D.J ERGASHEV

FIZIKADAN MASALALAR YECHIMI

Abituriyentlar va olimpiadachilar uchun

2

Ushbu kitobda Abituriyentlar, akademik litsey, kollej va maktab o'quvchilari uchun Fizikadan bir qator masalalar yechilish usullari ko'rsatib o'tilgan.

Muallif: Doniyor Ergashev

Telegramdagi kanalimiz: "FIZIKA VA MATEMATIKA YECHIM:

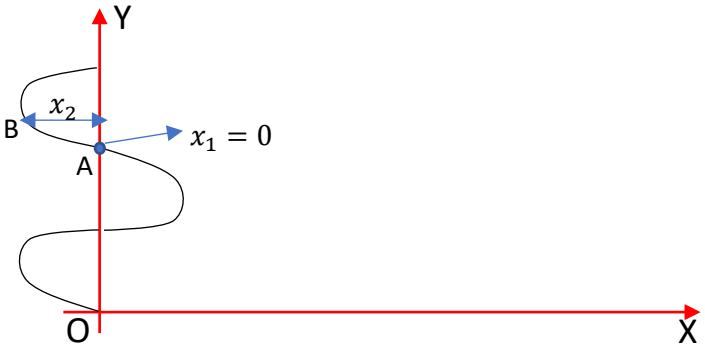
Kanalimiz manzili: @FizikaMatematika_yechim

Murojaat uchun: 88 284 07 02

Telegram: @Doniyor_Ergashev777

Masala: XOY tekisligida amplitudasi 10mm bo'lgan yassi garmonik to'lqin OY o'qi bo'ylab tarqalmoqda. Koordinatasi Y=6mm bo'lgan nuqtadagi zarraning muvozanat vaziyatidagi tezligi 30sm/s. Shu zarraning muvozanat vaziyatidan siljishi 8mm bo'lgandagi tezligi necha mm/s bo'ladi?

Yechim:



$$x_2 = 8mm$$

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

$$A = 10mm$$

Garmonik tebranayotgan to'lqin uchun Siljish tenglamasini yozaylik

$$x = Asin\omega t \Rightarrow sin\omega t = \frac{x}{A} (1)$$

Siljish tenglamasidam vaqt bo'yicha olingan birinchi tartibli hosila garmonik tebranayotgan to'lqin tezligiga teng:

$$\vartheta = \frac{dx}{dt} = A\omega cos\omega t \Rightarrow cos\omega t = \frac{\vartheta}{\omega A} (2)$$

(1) va ikkinchi tenglamalarni mos ravishda ikki tomonini kvadratga ko'tarib qo'shib yuborsak:

$$sin^2\omega t + cos^2\omega t = \frac{x^2}{A^2} + \frac{\vartheta^2}{\omega^2 A^2} \Rightarrow \frac{x^2}{A^2} + \frac{\vartheta^2}{\omega^2 A^2} = 1 \Rightarrow$$

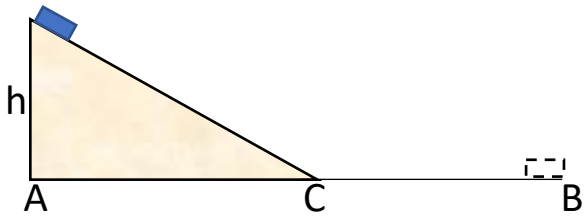
$\omega^2 = \frac{\vartheta^2}{A^2 - x^2}$; To'lqinning siklik chastotasi o'zgarmas kattalik bo'lgani uchun A va B holatlar uchun ularni tenglab yuboramiz:

$\frac{\vartheta_1^2}{A^2 - x_1^2} = \frac{\vartheta_2^2}{A^2 - x_2^2}$ Tenglamaning ikki tomonidan ildiz olib natijaviy formulani chiqaramiz:

$$\vartheta_2 = \sqrt{\frac{A^2 - x_2^2}{A^2 - x_1^2}} \cdot \vartheta_1 = \sqrt{\frac{36mm^2}{100mm^2}} \cdot 0{,}3\frac{m}{s} = 0{,}18\frac{m}{s} = 180mm/s$$

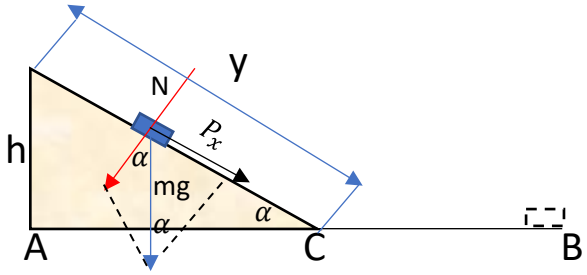
Javob: 180 mm/s Telegram: @FizikaMatematika_yechim

Masala:



Balandligi h bo'lgan qiya tekislikdan jism sirpanib tushib, B nuqtada to'xtaydi. Agar AB=l bo'lsa, yo'l davomida o'zgarmagan deb hisoblab ishqalanish koeffetsinentini toping.

Yechim:



$AC = x; CB = S$ ➡

$x + y = l$ (1)

$N = mgcos\alpha$

$P_x = mgsin\alpha$

Jismning tezlanishini topib olaylik:

$P_x - \mu N = ma$ ➡ $mgsin\alpha - \mu mgcos\alpha = ma$ ➡

$a = g(sin\alpha - \mu cos\alpha)$ (2); Jismning C nuqtadagi tezligini topaylik:

$\vartheta_0 = \sqrt{2ay} = \sqrt{2gy(sin\alpha - \mu cos\alpha)}$ (3)

Jism ishqalish kuchi ta'sirida tekis sekinlanuvchan harakat qilib to'xtaydi demak CB=S masofani topib olaylik:

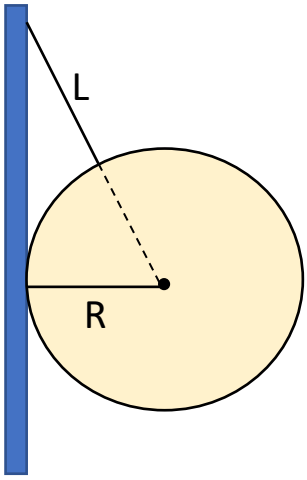
$-\mu mg = -ma = -m\frac{(0-\vartheta_0^2)}{2S}$ ➡ $S = \frac{\vartheta_0^2}{2\mu g}$ (4)

(3) ifodani (4) ifodaga keltrib qo'ysak:

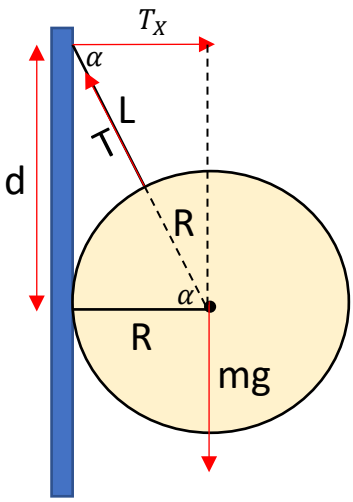
$S = \frac{2gy(sin\alpha - \mu cos\alpha)}{2\mu g}$ ➡ $S\mu = y(sin\alpha - \mu cos\alpha)$ (5)

$sin\alpha = \frac{h}{y}$ (6) ; $cos\alpha = \frac{x}{y}$ (7) ; (6) va (7) ifodalarni (5) ga keltrirb qo'yamiz: $S\mu = y\left(\frac{h}{y} - \mu\frac{x}{y}\right)$ ➡ $(S + x)\mu = h$ (8)

Va nihoyat (1) ifodani (8) ge keltrirb qo'yib ishqalanish koeffetsientini topamiz: $l\mu = h$ ➡ $\mu = \frac{h}{l}$ Javob: $\mu = \frac{h}{l}$



Masala: Massasi m, radiusi R bo'lgan shar vertikal silliq devorga uzunligi L bo'lgan ip yordamida rasmdagidek osilgan bo'lsa, ipning taranglik kuchini toping.



