Fizika

1 kurs

MAVZU: Suyukliklar mexanikasiga doir masalalar yechish.

O‘qituvchi:

“TIQXMMI” MTU FIZIKA va KIMYO KAFEDRASI

Ass. Suvonova Lola Suynovna

$$S_1\vartheta_1 = S_2\vartheta_2 = const.$$

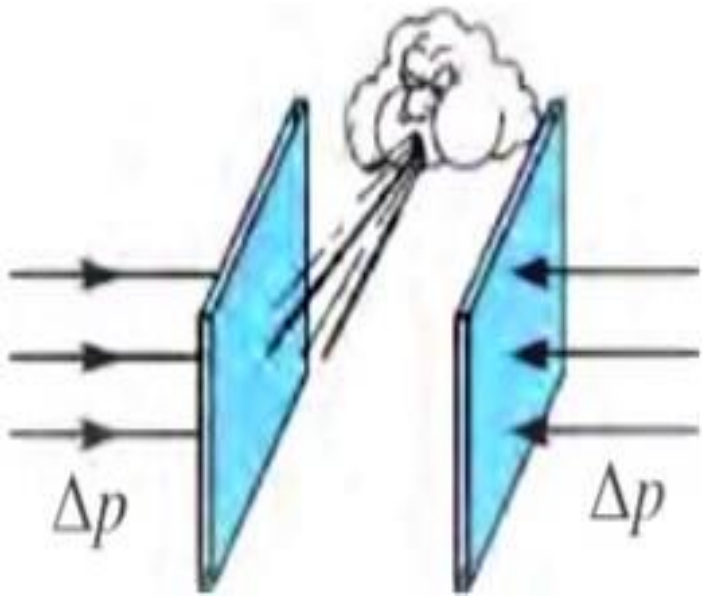
Oqim uzliksizligi tenglamasi

$$p_1 + \rho g h_1 + \frac{\rho\vartheta_1^2}{2} = p_2 + \rho g h_2 + \frac{\rho\vartheta_2^2}{2}$$

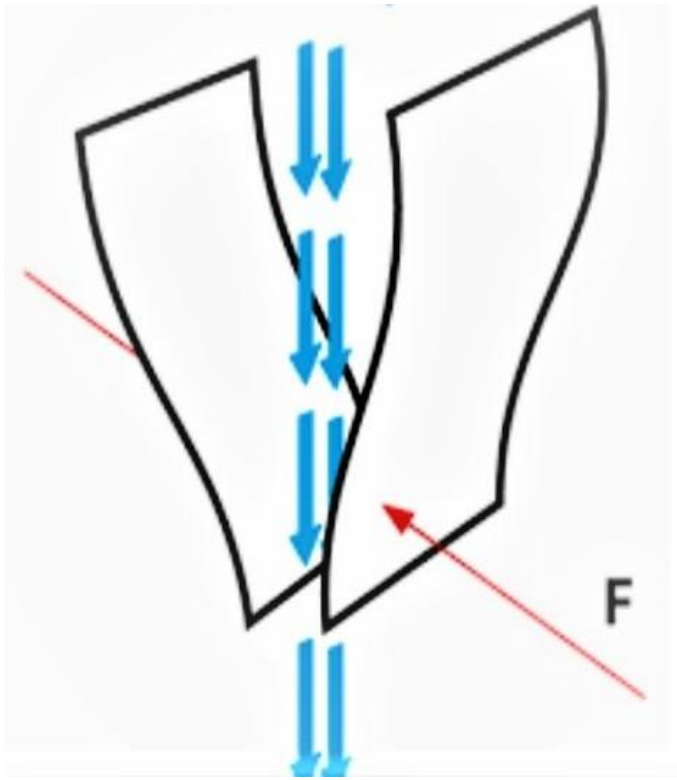
$$h_1 = h_2 \qquad p_1 + \frac{\rho\vartheta_1^2}{2} = p_2 + \frac{\rho\vartheta_2^2}{2}$$

