%.$

32. Massasi 0,012 kg va temperaturasi 177 ^{0}C bo'lgan gaz 0,004 m^3 hajmda turibdi. Agar gazning bosimi o'zgarmas saqlansa, qanday temperaturada (K da) uning zichligi 6 kg/m^3 bo'ladi?

(Javob: 225).

 Berilgan:	 Formula:
$P = const$ $m = 0{,}012\ kg$ $t_1 = 177^0C$ $T_1 = (177 + 273)\ K = 450\ K$ $V_1 = 0{,}004\ m^3$ $\rho = 6\ \frac{kg}{m^3}$ _____ *Topish kerak*: $T_2 = ?$	Izobarik jarayon tenglamasi: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (1) (1) ifodadan; $V_2 = \frac{m}{\rho}$ (2) (2) ifodani $\frac{V_1}{T_1} = \frac{m}{T_2 \cdot \rho}$ (3) (3) ifodadan; $T_2 = \frac{m \cdot T_1}{\rho \cdot V_1}$ (4)
Hisoblash:	
 $T_2 = \frac{m \cdot T_1}{\rho \cdot V_1} = \frac{0{,}012\ kg \cdot 450\ K}{6\ \frac{kg}{m^3} \cdot 0{,}004\ m^3} = 225\ K.$	

33. Gaz doimiy hajmda 127 ^{0}C dan 27 ^{0}C gacha sovutildi. Shundan so'ng gazning hajmi izotermik jarayonda necha % ga kamaytirilganda uning bosimi avvalgisiga teng bo'ladi?

(Javob: 25).

 Berilgan:	 Formula:
$V = const$ $m = 0{,}012\ kg$ $t_1 = 127^0C$ $T_1 = (127 + 273)\ K = 400\ K$ $t_2 = 27^0C$ $T_2 = (27 + 273)\ K = 300\ K$ $T = const$ _____ $Topish\ kerak$: $\frac{\Delta V}{V_2} = ?$	Izoxorik jarayon tenglamasi: $$\frac{P_1}{T_1} = \frac{P_2}{T_2} \quad (1)$$ Izotermik jarayon tenglamasi: $$P_1'V_1 = P_2'V_2 \quad (2)$$ (1) ifodadan; $$P_2 = \frac{P_1 \cdot T_2}{T_1} \quad (3)$$ Masala shartiga ko'ra; $$P_1' = P_1 \quad (4)$$ va $$P_2' = P_2 \quad (5)$$ (2) ifodadan; $$P_1 \cdot V_1 = P_2 \cdot V_2 \quad (6)$$ (3) va (6) ifodalarni birgalikda yechib; $$P_1 \cdot V_1 = \frac{P_1 \cdot T_2}{T_1} \cdot V_2 \quad (7)$$ (7) ifodadan; $$V_1 = \frac{T_2}{T_1} \cdot V_2 \quad (8)$$ (8) ifodadan; $$\Delta V = V_2 - V_1 = V_2 - \frac{T_2}{T_1} \cdot V_2 \quad (9)$$ (9) ifodadan; $$\Delta V = V_2 \cdot \left(1 - \frac{T_2}{T_1}\right) \quad (10)$$ Gaz hajmining kamayishi; $$\frac{\Delta V}{V_2} = \left(1 - \frac{T_2}{T_1}\right) \cdot 100\% \quad (11)$$
Hisoblash:	
 $\frac{\Delta V}{V_2} = \left(1 - \frac{T_2}{T_1}\right) \cdot 100\% = \left(1 - \frac{300\ K}{400\ k}\right) \cdot 100\% = 25\ \%.$	

34. Gaz 280 K dan 540 K gacha izoxorik qizdirilganda uning bosimi 39 kPa ga ortdi. Gaz dastlab qanday bosimda bo'lgan (kPa)?

(Javob: 42).