Yechim:

Pifagor teoremasiga asosan d uzunlikni topib olamiz:

$$d = \sqrt{(R+L)^2 - R^2} = \sqrt{L^2 + 2RL} \quad (1)$$

$$cos\alpha = \frac{R}{R+L} \quad (2)$$

Taranglik kuchini gorizontal tashkil etuvchisini topib olaylik: $T_x = T cos\alpha$ (3)

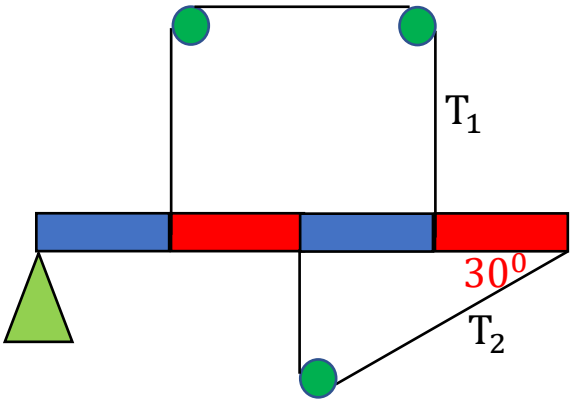
Momentlar qoidasiga asosan:

$$M_1 = M_2 \quad \Rightarrow \quad mg \cdot R = T_x \cdot d \quad (4)$$

(1), (2) va (3) ifodalardan foydalanib (4) ni quyidagicha yozamiz:

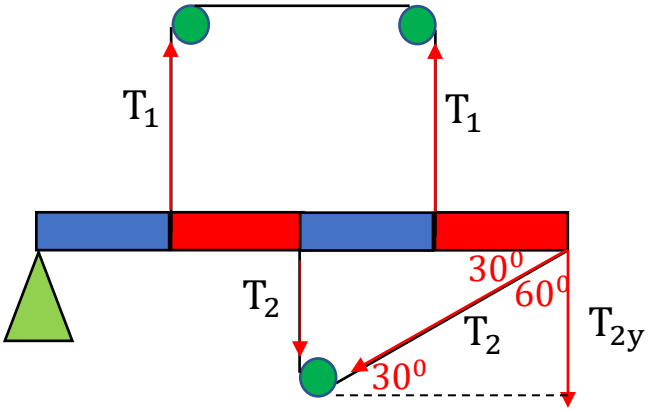
$$mg \cdot R = T \cdot \frac{R}{R+L} \cdot \sqrt{L^2 + 2RL} \Rightarrow$$

$$T = \frac{mg(R+L)}{\sqrt{L^2+2RL}} \quad \text{Javob: } T = \frac{mg(R+L)}{\sqrt{L^2+2RL}}$$



Masala: Rasmda ko’rsatilgan qo’zg’almas bloklardan tuzilgan ishqalanishsiz sistemada sterjen teng bo’laklarga bo’lingan. Iplardagi taranglik kuchlarining nisbatini toping.

Yechim:



T_2 Taranglik kuchining vertikal tashkil etuvchisini topib olaylik:

$\frac{T_{2y}}{T_2} = cos60^0 = 0{,}5 \Rightarrow T_{2y} = 0{,}5T_2$

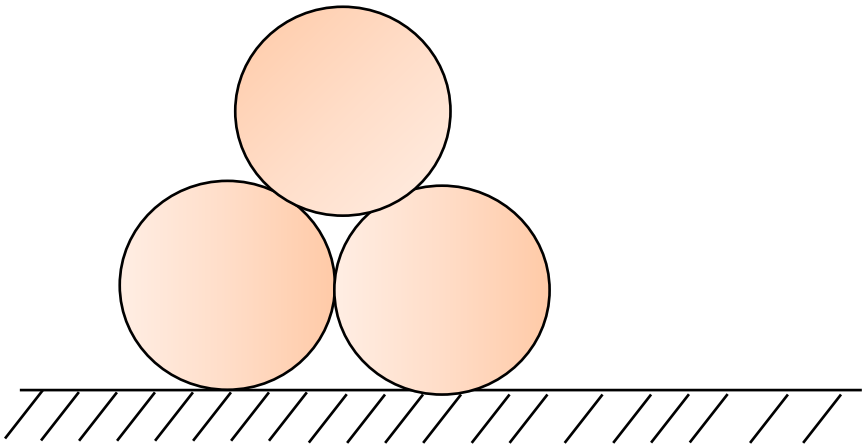
Momentlar qoidasiga asosan:

$M_1 + M_2 - M_3 - M_4 = 0 \Rightarrow M_1 + M_2 = M_3 + M_4$

Sterjen teng bo’laklarga bo’lingani uchun har bir bo’lakning uzunligini bir birlik deb olaylik, u holda:

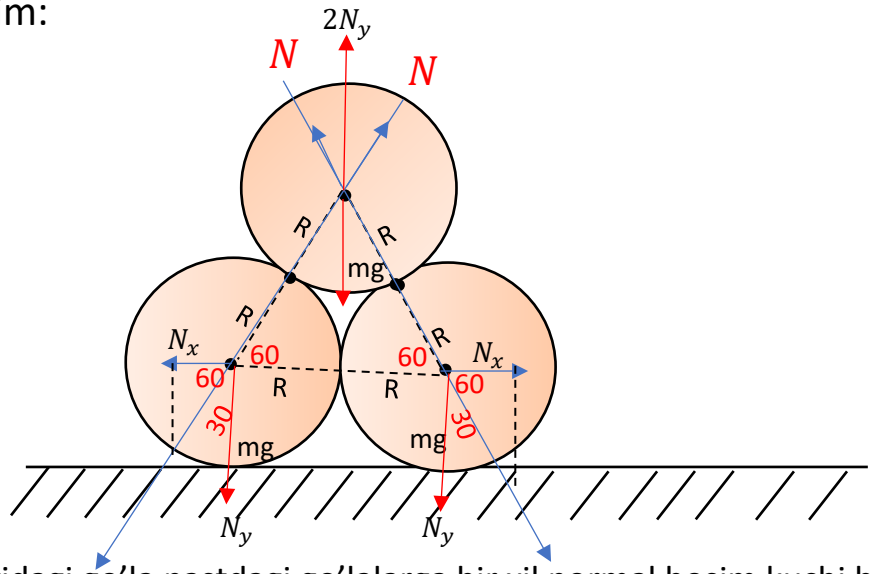
$T_1 \cdot 1 + T_1 \cdot 3 = T_2 \cdot 2 + T_{2y} \cdot 4 \Rightarrow 4T_1 = 2T_2 + 4 \cdot 0{,}5T_2 \Rightarrow$

$4T_1 = 4T_2 \Rightarrow \frac{T_1}{T_2} = 1$ Javob: $\frac{T_1}{T_2} = 1$



Masala: Tekislikda silindir shaklidagi 3 ta bir xil go'la rasmdagidek joylashtirilgan bo'lsa, Ishqalanish koeffetsinetining qanday qiymatlarida go'lalar tinch turadi?

Yechim:



Yuqoridagi go'la pastdagi go'lalarga bir xil normal bosim kuchi beradi, ushbu kuchlarning vertikal va gorizontal tashkil etuvchisini topib olamiz:

$$N_x = Ncos60 = \frac{1}{2}N; \quad N_y = Nsin60 = \frac{\sqrt{3}}{2}N \quad (1)$$

$$2N_y = mg \Rightarrow 2\frac{\sqrt{3}}{2}N = mg \Rightarrow N = \frac{mg}{\sqrt{3}} \quad (2)$$

Endi pastdahi go'laga ta'sir etuvchi umumiy normal bosim kuchini topaylik:

$$f = N_y + mg = 1{,}5mg \quad (3)$$

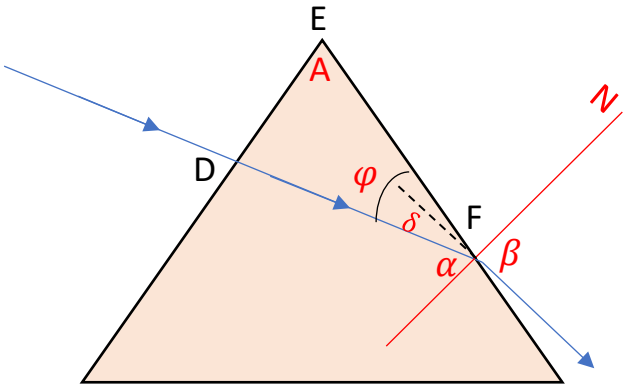
Go'lalar muvozanatda turishi uchun ishqalanish kuchi ,yuqoridagi go'la berayotgan normal bosim kuchining gorizontal tashkil etuvchisiga kamida teng bo;lishi kerak:

$$F_{ish} \geq N_x \Rightarrow \mu f \geq \frac{1}{2}N = \frac{mg}{2\sqrt{3}} \Rightarrow \mu 1{,}5mg \geq \frac{mg}{2\sqrt{3}} \Rightarrow \mu \geq 0{,}19$$

Javob: $\mu \geq 0{,}19$

Masala: Monoxromatik nur prizmaning yon sirtiga normal tushadi va undan $\delta = 25^0$ ga og'ib chiqib ketadi. Agar prizma materialning nur sindirish ko'rsatkichi $n = 1{,}7$ bo'lsa, prizmaning sindirish burchagini toping.