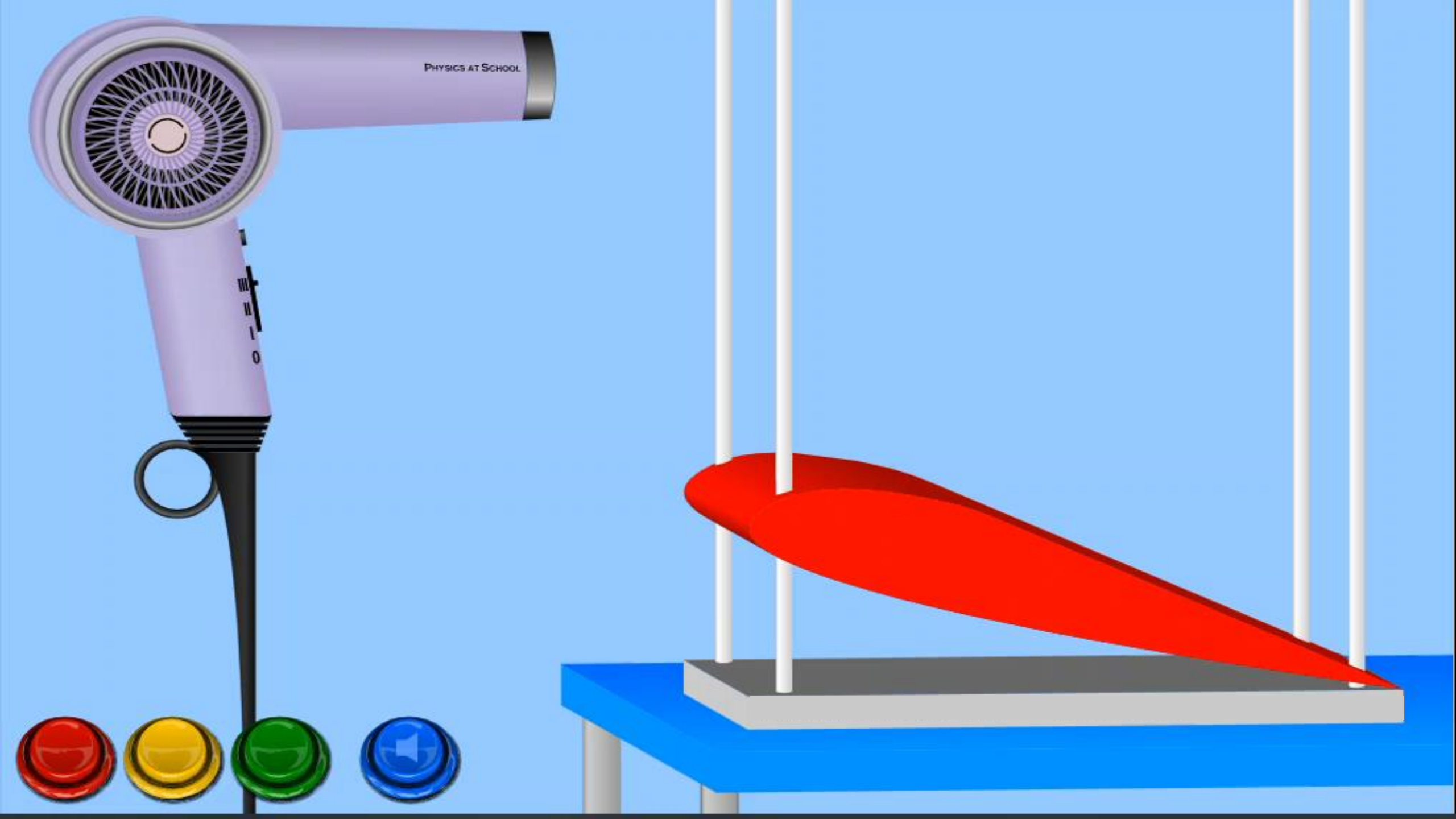
Bernulli tenglamasi

Dinamik bosim



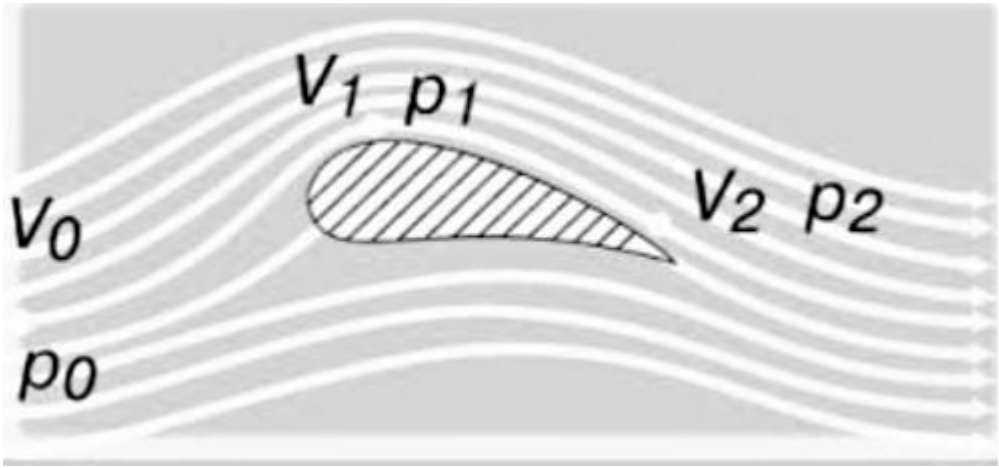
havo oqimi




PHYSICS AT SCHOOL

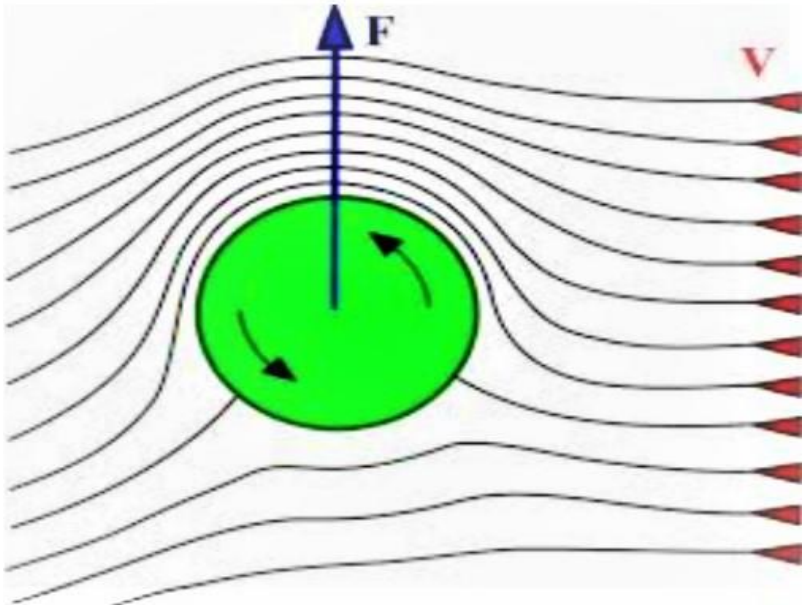
Samolyot qanotini ko‘taruvchi kuch

$$P = P_2 - P_1$$



Magnus effekti

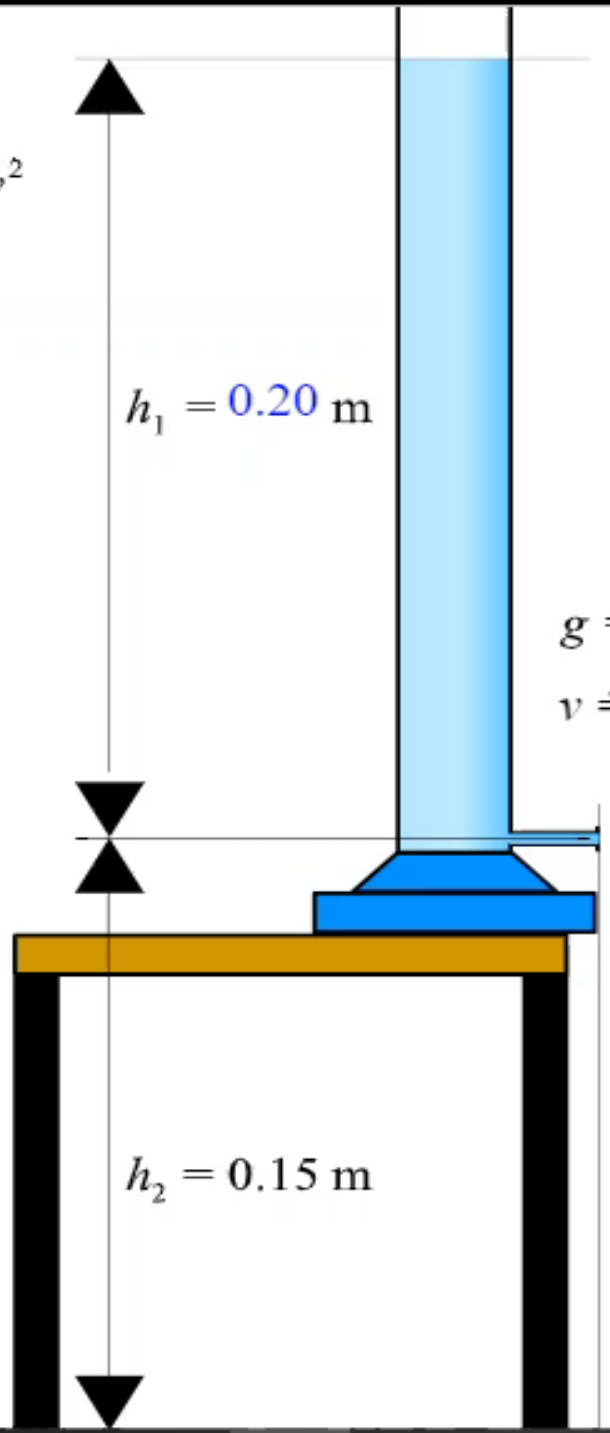