 Berilgan:	 Formula:
$V = const$ $T_1 = 280\ K$ $T_2 = 540\ K$ $\Delta P = 39\ kPa$ $P_2 = P_1 + \Delta P$ _____ $Topish\ kerak$: $P_1 = ?$	Izoxorik jarayon tenglamasi: $$\frac{P_1}{T_1} = \frac{P_2}{T_2} \quad (1)$$ (1) ifodadan; $$P_2 = \frac{P_1 \cdot T_2}{T_1} \quad (2)$$ Masala shartiga ko'ra; $$P_2 = P_1 + \Delta P \quad (3)$$ (2) va (3) ifodalarni tenglashtiramiz; $$\frac{P_1 \cdot T_2}{T_1} = P_1 + \Delta P \quad (4)$$ (4) ifodadan; $$\frac{P_1 \cdot T_2}{T_1} - P_1 = \Delta P \quad (5)$$ (5) ifodadan P_1 bosimni qavsdan chiqarib; $$P_1 \cdot \left(\frac{T_2}{T_1} - 1\right) = \Delta P \quad (6)$$ (6) ifodaga ega bo'lamiz. (6) ifodadan P_1 bosim quyidagiga teng: $$P_1 = \frac{\Delta P}{\left(\frac{T_2}{T_1} - 1\right)} \quad (7)$$
Hisoblash:	
 $P_1 = \frac{\Delta P}{\left(\frac{T_2}{T_1} - 1\right)} = \frac{39\ kPa}{\left(\frac{540\ K}{280\ K} - 1\right)} \approx 42\ kPa.$	

35. Ballondagi gaz 17 ^{0}C temperaturada $1{,}45 \cdot 10^5$ Pa bosimga ega bo'lsa, qanday temperaturada (K) uning bosimi $2 \cdot 10^5$ Pa bo'ladi?

(Javob: 400).

 Berilgan:	 Formula:
$V = \text{const}$ $t_1 = 17^0C$ $T_1 = (17 + 273)\ K = 290\ K$ $P_1 = 1{,}45 \cdot 10^5\ Pa$ $P_2 = 2 \cdot 10^5\ Pa$ _____ $Topish\ kerak$: $T_2 = ?$	Izoxorik jarayon tenglamasi: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (1) (1) ifodadan; $T_2 = \frac{P_2 \cdot T_1}{P_1}$ (2)
Hisoblash:	
 $T_2 = \frac{P_2 \cdot T_1}{P_1} = \frac{2 \cdot 10^5 \cdot 290\ K}{1{,}45 \cdot 10^5} = 400\ K.$	

36. Agar chog'lanma lampochka yonganda, temperaturasi 17 ^{0}C dan 360 ^{0}C gacha ko'tarilsa, uning ichidagi gaz bosimi qanday o'zgaradi?

(Javob: ≈2,2 marta ortadi).

 Berilgan:	 Formula:
$V = \text{const}$ $t_1 = 17^0C$ $T_1 = (17 + 273)\ K = 290\ K$ $t_2 = 360^0C$ $T_2 = (360 + 273)\ K = 633\ K$ _____ $Topish\ kerak$: $\frac{P_2}{P_1} = ?$	Izoxorik jarayon tenglamasi: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (1) (1) ifodadan; $\frac{P_2}{P_1} = \frac{T_1}{T_2}$ (2)
Hisoblash:	
 $\frac{P_2}{P_1} = \frac{T_1}{T_2} = \frac{290\ K}{633\ K} \approx \frac{1}{2{,}2} \quad \rightarrow P_2 = \frac{P_1}{2{,}2}.$	

37. Gaz 300 K dan 420 K gacha izoxorik qizdirilganda uning bosimi 50 kPa ga ortdi. Gaz dastlab qanday bosimda bo'lgan (kPa)?

(Javob: 125).