Yechim:



$\alpha + \delta = \beta$ (1); DEF uchburchak ichki burchaklar yig'indisi 180 gradusga teng bundan: $90 + A + \varphi = 180$ ➡ $A + \varphi = 90$ (2); $\alpha + \varphi = 90$ (3)

(2) va (3) Ifodalarni ayirib yuborsak: $A = \alpha$ (4) ifoda hosil bo'ladi.

Demak (4) ifodan e'tiborga olib,(1) ifodani quyidagicha yozamiz:

$\beta = \delta + A$ (5) ; $\frac{sin\alpha}{sin\beta} = \frac{1}{n}$ ➡ $sin\alpha \cdot n = sin\beta$ (6)

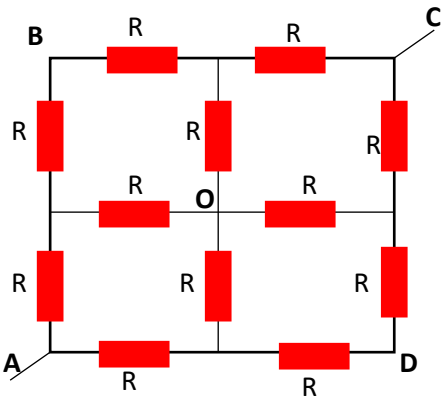
(4) va (5) ifodalarni e'tiborga olib (6) ni quyidagicha yozamiz:

$sinA \cdot n = \sin(\delta + A)$ ➡ $sinA \cdot n = sin\delta \cdot cosA + cos\delta \cdot sinA$ ➡

$sinA(n - cos\beta) = sin\delta \cdot cosA$ ➡ $tgA = \frac{sin\delta}{n - cos\beta}$ ➡

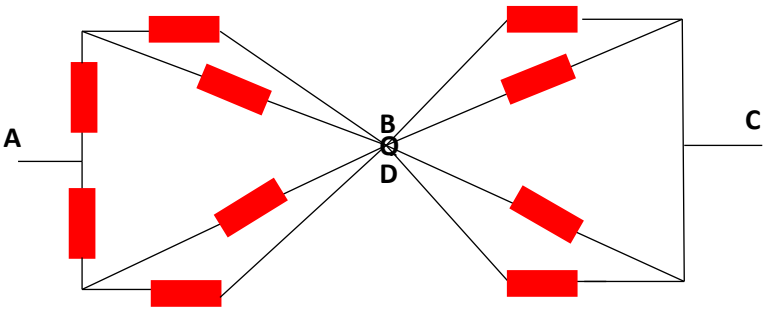
$tgA = \frac{sin25}{n - cos25} = \frac{0{,}42}{1{,}7 - 0{,}9} = 0{,}53$ ➡ $arctgA = 0{,}53$ ➡ $A = 28^0$

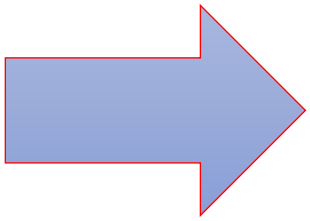
Javob: $A = 28^0$



Masala: A va C nuqtalar orasidagi umumiy qarshilikni hisoblang:

Yechim: BOD nuqtalarni tutashtiramiz:





$$R_{AB} = R + \frac{R}{2} = \frac{3R}{2};\quad R_{AD} = R + \frac{R}{2} = \frac{3R}{2}$$

$$\frac{1}{R_{AO}} = \frac{1}{R_{AB}} + \frac{1}{R_{AD}} \Rightarrow R_{OA} = \frac{3R}{4}$$

$$R_{BC} = R + \frac{R}{2} = \frac{3R}{2};\quad R_{DC} = R + \frac{R}{2} = \frac{3R}{2}$$

$$\frac{1}{R_{OC}} = \frac{1}{R_{BC}} + \frac{1}{R_{DC}} \Rightarrow R_{OC} = \frac{3R}{4}$$

$$R_{AC} = R_{OA} + R_{DC} \Rightarrow R_{AC} = \frac{6R}{4} = 1{,}5R$$

Javob: 1,5R

Masala: Hajmi 8,31 l bo'lgan idishda 4g azot (N_2) va huddi shuncha ozozn (O_3) aralashmasi bo'lib, uning harorati 17^0C. Agar azotning 40% i va ozonning 15% I atomlarga dissotsiyalansa, idishdagi bosimning toping. $\mu_{N_2} = 28\frac{g}{mol};\ \mu_{O_3} = 48\frac{g}{mol}$

Yechim: Azotning atomlarga dissotsiyalangan bosimnini topib olaylik:

$$P_1 = \frac{m\alpha}{\frac{\mu_{N_2}}{2}V}RT = \frac{2m\alpha RT}{\mu_{N_2}V}$$

Azotning molekulalarga dissotsiyalangan bosimini topaylik:

$$P_2 = \frac{m(1-\alpha)RT}{\mu_{N_2}V}$$

Idishdagi azotning umumiy bosimini topamiz:

$$P_{1,2} = P_1 + P_2 = \frac{2m\alpha RT}{\mu_{N_2}V} + \frac{m(1-\alpha)RT}{\mu_{N_2}V} = \frac{m(1+\alpha)RT}{\mu_{N_2}V}$$

Ozonning atomlarga dissotsiyalangan bosimnini topib olaylik:

$$P_3 = \frac{m\beta}{\frac{\mu_{O_3}}{3}V}RT = \frac{3m\beta RT}{\mu_{O_3}V}$$

Azotning molekulalarga dissotsiyalangan bosimini topaylik:

$$P_4 = \frac{m(1-\beta)RT}{\mu_{O_3}V}$$

Idishdagi Ozonning umumiy bosimini topamiz:

$$P_{3,4} = P_3 + P_2 = \frac{3m\beta RT}{\mu_{O_3}V} + \frac{m(1-\beta)RT}{\mu_{O_3}V} = \frac{m(1+2\beta)RT}{\mu_{O_3}V}$$

Dalton qonuniga asosan idishddagi umumiy bosimni topishimiz mumkin:

$$P_u = P_{1,2} + P_{3,4} = \frac{m(1+\alpha)RT}{\mu_{N_2}V} + \frac{m(1+2\beta)RT}{\mu_{O_3}V}$$

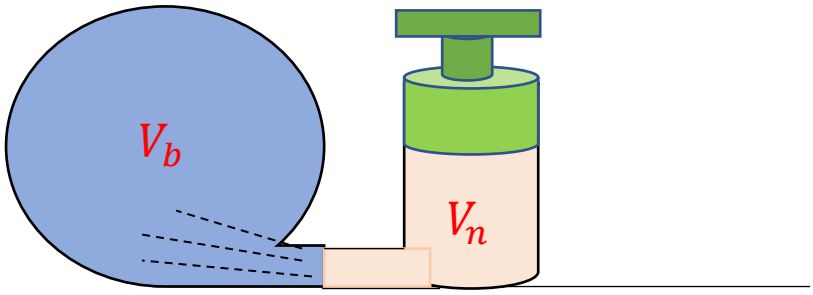
Berilgan kattaliklarni natijaviy formulaga keltrirb qo'ysak quyidagi natijaga erishamiz:

$P_u \approx 89kPa$ Javob: $P_u \approx 89kPa$

Masala: 60 l hajmli metall balonda qolib ketgan gazning bosimi $P_0 = 1atm$. Unga nasos yordamida gaz damalana boshladi. Agar nasosning ishchi hajmi 0,8 dm^3 bo'lsa, uning nechanchi ish taktidan boshlab balondagi bosim 2 atm dan katta bo'ladi? Jarayon izotermik.

(Har safar nasos so'rayotgan metanning bosimi balondagi metanning joriy bosimiga teng deb hisoblansin.)