To‘pni chap va o‘ng tomonidagi havo oqimining tezligi o‘zgarishi natijasida bosimlar farqining yuzaga kelishi ***Magnus effekti*** deyiladi.



$p_h = p_d$

$h_1 \rho g = \frac{1}{2} \rho v^2$

$v = \sqrt{2 h_1 g}$



$g \doteq 10\,\mathrm{m \cdot s^{-2}}$

$v \doteq 0.00\ \mathrm{m \cdot s^{-1}}$

V

$x = vt$

$y = h_2 - \frac{1}{2} g t^2$

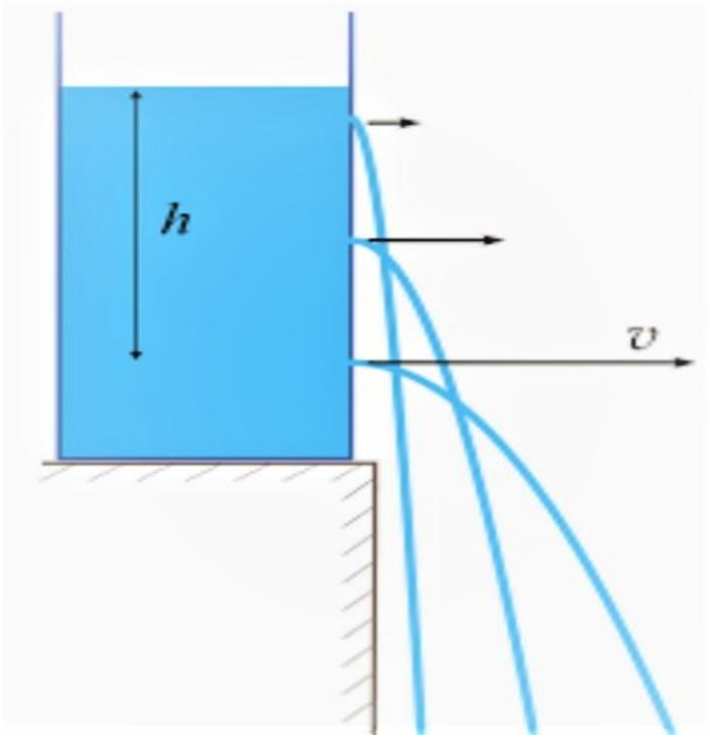
$\Rightarrow$ Парабола

$x^2 = -\frac{2v}{g}(y - h_2)$

$V = [\,0,\, h_2\,]$

$x \doteq 0.00$ m

Torrichelli formulasi



Idishdagi suyuqlikning ustki yuzasidagi bosim P_0 ga teng.

$$P_0 + \frac{\rho \vartheta^2}{2} = P_0 + \rho g h$$

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

Bu ideal suyuqlik uchun Torrichelli formulasi deyiladi.