 Berilgan:	 Formula:
$V = \text{const}$ $T_1 = 300\ \text{K}$ $T_2 = 420\ \text{K}$ $\Delta P = 50\ \text{kPa}$ $P_2 = \Delta P + P_1$ _____ $Topish\ kerak$: $P_1 = ?$	Izoxorik jarayon tenglamasi: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (1) (1) ifodadan; $P_2 = \frac{P_1 \cdot T_2}{T_1}$ (2) Masala shartiga ko'ra; $P_2 = \Delta P + P_1$ (3) (2) va (3) ifodalarni tenglashtirib; $\frac{P_1 \cdot T_2}{T_1} = \Delta P + P_1$ (4) (4) ifodadan P_1 bosimni topamiz; $\frac{P_1 \cdot T_2}{T_1} - P_1 = \Delta P$ (5) (5) ifodadan P_1 ni qavsdan chiqarib; $P_1 \cdot \left(\frac{T_2}{T_1} - 1\right) = \Delta P$ (6) Quyidagi tenglikka ega bo'lamiz; $P_1 = \frac{\Delta P}{\left(\frac{T_2}{T_1} - 1\right)}$ (7)
Hisoblash:	
 $P_1 = \frac{\Delta P}{\left(\frac{T_2}{T_1} - 1\right)} = \frac{50\ \text{kPa}}{\left(\frac{420\ \text{K}}{300\ \text{K}} - 1\right)} = 125\ \text{kPa}.$	

38. Gazning temperaturasini izoxorik ravishda 12 ^{0}C ga qizdirilganda gaz bosimi dastlabki qiymatning 1/75 qismiga ortdi. Gazning dastlabki temperaturasi qanday bo'lgan (K)?

(Javob: 900).

 Berilgan:	 Formula:
$V = const$ $\Delta t = 12^0C$ $\Delta T = 12\ K$ $T_2 = T_1 + \Delta T$ $P_1 = P$ $P_2 = P + \frac{1}{75}P = \frac{76}{75}P$ _____ $Topish\ kerak$: $T_1 = ?$	Izoxorik jarayon tenglamasi: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (1) (1) ifodadan; $T_1 = \frac{P_1 \cdot T_2}{P_2}$ (2) Masala shartidan T_2 haroratning qiymatini (2) ifodaga qo'yib, T_1 haroratni topamiz. $T_1 = \frac{P_1 \cdot (T_1 + \Delta T)}{P_2}$ (3) (3) ifodadan; $T_1 \cdot P_2 = P_1 \cdot (T_1 + \Delta T)$ (4) (4) ifodadan; $T_1 \cdot P_2 = P_1 \cdot T_1 + P_1 \cdot \Delta T$ (5) (5) ifodadan; $T_1 \cdot (P_2 - P_1) = P_1 \cdot \Delta T$ (6) (6) ifodadan T_1 haroratni topamiz; $T_1 = \frac{P_1 \cdot \Delta T}{(P_2 - P_1)}$ (7)
Hisoblash:	
 $T_1 = \frac{P_1 \cdot \Delta T}{(P_2 - P_1)} = \frac{P \cdot 12\ K}{\left(\frac{76}{75}P - P\right)} = \frac{P \cdot 12\ K \cdot 75}{(76 \cdot P - 75 \cdot P)} = 900\ K.$	

39. Ballonda 100 ^{0}C haroratli gaz bor. Gazning bosimi ikki marta ortishi uchun uni qanday haroratgacha qizdirish kerak (^{0}C)?

(Javob: 473).

 Berilgan:	 Formula:

$V = const$ $t_1 = 100^0C$ $T_1 = (100 + 273)\ K = 373\ K$ $P_2 = 2P_1$ _____ $Topish\ kerak$: $T_2 = ?$	Izoxorik jarayon tenglamasi: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (1) (1) ifodadan; $T_2 = \frac{P_2 \cdot T_1}{P_1}$ (2)
Hisoblash:	
 $T_2 = \frac{P_2 \cdot T_1}{P_1} = \frac{2 \cdot P_1 \cdot 373}{P_1} = 746\ K.$ $t_2 = (T_2 - 273)^0C = (746 - 273)^0C = 473^0C.$	

40. Gaz temperaturasi 286 K dan 326 K gacha o'zgarganda bosim 20 kPa ga ortdi. Gazning dastlabki bosimini toping (kPa). Jarayon izoxorik.

(Javob: 143).