Yechim:



Mendeleyev-Klapeyron tenglamasiga asosan:

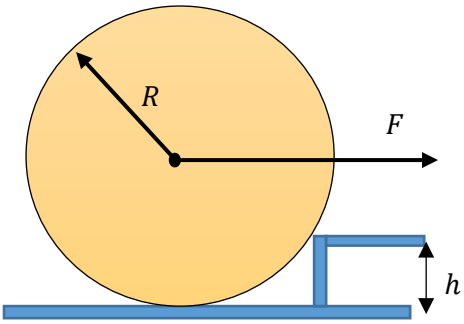
$$\begin{cases} P_0V = \frac{m_1}{\mu}RT \\ P_xV = \frac{m_1+nm_2}{\mu}RT \end{cases}$$ Sistemani bo'lib yuramiz: ➡

$$\frac{P_0}{P_x} = \frac{m_1}{m_1+nm_2} = \frac{\rho V_B}{\rho V_B+n\rho V_n} \Rightarrow \frac{P_0}{P_x} = \frac{1}{1+\frac{V_n}{V_b}n} \Rightarrow$$

$$P_x = P_0(\frac{V_n}{V_b}n + 1) \Rightarrow 2atm = 1atm(\frac{0,8}{60}n + 1) \Rightarrow$$

n=75

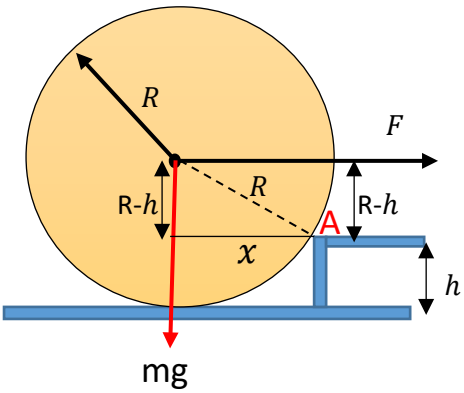
Javob: 75-ish taktidan keyin



Masala: Massasi 20 kg bo’lgan bir jinsli h balandlikka rasmda ko’rsatilgandek chiqarish uchun qanday minimla kuch talan qilinadi?.

(R=60sm, h=40 sm)

Yechim:



Pifagor teoramasiga asosan:

$$x = \sqrt{R^2 - (R-h)^2} = \sqrt{2Rh - h^2}$$

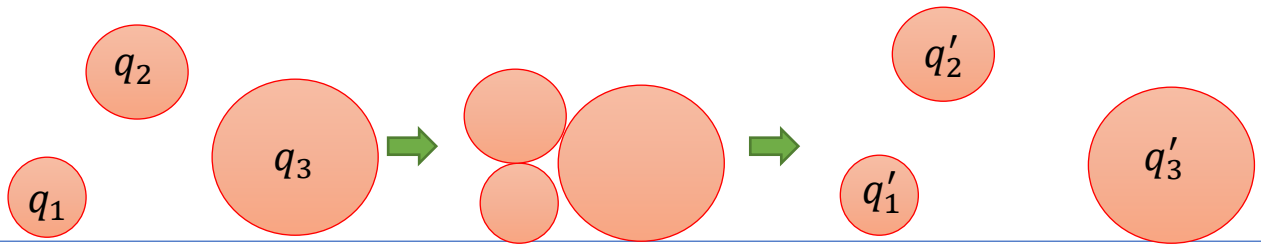
Bu holatda A nuqta tayanch vazifasini o’tab beradi demak momentlar qoidasiga asosan:

$$F \cdot (R-h) = mg \cdot x \quad \Rightarrow \quad F \cdot (R-h) = mg \cdot \sqrt{2Rh - h^2}$$

$$F = \frac{mg \cdot \sqrt{2Rh - h^2}}{(R-h)} = \frac{200\sqrt{2 \cdot 0{,}6 \cdot 0{,}4 - 0{,}16}}{0{,}2} = 565N$$

Javob:565N

Masala: Radiuslari 2R, R va 4R bo'lgan, bir-biridan izolyatsiyalangan uchta metal sfera mos ravishda $18q, -7q\ va\ 10q$ gacha zaryadlangan. SHarchalar bir vaqtda bir-biriga tekkizlidi va ajratildi sharchalarning keyingi zaryadi qanday bo'lib qoladi?



Yechim:

Elektr zaryading saqlanish qonuniga asosan:

$$q_1 + q_2 + q_3 = q_1' + q_2' + q_3' \quad (1)$$

SHarlar poetensiallari tenglashguncha biridan zaryad oladi yoki beradi:

$$\varphi_1 = \varphi_2 = \varphi_3 \quad \Rightarrow \quad \frac{kq_1'}{R_1} = \frac{kq_2'}{R_2} = \frac{kq_3'}{R_3}$$

$$q_3' = \frac{R_3 q_1'}{R_1} \ (2) \qquad q_2' = \frac{R_2 q_1'}{R_1} \ (3)$$

(2) va (3) ifodalarni (1) ga keltirib qo'ysak:

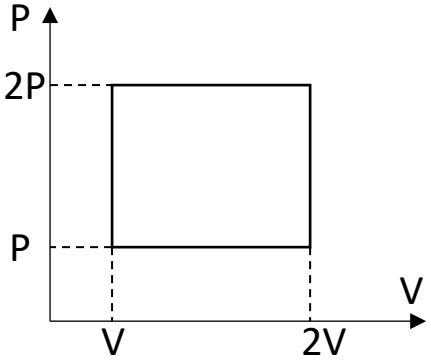
$$q_1 + q_2 + q_3 = q_1' + \frac{R_2 q_1'}{R_1} + \frac{R_3 q_1'}{R_1} \Rightarrow q_1 + q_2 + q_3 = \frac{(R_1+R_2+R_3)q_1'}{R_1}$$

$q_1' = \frac{R_1(q_1+q_2+q_3)}{R_1+R_2+R_3}$; Huddi shu tartibda qolgan ikki sfera uchun ham formula chiqaramiz:

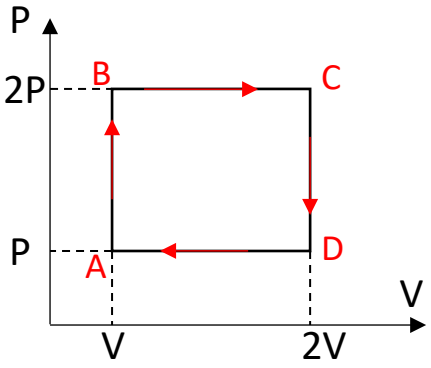
$$q_2' = \frac{R_2(q_1+q_2+q_3)}{R_1+R_2+R_3};\ q_3' = \frac{R_3(q_1+q_2+q_3)}{R_1+R_2+R_3} \Rightarrow$$

$$q_1' = \frac{2R \cdot 21q}{7R} = 6q;\ q_2' = \frac{R \cdot 21q}{7R} = 3q\ ;\ q_3' = \frac{4R \cdot 21q}{7R} = 12q$$

Javob: Ajratilgandan so'ng sharchalarning zaryadlari mos ravishda $6q, 3q\ va\ 12q$ bo'lib qoladi.



Masala: Ishchi moddasi bir atomli gaz bo'lgan issiqlik mashinasi rasmda ko'rsatilgani kabi sikl bo'yicha ishlaydi uning FIK ni toping (%)



Yechim: A nuqtaning haroratini $T_A = T$ deb belgilab olaylik u holda AB izoxorik jarayondan:

$\frac{P}{T} = \frac{2P}{T_B}$ ➡ $T_B = 2T$; BC Izobarik jarayondan:

$\frac{V}{T_B} = \frac{2V}{T_C}$ ➡ $T_C = 2T_B = 4T$;

CD Izoxorik jarayondan: $\frac{2P}{T_C} = \frac{P}{T_D}$ ➡ $T_D = \frac{T_C}{2} = 2T$

Yuqoridagi tenglamalardan ko'rinib turubdiki jismga A-B va B-C sikllarda issiqlik berilgan demak umumiy issiqlik miqdorinini quyidagicha topamiz:

$Q_{AB} = \Delta U = \frac{3}{2}\nu R\Delta T = \frac{3}{2}\nu RT = \frac{3}{2}PV$;

$Q_{BC} = A + \Delta U = \frac{5}{2}\nu R(T_C - T_B) = 5\nu RT = 5PV$ Yoki:

$Q_{BC} = \frac{5}{2} \cdot 2P\Delta V = 5PV$; $Q = Q_{AB} + Q_{BC} = \frac{13PV}{2}$

Foydali ish bosim va hajm o'qi bilan chegaralangan yuzaga teng bo'ladi:

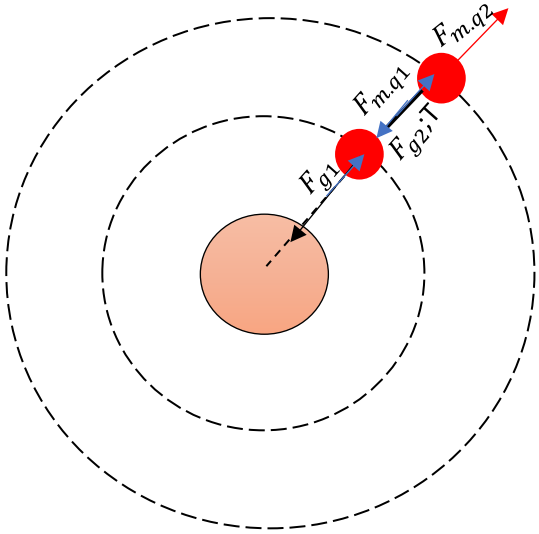
$$A = (P_2 - P_1)(V_2 - V_1) = PV$$

Yuqoridagilardan foydalanib foydali ish koeffetsientini topishimiz mumkin:

$$\eta = \frac{A_F}{A_U} \cdot 100\% = \frac{A}{Q} \cdot 100\% = \frac{2}{13} \cdot 100\% \approx 15{,}4\%$$

Javob: $\eta = 15{,}4\%$

Masala: Yerning m massali ikki yo'ldoshi yer markazidan r_1 va r_2 masofada tros bilan bog'langan holda erkin parvoz qilmoqda. Tros doimo yerning radiusi bo'ylab tarang turadi deb hisoblab, taranglik kuchini toping.