Energiya va ish. Energiyaning saqlanish qonuni. Jismning qiya tekislik bo‘ylab harakatlanishida bajarilgan ish

Jismlarning absolyut elastik va noelastik to‘qnashishi

Jismlarning muvozanatda bo‘lish shartlari

Momentlar qoidasiga asoslanib ishlaydigan mexanizmlar

Aylanma harakat dinamikasi

Suyuqlik va gazlar harakati, oqimining uzluksizlik teoremasi. Bernulli tenglamasi

Harakatlanayotgan gazlar va suyuqliklarda bosimning tezlikka bog‘liqligidan texnikada foydalanish

Masala

Simobli barometrdagi simob ustunining balandligi 75 cm, qanday balandlikdagi suv ustuni xuddi shunday bosimni hosil qiladi?

$\rho_{simob} = 13600\ kg/m^3$, $\rho_{suv} = 1000\ kg/m^3$

Berilgan:

$h_1 = 75\ cm$

$\rho_1 = 13600\ kg/m^3$

$\rho_2 = 1000\ kg/m^3$

Topish kerak: $h_2 - ?$

Formula:

$p_1 = p_2$

$\rho_1 g h_1 = \rho_2 g h_2$

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

Yechish: $h_2 = \frac{13600\frac{kg}{m^3} \cdot 75\ cm}{1000\frac{kg}{m^3}} = 1020\ cm = 10{,}2\ m$

Javob: $h_2 = 10{,}2\ m$

Masala

Neft solinadigan bak tagidagi teshik silindrik propka bilan berkitilgan. Probkani tashqariga itarib chiqarish uchun 16 N kuch kerak.

Agar probkaning yuzasi $10\,cm^2$ bo‘lsa, bu bakka qanday balandlikkacha neft quyish mumkin?

Neftning zichligi $800\,\frac{kg}{m^3}$, $g = 10\,\frac{m}{s^2}$.

Berilgan:

$F = 16\ N$

$S = 10\ cm^2 = 0{,}001\ m^2$

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

$g = 10\ m/s^2$

Topish kerak: $h - ?$

Formula:

$$p = \frac{F}{S} \qquad p = \rho g h$$

$$\frac{F}{S} = \rho g h$$

$$h = \frac{F}{\rho g S}$$

Yechish:

$$h = \frac{16\ N}{800\frac{kg}{m^3} \cdot 10\frac{m}{s^2} \cdot 0{,}001\ m^2} = 2\ m$$

Javob: $h = 2\ m$

Masala

Qiyalik burchagi 45° bo‘lgan qiya tekislikdan jism yuqoriga ko‘tarilmoqda. Jism va qiya tekislik orasidagi ishqalanish koeffitsiyenti 0,3 bo‘lsa, qiya tekislikning FIK ni toping.

Berilgan:

$\alpha = 45°$

$\mu = 0{,}3$

Topish kerak: $\eta - ?$

Formula:

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

Yechish: $ctg45° = 1$

$$\eta = \frac{1}{1+0{,}3 \cdot 1} \cdot 100\ \% \approx 77\ \%$$

Javob: $\eta \approx 77\ \%$

Masala

Massasi 80 kg, hajmi 0,02 m^3 bo‘lgan jismni chuqurligi 4 m bo‘lgan hovuzdan butunlay chiqarib olish uchun qancha ish bajarish kerak?

$\rho_{suv} = 1000\ kg/m^3, \quad g = 10\frac{m}{s^2}$.

Berilgan:

$m = 80\ kg$

$V = 0{,}02\ m^3$

$\rho_s = 1000\ kg/m^3$

$g = 10\frac{m}{s^2}$

$h = 4\ m$

Formula:

$$A = FS = Fh$$

$$F = mg - F_A \qquad F_A = \rho_s V g$$

$$A = (mg - \rho_s V g)h$$

$$A = (m - \rho_s V)gh$$

Topish kerak: $A - ?$

Yechish: $A = \left(80\ kg - 1000\frac{kg}{m^3} \cdot 0{,}02\ m^3\right) \cdot 10\frac{m}{s^2} \cdot 4\ m = 2400\ J$

Javob: $A = 2400\ J$

Mustaqil bajarish uchun topshiriiqlar

1. Qiyalik burchagi 60° bo‘lgan qiya tekislikdan jism yuqoriga ko‘tarilmoqda. Jism va qiya tekislik orasidagi ishqalanish koeffitsiyenti 0,4 bo‘lsa, qiya tekislikning FIK ni toping.