 Berilgan:	 Formula:
$V = const$ $T_1 = 286\ K$ $T_2 = 326\ K$ $\Delta P = 20\ kPa$ $P_2 = \Delta P + P_1$ _____ $Topish\ kerak$: $P_1 = ?$	Izoxorik jarayon tenglamasi: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (1) (1) ifodadan; $P_2 = \frac{P_1 \cdot T_2}{T_1}$ (2) Masala shartiga ko'ra; $P_2 = \Delta P + P_1$ (3) (2) va (3) ifodalarni tenglashtirib; $\frac{P_1 \cdot T_2}{T_1} = \Delta P + P_1$ (4) (4) ifodadan P_1 bosimni topamiz; $\frac{P_1 \cdot T_2}{T_1} - P_1 = \Delta P$ (5) (5) ifodadan P_1 ni qavsdan chiqarib; $P_1 \cdot \left(\frac{T_2}{T_1} - 1\right) = \Delta P$ (6) Quyidagi tenglikka ega bo'lamiz;

	$$P_1 = \frac{\Delta P}{\left(\frac{T_2}{T_1} - 1\right)} \quad (7)$$
Hisoblash:	
 $P_1 = \frac{\Delta P}{\left(\frac{T_2}{T_1} - 1\right)} = \frac{20\ \text{kPa}}{\left(\frac{326\ \text{K}}{286\ \text{K}} - 1\right)} \approx 143\ \text{kPa}.$	

41. Havo harorati ertalab 7 ^{0}C bo'lganda rezinali qayiqqa puflab dam berildi. Agar qayiq kunduzi quyosh nurlari ostida 21 ^{0}C gacha qizigan bo'lsa, undagi havo bosimi necha % ga ortgan? Qayiqning hajmi o'zgarmagan?

(Javob: 5).

 Berilgan:	 Formula:
$V = \text{const}$ $t_1 = 7^0\text{C}$ $T_1 = (7 + 273)\text{K} = 280\ \text{K}$ $t_2 = 21^0\text{C}$ $T_2 = (21 + 273)\text{K} = 294\ \text{K}$ ——————————— *Topish kerak*: $\frac{\Delta P}{P_1} = ?$	Izoxorik jarayon tenglamasi: $$\frac{P_1}{T_1} = \frac{P_2}{T_2} \quad (1)$$ (1) ifodadan; $$P_2 = \frac{P_1 \cdot T_2}{T_1} \quad (2)$$ Masala shartiga ko'ra; $$P_2 = \Delta P + P_1 \quad (3)$$ (2) va (3) ifodalarni tenglashtirib; $$\frac{P_1 \cdot T_2}{T_1} = \Delta P + P_1 \quad (4)$$ (4) ifodadan P_1 bosimni topamiz; $$\frac{P_1 \cdot T_2}{T_1} - P_1 = \Delta P \quad (5)$$ (5) ifodadan P_1 ni qavsdan chiqarib; $$P_1 \cdot \left(\frac{T_2}{T_1} - 1\right) = \Delta P \quad (6)$$ Quyidagi tenglikka ega bo'lamiz; $$P_1 = \frac{\Delta P}{\left(\frac{T_2}{T_1} - 1\right)} \quad (7)$$

	(7) ifodadan; $$\frac{\Delta P}{P_1} = \left(\frac{T_2}{T_1} - 1\right) \cdot 100\ \%\quad (8)$$
Hisoblash:	
 $\frac{\Delta P}{P_1} = \left(\frac{T_2}{T_1} - 1\right) \cdot 100\ \% = \left(\frac{294\ K}{280\ K} - 1\right) \cdot 100\ \% = 5\ \%.$	

42. Gaz o'zgarmas hajmda 1 K ga qizdirilganda bosim 0,2 % ga ortdi. Gaz qanday boshlang'ich temperaturada (^{0}C) bo'lgan?

(Javob: 227).