Yechim:

$$\begin{cases} F_{g1} = T + F_{m.q1} \\ T + F_{g2} = F_{m.q2} \end{cases} \Rightarrow$$

$$\begin{cases} \frac{GmM}{r_1^2} = T + m\omega^2 r_1 \\ T + \frac{GmM}{r_2^2} = m\omega^2 r_2 \end{cases} \Rightarrow$$

$$\begin{cases} \frac{GmM}{r_1^2} - T = m\omega^2 r_1 \\ T + \frac{GmM}{r_2^2} = m\omega^2 r_2 \end{cases}$$ Sistemani chap va o'ng tomonlarini mos ravishda bo'lib yuboramiz:

$$\frac{\frac{GmM}{r_1^2} - T}{T + \frac{GmM}{r_2^2}} = \frac{r_1}{r_2} \Rightarrow \frac{(GmM - r_1^2 T)r_2^2}{(Tr_2^2 + GmM)r_1^2} = \frac{r_1}{r_2} \Rightarrow$$

$$(GmM - r_1^2 T)r_2^3 = (Tr_2^2 + GmM)r_1^3 \Rightarrow$$

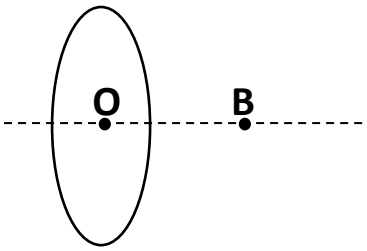
$$GmMr_2^3 - r_1^2 r_2^3 T = r_2^2 r_1^3 T + GmMr_1^3 \Rightarrow$$

$$GmMr_2^3 - GmMr_1^3 = r_2^2 r_1^3 T + r_1^2 r_2^3 T \Rightarrow$$

$$GmM(r_1^3 - r_2^3) = r_1^2 r_2^2 (r_1 + r_2)T \Rightarrow$$

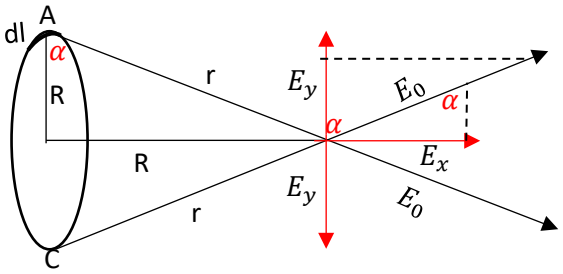
$$\boxed{T = \frac{GmM(r_1^3 - r_2^3)}{r_1^2 r_2^2 (r_1 + r_2)}}$$

Javob: $T = \frac{GmM(r_1^3 - r_2^3)}{r_1^2 r_2^2 (r_1 + r_2)}$



Masala: Radiusi 20 sm bo'lgan o'tkazgichli halqa bir xil chiziqli zichlikda 14,1 mkC gacha zaryadlangan. Rasmda ko'rsatilgan B nuqtadagi natijaviy elektr maydon kuchlanganligini toping (kV/m). (OB=20sm)

Yechim: OB=R



Pifagor teoremasiga asosan:

$$r = \sqrt{R^2 + R^2} = \sqrt{2}R$$

A nuqtadagi elementar dl uzunlikning B nuqtadagi maydon kuchlanganligini vertikal va gorizontal tashkil etuvchilarini topaylik,huddi shunday unga qarama-qarshi C uqtadagi tashkil etuvchilarni ham topib olsak, vertikal tashkil etuvchilar bir-biriga qarama-qarshi bolib qoladi. Shu sababli Elektr maydon superpozitsiya prinsipiga asosan natijaviy maydon gorizontal tashkil etuvchilar yig'indisiga teng bo'ladi:

$$dE = dE_x \Rightarrow dE = d\frac{k\tau l}{r^2}sin\alpha; \quad dE = \frac{k\tau}{r^2}sin\alpha dl$$

Formulani 0 da $2\pi R$ gacha integrallab yuboramiz:

$$E = \int_0^{2\pi R} \frac{k\tau}{r^2}sin\alpha dl = \frac{k\tau 2\pi R}{r^2}sin\alpha = \frac{k\tau l}{r^2}sin\alpha = \frac{kq}{r^2}sin\alpha$$

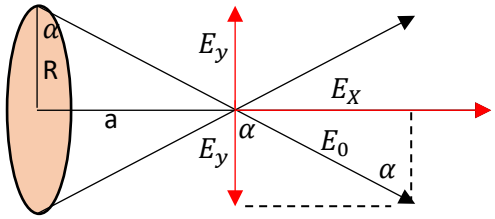
$$sin\alpha = \frac{R}{\sqrt{2}R} = \frac{1}{\sqrt{2}}; \Rightarrow E = \frac{kq}{2R^2}sin\alpha = \frac{9\cdot10^9 1{,}41\cdot10^{-5}}{2\cdot4\cdot10^{-2}\cdot\sqrt{2}} = 1125kV/m$$

Javob: 1125kV/m

Masala: (Sedrik 17.36)

q=9nC zaryad $R = 4sm$ radiusli, vakumda joylashgan disk sirti bo'ylab tekis taqsimlangan. Disk markazidan o'tkazilgan chiziqda, markazdan $a = 3sm$ masofada joylashgan elektr maydon kuchlanganligi topilsin.

Yechim:



Kuchlanganlikning vertikal proyeksiyalari qarama-qarshi bo'lgani uchun nol ga teng bo'ladi, shu sababli natijaviy maydon kuchlanganligi gorizontal proyeksiyalar yig'indisiga teng bo'ladi.

$E_x = E_0 sin\alpha$ ➡ $sin\alpha = \frac{a}{r}$ ➡ $E_x = \frac{kq}{r^2}\frac{a}{r} = \frac{kqa}{r^3}$ ➡

$r = \sqrt{R^2 + a^2}$ ➡ $E_x = \frac{kqa}{r^{\frac{3}{2}}} = \frac{ka\sigma S}{r^{\frac{3}{2}}}$ ➡ $dE_x = \frac{kqa}{r^{\frac{3}{2}}} = \frac{ka\sigma dS}{r^{\frac{3}{2}}}$

$dE_x = \frac{ka\sigma d\pi R^2}{r^{\frac{3}{2}}}$ ➡ $dE_x = \frac{ka\sigma\pi dR^2}{r^{\frac{3}{2}}}$ a o'zgarmas son bo'lgani uchun diffrensial ostiga kiritib, ifodani quyidagi ko'rinishda yozamiz:

$dE_x = \frac{ka\sigma\pi d(R^2+a^2)}{r^{\frac{3}{2}}} = \frac{ka\sigma\pi dr}{r^{\frac{3}{2}}}$ ➡

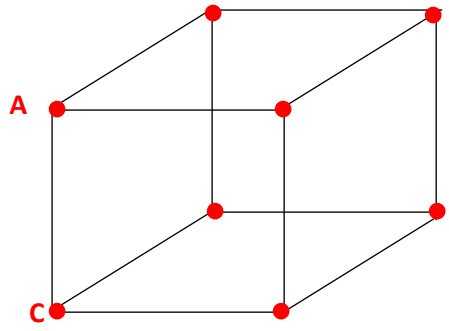
$E_x = ka\sigma\pi \int_0^R \frac{dr}{r^{\frac{3}{2}}} = -ka\sigma\pi {}_0^R| \frac{2}{\sqrt{r}} = \int_0^R \frac{dr}{r^{\frac{3}{2}}} = -ka\sigma\pi {}_0^R| \frac{2}{\sqrt{R^2+a^2}}$ ➡

$E_x = ka\sigma\pi E_x = ka\sigma\pi\left(\frac{2}{a} - \frac{2}{\sqrt{R^2+a^2}}\right) = \frac{1}{4\pi\varepsilon\varepsilon_0} a\sigma\pi 2(\frac{1}{a} - \frac{1}{a\sqrt{R^2+a^2}})$ ➡