2. Massasi 100 kg hajmi 0,01 m^3 bo‘lgan jismni chuqurligi 4 m bo‘lgan hovuzdan butunlay chiqarib olish uchun qancha ish bajarish kerak?

$$\rho_{suv} = 1000\ kg/m^3, \quad g = 10\,\frac{m}{s^2}\ .$$

Ideal siqilmaydigan suyuqliklarning harakatini aniqlash uchun Bernulli tenglamasi o'rinlidir:

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

bu yerda ρ – suyuqlikning zichligi, υ – trubaning berilgan kesimidagi suyuqlik harakatining tezligi, h – truba kesimining biror sathdan balandligi va p – bosim. Kichik teshikdan oqib chiqayotgan suyuqlikning tezligi Bernulli tenglamasiga asosan $v = \sqrt{2gh}$ ga tengdir, bunda h – teshikdan suyuqlik sathigacha bo'lgan balandlik. Trubaning ixtiyoriy ko'ndalang kesimidan teng hajmda suyuqlik o'tganligidan S_1 $\upsilon_1 = S_2$ υ_2 bo'ladi, bunda υ_1 va υ_2 – ko'ndalang kesimining yuzi S_1 va S_2 bo'lgan trubaning ikkita kesimidagi suyuqlikning tezligi.

Yopishqoq suyuqlikda (yoki gazda) tushayotgan kichik radiusli sharchaga ta’sir qiluvchi qarshilik kuchi Stoks formulasidan aniqlanadi:

$$F = 6\pi\eta r\upsilon.$$

bunda η – suyuqlik yoki gazning ichki ishqalanish koeffitsienti (dinamik yopishqoqlik), r – sharchaning radiusi, υ – uning harakat tezligi. Stoks qonuni faqat laminar harakat uchun o’rinlidir. Radiusi r va uzunligi l bo’lgan kapillyar trubadan t vaqt ichida laminar oqib o’tgan suyuqlikning (gazning) hajmi Puazeyl formulasidan aniqlanadi:

$$V = \frac{\pi r^4 \cdot t \cdot \Delta p}{8 l \eta}$$

bunda η – suyuqlikning (gazning) dinamik yopishqoqligi, Δp – truba uchlaridagi bosimlarning farqi.

Suyuqlik (gaz) harakatining xarakteri Reynoldsning o'lchamsiz sonidan aniqlanadi:

$$R_e = \frac{D\upsilon\rho}{\eta} = \frac{D\upsilon}{\nu}$$

bunda D – atrofidan suyuqlik (gaz) oqib o'tayotgan jismning chiziqli o'lchamini xarakterlab beruvchi kattalikdir, υ – oqimning tezligi, ρ – zichlik, η – dinamik yopishqoqlik. $\nu = \frac{\eta}{\rho}$ nisbatga kinematik yopishqoqlik deyiladi. Laminar harakatning turbulent harakatga o'tishidan aniqlanadigan Reynolds sonining kritik qiymati turli shakldagi jismlar uchun har xildir.

4.1. Trubaning ko'ndalang kesimidan yarim soatda 0,51 *kg* karbonat angidrid gazi oqib o'tganligi ma'lum bo'lsa, trubadagi gazning oqim tezligi topilsin. Gazning zichligini 7,5 kg/m^3 ga teng deb olinsin. Trubaning diametri 2 *sm* ga teng.

Berilgan:

m= $0{,}51\ kg$

$t = 0{,}5\ h = 1800\ s$

ρ= $7{,}5\ kg/m^3$

d = $2\ cm = 0{,}02\ m$

Formula:

m= ρV

$$l = \vartheta \cdot t \Rightarrow S = \frac{\pi d^2}{4} \Rightarrow$$

$$\Rightarrow m = \rho \frac{\pi d^2}{4} \vartheta t \Rightarrow \vartheta = \frac{4m}{\rho \pi d^2 t}$$

Topish kerak: ϑ −?