 Berilgan:	 Formula:
$V = const$ $\Delta T = 1\ K$ $T_2 = T_1 + \Delta T$ $P_1 = P$ $P_2 = P + \frac{0,2\ \%}{100\ \%} P = 1,002\ P$ $Topish\ kerak$: $t_1 = ?$	Izoxorik jarayon tenglamasi: $$\frac{P_1}{T_1} = \frac{P_2}{T_2}\quad (1)$$ (1) ifodadan; $$T_2 = \frac{P_2 \cdot T_1}{P_1}\quad (2)$$ Masala shartiga ko'ra; $$T_2 = T_1 + \Delta T\quad (3)$$ (2) va (3) ifodalarni tenglashtirib; $$\frac{P_2 \cdot T_1}{P_1} = T_1 + \Delta T\quad (4)$$ (4) ifodadan T_1 haroratni topamiz; $$\frac{P_2 \cdot T_1}{P_1} - T_1 = \Delta T\quad (5)$$ (5) ifodadan T_1 ni qavsdan chiqarib; $$T_1 \cdot \left(\frac{P_2}{P_1} - 1\right) = \Delta T\quad (6)$$ Quyidagi tenglikka ega bo'lamiz; $$T_1 = \frac{\Delta T}{\left(\frac{P_2}{P_1} - 1\right)}\quad (7)$$ T_1 haroratni gradusdagi qiymati; $$t_1 = (T_1 - 273)^0 C\quad (8)$$

Hisoblash:
 $T_1 = \frac{\Delta T}{\left(\frac{P_2}{P_1} - 1\right)} = \frac{1\ K}{\left(\frac{1{,}002\ P}{P} - 1\right)} = 500\ K.$ $t_1 = (T_1 - 273)^0 C = (500 - 273)^0 C = 227^0 C$

43. Ochiq idishdagi havo sekinlik bilan 400 K gacha qizdirildi, so'ngra idish germetik bekitilib, 280 K gacha sovutildi. Bunda idishdagi bosim necha % ga o'zgargan?

(Javob: 30).

 Berilgan:	 Formula:
$V = const$ $T_1 = 400\ K$ $T_2 = 280\ K$ _____ $Topish\ kerak: \frac{\Delta P}{P_1} \cdot 100\ \% = ?$	Izoxorik jarayon tenglamasi: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (1) (1) ifodadan; $P_2 = \frac{P_1 \cdot T_2}{T_1}$ (2) Masala shartiga ko'ra; $P_1 = \Delta P + P_2$ (3) (3) ifodadan; $\Delta P = P_1 - P_2$ (4) (4) ifodaga (2) ifodani qo'yib natijani 100 % ga ko'paytiramiz; $\Delta P = \left(P_1 - \frac{P_1 \cdot T_2}{T_1}\right) \cdot 100\ \%$ (5) (5) ifodadan P_1 bosimni qavsdan chiqarib; $\frac{\Delta P}{P_1} = \left(1 - \frac{T_2}{T_1}\right) \cdot 100\ \%$ (5) Ifodaga ega bo'lamiz.
Hisoblash:	
 $\frac{\Delta P}{P_1} = \left(1 - \frac{T_2}{T_1}\right) \cdot 100\ \% = \left(1 - \frac{280\ K}{400\ K}\right) \cdot 100\ \% = 30\ \%.$	

44. Silindr ichida, porshen ostida gaz bor. Gazning absolyut temperaturasi 2 marta oshirilganda porshen o'zgarmas holatda qolishi uchun uning ustiga 10 kg yuk qo'yish lozim. Porshenning yuzasi 10 cm^2. Gazning boshlang'ich bosimini (kPa da) toping. g=10 m/s^2.

(Javob: 100).

 Berilgan:	 Formula:
$T_2 = 2T_1$ $m = 10\ kg$ $S = 10\ cm^2 = 10 \cdot 10^{-4}\ m^2$ $g = 10\ \frac{m}{s^2}$ $V = const$ _____ $Topish\ kerak$: $P_1 = ?$	Izoxorik jarayon tenglamasi: $$\frac{P_1}{T_1} = \frac{P_2}{T_2} \quad (1)$$ (1) ifodadan; $$P_2 = P_1 + \frac{F}{S} \quad (2)$$ (2) ifodadan yukning og'irligi; $$F = m \cdot g \quad (3)$$ (3) ifodadan; $$P_2 = P_1 + \frac{m \cdot g}{S} \quad (4)$$ (4) ifodadagi P_2 bosimning qiymatini (1) ifodaga qo'yib; $$\frac{P_1}{T_1} = \frac{\left(P_1 + \frac{m \cdot g}{S}\right)}{T_2} \quad (5)$$ (5) ifodadan P_1 bosimni topamiz; $$P_1 \cdot T_2 = T_1 \cdot \left(P_1 + \frac{m \cdot g}{S}\right) \quad (6)$$ (6) ifodadan; $$P_1 \cdot T_2 = P_1 \cdot T_1 + T_1 \cdot \frac{m \cdot g}{S} \quad (7)$$ (7) ifodadan; $$P_1 \cdot T_2 - P_1 \cdot T_1 = T_1 \cdot \frac{m \cdot g}{S} \quad (8)$$ (8) ifodadan P_1 bosimni qavsdan chiqarib; $$P_1 \cdot (T_2 - T_1) = T_1 \cdot \frac{m \cdot g}{S} \quad (9)$$ (9) ifodadan; $$P_1 = \frac{T_1 \cdot \frac{m \cdot g}{S}}{(T_2 - T_1)} \quad (10)$$