$E = \frac{\sigma}{2\varepsilon\varepsilon_0}\left(1 - \frac{a}{\sqrt{R^2+a^2}}\right) = \frac{q}{2\varepsilon\varepsilon_0\pi R^2}\left(1 - \frac{a}{\sqrt{R^2+a^2}}\right) = \frac{2q}{4\varepsilon\varepsilon_0\pi R^2}\left(1 - \frac{a}{\sqrt{R^2+a^2}}\right)$ ➡

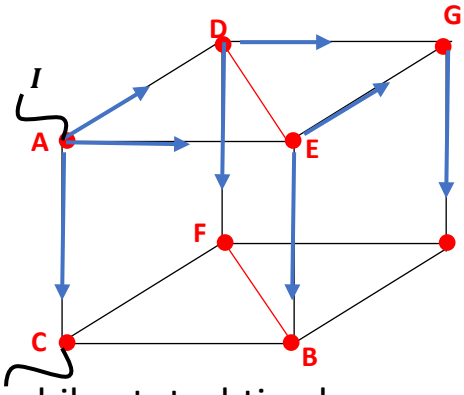
$$E = \frac{2kq}{R^2}\left(1 - \frac{a}{\sqrt{R^2+a^2}}\right) = \frac{2\cdot 9\cdot 10^9 9\cdot 10^{-9}}{16\cdot 10^4}\left(1 - \frac{3\cdot 10^{-4}}{5\cdot 10^{-4}}\right) = \frac{81\cdot 10^4\cdot 0{,}4}{8} = 40{,}5\cdot 10^3 V$$

Javob: $E = 40{,}5\cdot 10^3 V$

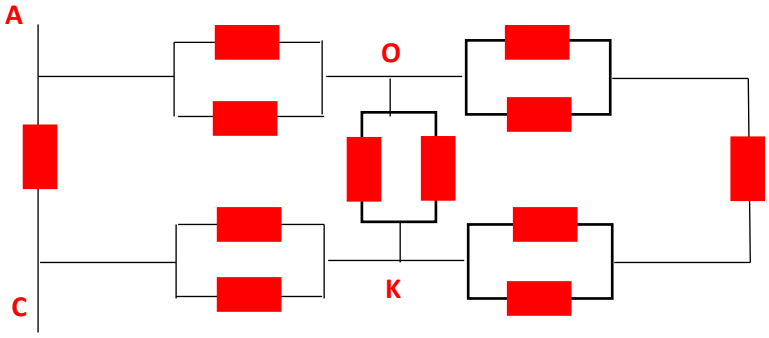


Masala: Rasmda ko’rsatilgan kubning AC nuqtalari orasidagi umumiy qarshilikni toping. Har bir qirraning qarshiligi R ga teng.

Yechim:



Chizmadan ko’rinadiki D va E hamda B va F nuqtalarda potensiallar teng demak, D-E va F-B nuqtalarda potensiallar farqi nolga teng bo’ladi va ushbu oralqidan tok oqmaganligi uchun ushbu nuqtalarni sim bilan tutashtirsak sxema tushunarli holatga keladi va ekvisxemani quyidagicha chizamiz:



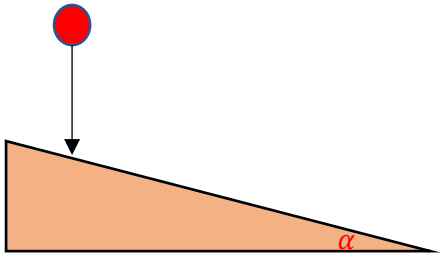
O-K nuqtalar orasidagi umumiy qarshilik:

$$R_{OK} = \frac{\frac{R}{2}\cdot(R+\frac{R}{2}+\frac{R}{2})}{\frac{R}{2}+(R+\frac{R}{2}+\frac{R}{2})} = \frac{2R}{5}$$

A-C nuqtalar orasidagi umumiy qarshilik:

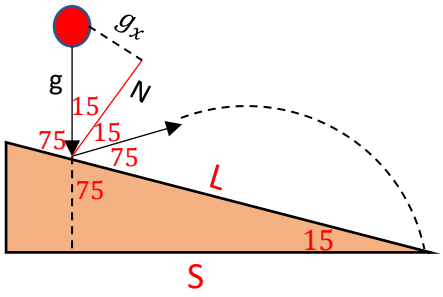
$$R_{AC} = \frac{R\cdot(\frac{R}{2}+R_{OK}+\frac{R}{2})}{R+(\frac{R}{2}+R_{OK}+\frac{R}{2})} = \frac{R\cdot\frac{7R}{5}}{R+\frac{7R}{5}} = \frac{7R}{12}$$

Javob: $R_{AC} = \frac{7R}{12}$



Masala: Kichik elastik sharcha vertikal tushayotib, qiyaligi $\alpha = 15^0$ bo'lgan elastik tekislikka $5m/s$ tezlikda uriladi. sharchaning tekislikka birinchi va ikkinchi urilishi oralig'idagi gorizontal ko'chishi nimaga teng bo'ladi?

Yechim:



Erkin tushish tezlanishi va urilish tezligining tekislikka nisbatan vertikal va gorizontal tashkil etuvchilarini topib olaylik:

$$g_x = gsin15\ ;\ g_y = gcos15$$

$$\vartheta_x = \vartheta cos75 = \vartheta sin15; \vartheta_y = \vartheta cos15$$

Birinchi va ikkinchi urulishda jism qancha vaqt harakat qilganini topib olaylik: $t = \frac{2\vartheta_y}{g_y} = \frac{2\vartheta cos15}{gcos15} = \frac{2\vartheta}{g} = 1s$

Jism tekislik bo'ylab L masofaga ko'chganda tekis tezlanuvchan harakat qiladi demak:

$$L = \vartheta_x t + \frac{g_x t^2}{2} = \vartheta sin15t + \frac{gsin15t^2}{2} = sin15(\vartheta t + \frac{gt^2}{2})$$

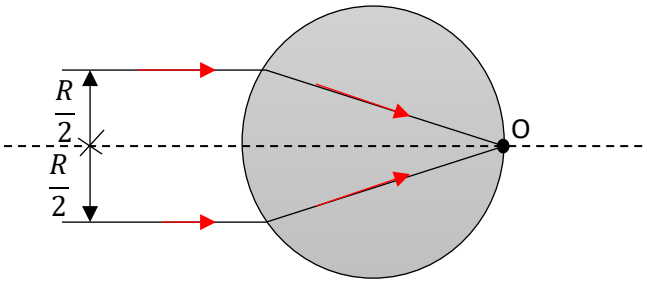
Endi to'g'ri burchakli uchburchak xossasidan gorizontal ko'chishni topishimiz mumkin:

$$\frac{S}{L} = cos15 \Rightarrow S = Lcos15 = sin15 \cdot cos15(\vartheta t + \frac{gt^2}{2})$$

Tenglamani surat maxrajini 2 ga ko'paytirib bo'lamiz:

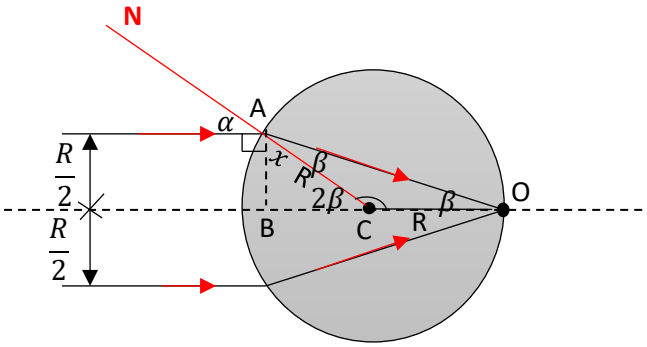
$$S = \frac{2sin15 \cdot cos15(\vartheta t + \frac{gt^2}{2})}{2} = \frac{sin30(\vartheta t + \frac{gt^2}{2})}{2} = \frac{5+5}{4} = 2{,}5m$$

Javob: Gorizontal 2,5 masofaga ko'chadi



Masala: Silindir shaklidagi shaffof jismning yon tarafidan silindirning asosiga parallel yo'nalgan 2 ta nur dastasi tushmoqda. Bu ikkita nur silindirning qarama-qarshi tarafidagi O nuqtada uchrashishlari uchun silindirning optic zichligi qanday bo'lishi kerak?. Silindir asosining radiusi R ga teng.