Yechish: $\vartheta = \frac{4 \cdot 0{,}51\ kg}{7{,}5\ kg/m^3 \cdot 3{,}14 \cdot (0{,}02m)^2 \cdot 1800s} = \frac{2{,}04\ kg}{16{,}956 \frac{kg}{m^3} m^2 s} =$

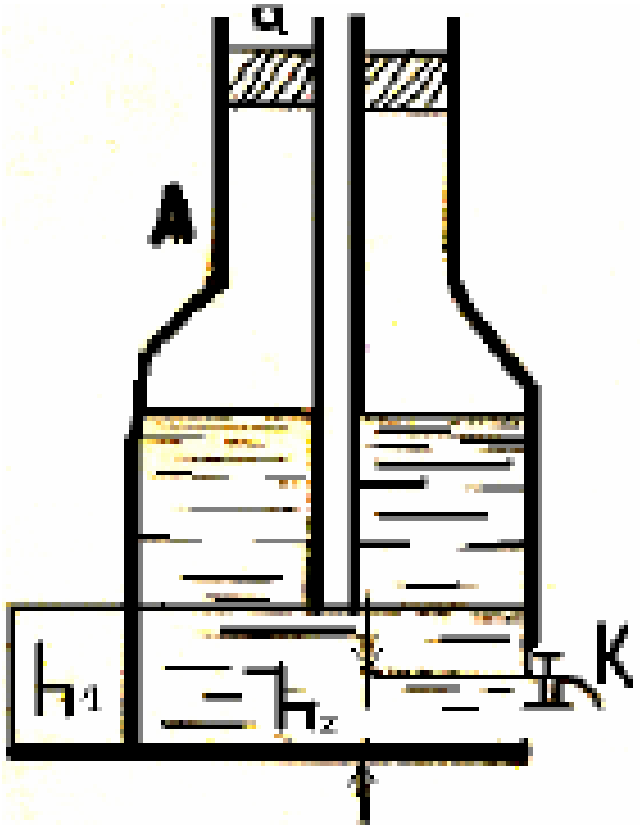
$= 0{,}12$ m\s

Javob: ϑ=0,12 m\s

4.2. Silindrsimon idishning asosida $d=1$ *sm* diametrli doiraviy teshik bor. Idishning diametri D =0,5 *m*. Idishdagi suv sathining pasayish tezligi υ ning suv sathining balandligi h ga bog'lanishi topilsin. h=0,2 *m* balandlik uchun bu tezlikning son qiymati topilsin.

4.3. Stol ustidagi suvli idishning yon sirtida idishning asosidan h_1 masofada va suvning sathidan h_2 masofada joylashgan teshigi bor. Idishdagi suvning sathi har doim o'zgarmas saqlanadi. Suv jarayoni stolga (gorizontal bo'ylab) qanday masofada tushadi? Masala 1) h_1 = 25 *sm* va h_2 = 16 *sm*, 2) h_1=16 *sm* va h_2 = 25 *sm* hollar uchun yechilsin.

4.4. Suv to'ldirilgan A idish (Mariott idishi) og'ziga mahkamlangan a shisha naycha orqali atmosfera bilan tutashtirilgan (5-rasm). Tubidan h_2 = 2 *sm* balandlikda idishning K jo'mragi bor. Truba a ning pastki uchi idish tubidan: 1) h_1 = 2 *sm*, 2) h_1 = 7,5 *sm* va 3) h_1 = 10 *sm* ga teng oraliqda bo'lgan hollarda K jo'mrakdan oqib chiqayotgan suvning tezligi topilsin.



5-rasm

4.5. Balandligi $h = 1$ *m* bo'lgan silindrsimon bakka suv to'ldirilgan. 1) Bakning tubidagi teshikdan qancha vaqtda suv to'liq oqib chiqadi? Teshikning ko'ndalang kesim yuzi bakning ko'ndalang kesim yuzidan 400 marta kichik. 2) Bu topilgan vaqtni, bakdagi suvning sathi teshikdan $h=1$ *m* balandlikda o'zgarmas holda saqlanganda (suv to'ldirib turilganda) teshikdan o'shancha suv oqib tushgungacha ketgan vaqt bilan solishtiring.

4.6. Idishga har 1 *sek* da 0,2 *l* suv quyila boriladi. Bunda idishdagi suvning sathi $h = 8{,}3$ sm ,balandlikda o'zgarmasdan qolishi uchun idish tubidagi teshikning *d* diametri qanday bo'lishi kerak?