Hisoblash:
 $P_1 = \frac{T_1 \cdot \frac{m \cdot g}{S}}{(T_2 - T_1)} = \frac{T_1 \cdot \frac{m \cdot g}{S}}{(2T_1 - T_1)} = \frac{m \cdot g}{S} = \frac{10\ \text{kg} \cdot 10\ \frac{m}{s^2}}{10 \cdot 10^{-4}\ m^2} = 100\ \text{kPa}.$

45. Vertikal silindr ichidagi 5 kg massali porshen ostida gaz bor. Gazning absolyut temperaturasi ikki marta oshirilganda porshen o'zgarmas holatda qolishi uchun uning ustiga qanday massali yuk qo'yish kerak (kg)? Atmosfera bosimi 100 kPa, porshenning yuzasi 0,001 m^2.

(Javob: 15).

 Berilgan:	 Formula:
$m_1 = 5\ \text{kg}$ $T_2 = 2T_1$ $V = \text{const}$ $P_0 = 100\ \text{kPa} = 10^5\ \text{Pa}$ $S = 0,001\ m^2$ $g = 10\ \frac{m}{s^2}$ _____ *Topish kerak*: $m_2 = ?$	Izoxorik jarayon tenglamasi: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (1) 1- hol uchun umumiy bosim $m_1$massali porshenning S yuzaga beradigan bosimi va normal atmosfera bosimi yig'indisiga teng, ya'ni; $P_1 = P_0 + \frac{m_1 \cdot g}{S}$ (2) 2-hol uchun esa umumiy bosim, m_1 massali porshen va m_2 massali yukning S yuzaga beradigan bosimi va normal atmosfeara bosimi yig'indisiga teng; $P_2 = P_0 + \frac{(m_1 + m_2) \cdot g}{S}$ (3) (2) va (3) ifodalarni (1) ifodaga qo'yib; $\frac{P_0 + \frac{m_1 \cdot g}{S}}{T_1} = \frac{P_0 + \frac{(m_1 + m_2) \cdot g}{S}}{T_2}$ (4) (4) ifodadan; $\left(P_0 + \frac{m_1 \cdot g}{S}\right) \cdot T_2 = \left(P_0 + \frac{(m_1 + m_2) \cdot g}{S}\right) \cdot T_1$ (5) (5) ifodadan;

	$$m_2 = \left[\frac{\left(P_0 + \frac{m_1 \cdot g}{S}\right) \cdot T_2}{T_1} - P_0\right] \cdot \frac{S}{g} - m_1 \quad (6)$$ (6) ifodadagi T_2 haroratni o'rniga $2T_1$ haroratni qo'yib; $$m_2 = \left[\frac{\left(P_0 + \frac{m_1 \cdot g}{S}\right) \cdot 2T_1}{T_1} - P_0\right] \cdot \frac{S}{g} - m_1 \quad (7)$$ (7) ifodadan T_1 haroratlarni qisqartirsak; $$m_2 = \left[2\left(P_0 + \frac{m_1 \cdot g}{S}\right) - P_0\right] \cdot \frac{S}{g} - m_1 \quad (8)$$ (8) ifodadan; $$m_2 = \left(P_0 + \frac{2m_1 \cdot g}{S}\right) \cdot \frac{S}{g} - m_1 \quad (9)$$ (9) ifodadan; $$m_2 = \frac{P_0 \cdot S}{g} + 2m_1 - m_1 = \frac{P_0 \cdot S}{g} + m_1 \quad (10)$$ Ifodaga ega bo'lamiz;
Hisoblash:	
 $m_2 = \frac{P_0 \cdot S}{g} + m_1 = \frac{10^5\ \text{Pa} \cdot 0,001\ \text{m}^2}{10\ \frac{\text{m}}{\text{s}^2}} + 5\ \text{kg} = 15\ \text{kg}.$	

46. Zich berkitilgan shisha idishning ichidagi havo bosimi 7 ^{0}C temperaturada 150 kPa ga teng. Agar idishni qizdirmay turib, tiqinni tortib olish uchun 45 N minimal kuch talab etilsa, u shisha og'zidan otilib chiqishi uchun idishni qanday temperaturagacha (^{0}C da) qizdirish kerak bo'ladi? Tiqinning ko'ndalang kesim yuzasi 4 cm^2.

(Javob: 217).

 Berilgan:	 Formula:
$V = \text{const}$ $t_1 = 7^0\text{C}$ $T_1 = (7 + 273)\ \text{K} = 280\ \text{K}$	Izoxorik jarayon tenglamasi, Sharl qonuniga ko'ra; $V = \text{const}$.

$P_1 = 150\ \text{kPa} = 1{,}5 \cdot 10^5\ \text{Pa}$ $F = 45\ \text{N}$ $S = 4\ \text{cm}^2 = 4 \cdot 10^{-4}\ \text{m}^2$ $Topish\ kerak: T_2 = ?$	$$\frac{P}{T} = \text{const} \quad (1)$$ ya'ni: $$\frac{P_1}{T_1} = \frac{P_2}{T_2} \quad (2)$$ ΔP-biz qo'ygan kuchning bosimi. $$\Delta P + P_1 \geq P_0 \quad (3)$$ (3) shart bajarilganda idishdagi tiqin ochilishi mumkin. Harorat T_2 gacha ortib, $$P_q = P_2 - P_0 \quad (4)$$ qo'shimcha bosim hosil qiladi. Shu bosim F kuch hosil qilayotgan bosim bilan P_1 bosim yig'indisiga teng bo'lishi kerak, ya'ni; $$P_2 = P_1 + \frac{F}{S} \quad (5)$$ (5) ifodani (2) ifodaga keltirib qo'yib; $$\frac{P_1}{T_1} = \frac{\left(P_1 + \frac{F}{S}\right)}{T_2} \quad (6)$$ ifodaga ega bo'lamiz. (6) ifodadan; $$T_2 = \frac{T_1 \cdot \left(P_1 + \frac{F}{S}\right)}{P_1} \quad (7)$$ (7) ifodaning gradusdagi qiymati; $$t_2 = (T_2 - 273)^0\text{C} \quad (8)$$ ga teng.

Hisoblash:

$$T_2 = \frac{T_1 \cdot \left(P_1 + \frac{F}{S}\right)}{P_1} = \frac{280\ K \cdot \left(1{,}5 \cdot 10^5\ \text{Pa} + \frac{45\ \text{N}}{4 \cdot 10^{-4}\ \text{m}^2}\right)}{1{,}5 \cdot 10^5\ \text{Pa}} = 490\ \text{K}$$

$$t_2 = (T_2 - 273)^0\text{C} = (490 - 273)^0\text{C} = 217^0\text{C}$$

47. Gaz dastlab 400 K dan 600 K gacha izoxorik ravishda, keyin esa T temperaturagacha izobarik ravishda qizdirildi. Shundan so'ng bosim gazning hajmiga to'g'ri proporsional ravishda kamayadigan jarayonda gaz boshlang'ich holatga keltirildi. T temperaturani (K da) toping.

(Javob: 900).

 Berilgan:	 Formula:
$T_1 = 400\ K$ $T_2 = 600\ K$ $V_{1,2} = const$ $P_{2,3} = const$ _____ $Topish\ kerak$: $T_3 = ?$	Izoxorik jarayon tenglamasi, Sharl qonuniga ko'ra; $V = const$ $\frac{P}{T} = const \quad (1)$ 1→2 o'tish $V_{1,2} = const$ $\frac{P_1}{T_1} = \frac{P_2}{T_2} \quad (2)$ 2→3 o'tish $P_{2,3} = const$ $\frac{V_2}{T_2} = \frac{V_3}{T_3} \quad (3)$ 3→1 o'tishda $\frac{P_1}{V_1} = \frac{P_3}{V_3} \quad (4)$ Masala shartidan; $V_1 = V_2 \quad (5)$ va $P_2 = P_3 \quad (6)$

Hisoblash:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow \frac{P_1}{400\ K} = \frac{P_2}{600\ K} \Rightarrow P_2 = \frac{3}{2}P_1 = P_3$$

$$\frac{P_1}{V_2} = \frac{\frac{3}{2}P_1}{V_3} \Rightarrow V_3 = \frac{3}{2}V_2$$

$$\frac{V_2}{T_2} = \frac{\frac{3}{2}V_2}{T_3} \Rightarrow T_3 = \frac{3}{2}T_2 = \frac{3}{2}\cdot 600\ K = 900\ K.$$

48. Normal atmosfera bosimi sharoitida ideal gaz 6 litr hajmni egallaydi. Agar gaz bosimi 20 kPa ga ortsa, gaz qanday hajmni egallaydi (litr)? T=const.

(Javob: 5).

 Berilgan:	 Formula:
$V_1 = 6\ l$ $P_1 = 100$ kPa $P_2 = P_1 + 20$ kPa $= 120$ kPa $T = \text{const}$ _____ *Topish kerak*: $V_2 = ?$	Izotermik jarayon tenglamasi $T = \text{const}$ $PV = \text{const}$ (1) ya'ni; $P_1V_1 = P_2V_2$ (2) masala shrtidan; $P_2 = P_1 + 20$ kPa ekanligidan; $V_2 = \frac{P_1V_1}{P_2}$ (3)

Hisoblash:
 $V_2 = \frac{P_1V_1}{P_2} = \frac{100\ \text{kPa} \cdot 6\ l}{120\ \text{kPa}} = 5\ l.$

49. Gazning dastlabki hajmi 0,2 litr, bosimi esa 300 kPa bo'lgan. Gaz izotermik kengayib, bosimi 120 kPa ga erishdi. Gazning keying hajmini toping (litr).

(Javob: 0,5).

 Berilgan:	 Formula:
$V_1 = 0{,}2\ l$ $P_1 = 300$ kPa $P_2 = 120$ kPa $T = \text{const}$ _____ *Topish kerak*: $V_2 = ?$	Izotermik jarayon tenglamasi $T = \text{const}$ $PV = \text{const}$ (1) ya'ni; $P_1V_1 = P_2V_2$ (2) (2) ifodadan;

	$V_2 = \frac{P_1 V_1}{P_2}$ (3)
Hisoblash:	
 $V_2 = \frac{P_1 V_1}{P_2} = \frac{300\ \text{kPa} \cdot 0{,}2\ l}{120\ \text{kPa}} = 0{,}5\ l.$	

50. Porshenli silindr ichiga qamalgan gazning dastlabki hajmi 24 cm^3, bosimi 0,8 MPa bo'lgan. Gaz izotermik siqilib, gazning hajmi 16 cm^3 ga keltirilganda uning bosimi qanday qiymatga erishadi (MPa)?

(Javob: 1,2).

 Berilgan:	 Formula:
$V_1 = 24\ \text{cm}^3$ $P_1 = 0{,}8\ \text{MPa}$ $V_2 = 16\ \text{cm}^3$ $T = \text{const}$ _____ *Topish kerak*: $P_2 = ?$	Izotermik jarayon tenglamasi $T = \text{const}$ $PV = \text{const}$ (1) ya'ni; $P_1 V_1 = P_2 V_2$ (2) (2) ifodadan; $P_2 = \frac{P_1 V_1}{V_2}$ (3)
Hisoblash:	
 $P_2 = \frac{P_1 V_1}{V_2} = \frac{0{,}8\ \text{MPa} \cdot 24\ \text{cm}^3}{16\ \text{cm}^3} = 1{,}2\ \text{MPa}.$	

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