Yechim:



ABC to'g'ri burchakli uchburchakdan:

$sin2\beta = \frac{\frac{R}{2}}{R} = \frac{1}{2} \Rightarrow 2\beta = 30^0 \Rightarrow \beta = 15^0;$

$\alpha + 90^0 + x = 180^0 \qquad x = 90 - \alpha$

ABC uchburchak ichki burchaklar yig'indisi 180^0 ligidan:

$x + 90 + 2\beta = 180^0 \qquad 90 - \alpha + 2\beta = 90 \Rightarrow \alpha = 2\beta = 30^0$

$$n = \frac{sin\alpha}{sin\beta} = \frac{sin30^0}{sin15^0} = \frac{0{,}5}{0{,}259} = 1{,}92$$

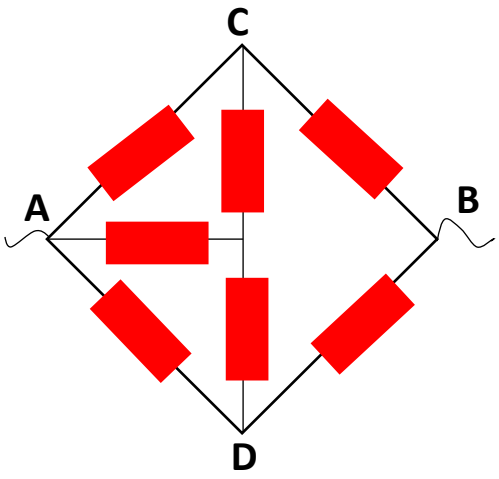
2-Usul mikrokalkulyator bo'lmagan holatlarda:

$sin2\beta = \frac{1}{2} \Rightarrow 2sin\beta cos\beta = \frac{1}{2} \Rightarrow sin\beta\sqrt{1 - sin^2\beta} = \frac{1}{4} \Rightarrow$

$sin^2\beta = t$ deb olsak: $t^2 - t + \frac{1}{16} = 0 \Rightarrow$ kvadrat tenglamani yechsak

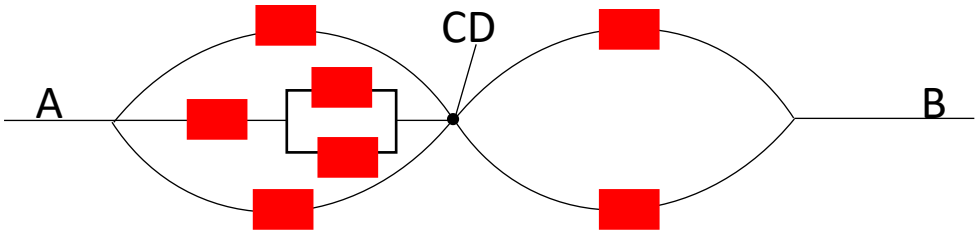
$t = 0{,}07 \Rightarrow sin^2\beta = 0{,}07 \Rightarrow sin\beta = 0{,}259\ n = \frac{sin\alpha}{sin\beta} = \frac{0{,}5}{0{,}259} = 1{,}92$

Javob: n=1,92



Masala: CHizmadan foydalanib AB nuqtalar orasidagi qarshilikni toping. Har bir qarshlik R ga teng.

Yechim: CHizma soda holatga kelishi uchun C va D nuqtalarni birlashtirib yuboraylik:



A va CD nuqtalarni tutashtiruvchi chiziqdagi qarshilikni topaylik:

$$R_x = R + \frac{R}{2} = \frac{3R}{2}$$

A va CD nuqtalar orasidagi umumiy qarshilikni topaylik:

$$\frac{1}{R_{ACD}} = \frac{1}{R} + \frac{1}{R_x} + \frac{1}{R} = \frac{2}{R} + \frac{2}{3R} = \frac{8}{3R} \Rightarrow R_{ACD} = 3R/8$$

CDB nuqtalar orasidagi umumiy qarshilikni topaylik:

$$R_{CDB} = R/2$$

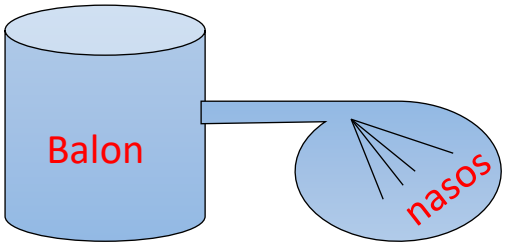
Edi ACD va CDB nuqtalar ketma-ket ulanganligi uchun A va B nuqtalar orasidagi qarshlikni quyidagi ifoda orqali topishimiz mumkin:

$$R_{AB} = R_{CDB} + R_{ACD} = \frac{R}{2} + \frac{3R}{8} = \frac{7R}{8}$$

Javob: $R_{AB} = \frac{7R}{8}$

Masala: Hajmi $V_b = 1{,}5dm^3$ bo'lgan balondagi bosimni $k = 100$ marta kamaytirish uchun porshenli nasos necha marta xavo so'rib olishi kerak?. Gazni so'rib olish paytiada harorat o'zgarishini hisobga olmang.

Yechim:



Harorat o'zgarmagan bo'lsa, Klapeyron tenglamasiga asosan:

$T = const \Rightarrow PV = const$

Birinchi taktda :

$\mathrm{P_0V_B} = (\mathrm{V_B} + \mathrm{V_n})\mathrm{P_1}$

Ikkinchi taktda:

$P_1V_B = (V_B + V_n)P_2$

Uchinchi taktda:

$P_2V_B = (V_B + V_n)P_3$ va. ha zo

Birnchi taktdagi ifodanan P_1 topib, ikkinchisiga qo'ysak:

$P_2 = P_0(\frac{V_B}{V_B+V_n})^2$

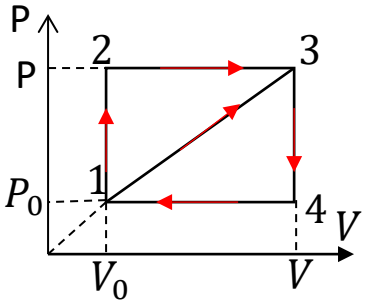
huddi shu tartibda n ta takt uchun quyidagi formulani yoza olamiz:

$P_n = P_0(\frac{V_B}{V_B+V_n})^n \Rightarrow \frac{P_0}{P_n} = (\frac{V_B+V_n}{V_B})^n \Rightarrow k = (\frac{V_B+V_n}{V_B})^n$

Tenglamani ikki tomonini natural logorifmlab yuborsak:

$\ln k = ln(\frac{V_B+V_n}{V_B})^n \Rightarrow lnk = nln(\frac{V_B+V_n}{V_B}) \Rightarrow n = \frac{lnk}{\ln(\frac{V_B+V_n}{V_B})} \Rightarrow$

$n = \frac{ln100}{\ln(\frac{15\cdot10^{-4}+10^{-4})}{15\cdot10^{-4}}} = \frac{ln100}{ln\frac{16}{15}} = \frac{4{,}6}{0{,}065} = 71$ Javob: 71 marta



Masala: Grafikda ko'rsatilgan 1-2-3-4-1 siklning FIKi 40% bo'lsa, 1-3-4-1 siklning FIKini toping.

Yechim:

Grafikdan ko'rinib turubdiki, 1-3 to'gri chiziqda Bosim hajmga proporsional ravishda chiziqli oshib bormoqda, demak ushbu oraliq uchun to'g'ri chiziq tenglamasini tuzub olamiz:

$P_0 = kV_0;\ P = kV$; (1)

Foydali ish bosim va hajm o'qi orasidagi yuzaga teng bo'ladi, 1-2-3-4-1 sikl uchun:

$A = (P - P_0)(V - V_0) = k(V - V_0)^2$ (2)

Gaz isitgichdan 1-2 va 2-3 sikllarda issiqlik olgan demak umumiy issiqlik miqdori quyidagiga teng:

$$Q = Q_{1-2} + Q_{2-3} = \frac{i}{2}V_0(P - P_0) + \frac{i+2}{2}P(V - V_0) = \frac{i}{2}V_0k(V - V_0) + \frac{(i+2)(kV^2 - VV_0)}{2} = \frac{ikVV_0 - ikV_0^2 + ikV^2 - ikVV_0 + 2kV^2 - 2kVV_0}{2} = \frac{ik(V-V_0)(V+V_0) + 2kV(V-V_0)}{2} = \frac{(V-V_0)(ikV + ikV_0 + 2kV)}{2}$$ (3)

$$\eta = \frac{A}{Q} = \frac{k(V-V_0)^2}{\frac{(V-V_0)(ikV+ikV_0+2kV)}{2}} = \frac{2(V-V_0)}{iV+iV_0+2V}$$ ➡

$$\frac{iV+iV_0+2V}{2(V-V_0)} = \frac{1}{\eta}$$ (4)

1-3-4-1 sikl uchun quyidagiga teng:

$$A = \frac{1}{2}(P - P_0)(V - V_0) = \frac{1}{2}k(V - V_0)^2$$ (5)

Bu siklda gaz faqat 1-3 siklda istigichdan issiqlik olgan demak umumiy olgan issqilik miqdorini topamiz:

$Q = \Delta U + A$ ➡

$$A = \int_{V_0}^{V} PdV = \int_{V_0}^{V} kVdV = k\frac{V^2}{2}\Big|_{V_0}^{V} = \frac{k(V^2 - V_0^2)}{2} = \frac{k(V-V_0)(V+V_0)}{2}$$ (6)

$$\Delta U = \frac{i}{2}(PV - P_0V_0) = \frac{i}{2}(kV^2 - kV_0^2) = \frac{ik(V-V_0)(V+V_0)}{2} \quad (7)$$

$$Q = \Delta U + A = \frac{k(V-V_0)(V+V_0)}{2} + \frac{ik(V-V_0)(V+V_0)}{2} = \frac{k(i+1)(V-V_0)(V+V_0)}{2} \quad (8)$$

$$\varphi = \frac{A}{Q} = \frac{\frac{1}{2}k(V-V_0)^2}{\frac{k(i+1)(V-V_0)(V+V_0)}{2}} = \frac{(V-V_0)}{(i+1)(V+V_0)} = \frac{(V-V_0)}{iV+iV_0+V+V_0} \quad (9) \quad \Rightarrow$$

$$\frac{iV+iV_0+V+V_0}{(V-V_0)} = \frac{1}{\varphi} \Rightarrow \frac{iV+iV_0+V+V_0}{2(V-V_0)} = \frac{1}{2\varphi} \quad (10)$$

(10) va (4) formulalarni mos ravishda ayirib yuborib quyidagi natijaga erishamiz:

$$\frac{iV+iV_0+V+V_0}{2(V-V_0)} - \frac{iV+iV_0+2V}{2(V-V_0)} = \frac{1}{2\varphi} - \frac{1}{\eta} \Rightarrow \frac{1}{\varphi} - \frac{1}{\eta} = \frac{iV+iV_0+V+V_0-iV-iV_0-2V}{2(V-V_0)}$$

$$\frac{1}{2\varphi} - \frac{1}{\eta} = \frac{V_0-V}{2(V-V_0)} = -\frac{1}{2} \Rightarrow \frac{1}{2\varphi} = \frac{1}{\eta} - \frac{1}{2} = \frac{2-\eta}{2\eta} \Rightarrow$$

$$\varphi = \frac{\eta}{2-\eta}$$

Shu tipdagi masalalar uchun ishchi formula

$$\varphi = \frac{\eta}{2-\eta} = \frac{0{,}4}{2-0{,}4} = 0{,}25 \Rightarrow \varphi = 25\%$$

Javob: $\varphi = 25\%$

Masala: Vertolyot ma’lum balandlikka ko’tarilganda uning kabinasiga joylashtirilgan barometrning ko’rsatishi 11kPa ga o’zgargan. Agar uchish maydonchasida barometr 0,1MPa ni ko’rsatgan bo’lsa, vertalyot qanday balandlikda uchmoqda? Harorat esa 17^0C. Haroratning balandlik ortishi bilan o’zgarishini hisobga olmang.

Yechim:

Agar h=0 balandlikda bosim p_0 bo’lsa, h baladlikda bosim p ga o’zgarsin u holda: $dP = -\rho g dh$(1)

Bu yerda: ρ-havo zichligi

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

P=nkT (3) dan foydalanib (2) ni quyidagicha yozamiz:

$\rho = \frac{Pm}{kT}$ (4) bu ifodani (1) ga keltirib qo’yamiz:

$dP = -\frac{Pmgdh}{kT}$ ➡ $\frac{dP}{P} = -\frac{mgdh}{kT}$ formulani integrallab yuboramiz:

$lnP = -\frac{mgh}{kT}$+C ➡ h=0 da C=lnP_0 deb olib, formulani quyidagicha yozamiz:

$lnP = -\frac{mgh}{kT} + lnP_0$ ➡ $lnP_0 - lnP = \frac{mgh}{kT}$ ➡ $ln\frac{P_0}{P} = \frac{mgh}{kT}$ ➡

$h = \frac{kTln\frac{P_0}{P}}{mg}$ ➡ $h = \frac{kTln\frac{P_0}{P}}{\frac{\mu}{N_A}g} = \frac{RTln\frac{P_0}{P}}{\mu g} = \frac{8{,}31 \cdot 290 \cdot ln9{,}09}{29 \cdot 10^{-3}10} = 18km$

Masala:

1 mol gazning o'zgarmas hajmdagi issiqlik sig'imi 11,69 J/Kbo'lsa, ushbu gazning o'zgarmas bosimdagi issiqlik sig'imini toping.

Yechim:

O'zgarmas bosimdagi issiqlik sig'imi

$C_P = \frac{dQ}{dT}$ (1)

O'zgarmas hajmdagi issiqlik sig'imi

$dQ = dU \Rightarrow C_V = \frac{dU}{dT}$ (2)

$dQ = dU + dA$ (3)

(1) va (2) tenglamalarni (3) ga keltirib qo'yamiz:

$C_P dT = C_V dT + dA$ (4)

$A = \nu RT$ 1mol gaz uchun $dA = RdT$ (5)

(5) ni (3) ga keltirib qo'yib quyidagi ifodani hosil qilamiz:

$\boxed{C_P = C_V + R}$ (6)

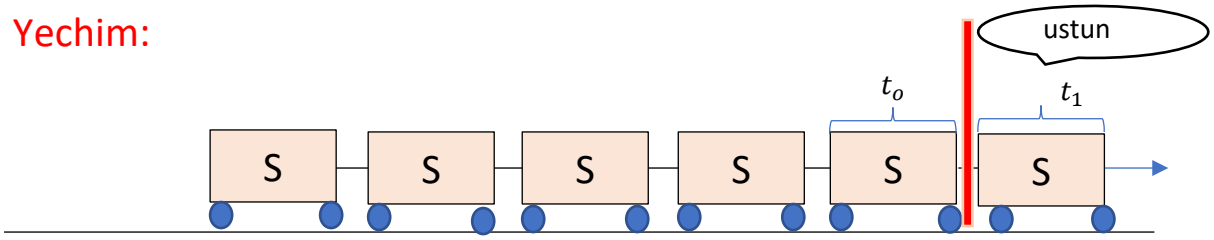
(6) Ifoda Mayer tenglamasi deyiladi.

$$C_P = C_V + R = 11{,}69 + 8{,}21 = 20 J/k$$

Javob: 20J/k

Masala: Tinch holatdan tekis tezlanuvchan harakatlana boshlagan poyezdning ikkinchi vagoni biror ustun yonidan t_0 vaqtda o'tib ketsa, oltinchi vagon shu ustun yonidan qancha vaqtda o'tadi?

Yechim:



Harakat tekis tezlanuvchan bo'lganligi uchun butun harakat davomida tezlanish o'zgarmas bo'ladi demak birinchi vagonning ustun yonidan o'tish vaqtini t_1 deb olsak:

$S = \frac{at_1^2}{2}$ (1) ifodani yoza olamiz:

birinchi va ikkinchi vagonlar uchun: $2S = \frac{a(t_1+t_0)^2}{2}$ (2) birinchi va ikkinchi tenglamalarni bo'lib yuborsak: $\frac{1}{2} = \frac{t_1^2}{(t_1+t_0)^2}$ ➡ $\frac{t_1+t_0}{t_1} = \sqrt{2}$ ➡

$t_1 = \frac{t_0}{\sqrt{2}-1}$ (3)

huddi shu tartibda 5 ta va 6 ta vagonlar ustun yonidan qancha vaqtda o'tganini topamiz:

$\begin{cases} S = \frac{at_1^2}{2} \\ 5S = \frac{at_5^2}{2} \end{cases}$ ➡ sistemani bo'lib yuborsak : $t_5 = \sqrt{5}t_1$

$\begin{cases} S = \frac{at_1^2}{2} \\ 6S = \frac{at_6^2}{2} \end{cases}$ sistemani bo'lib yuborsak : $t_6 = \sqrt{6}t_1$

6-vagonning o'tish vaqti esa quyidagiga teng:

$$t = t_6 - t_5 = \sqrt{6}t_1 - \sqrt{5}t_1 = (\sqrt{6} - \sqrt{5})t_1 = (\sqrt{6} - \sqrt{5})\frac{t_0}{\sqrt{2}-1}$$

Javob: $\frac{(\sqrt{6}-\sqrt{5})}{\sqrt{2}-1}t_0$ Telegram: