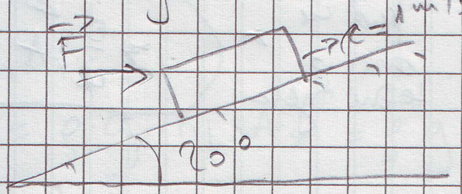
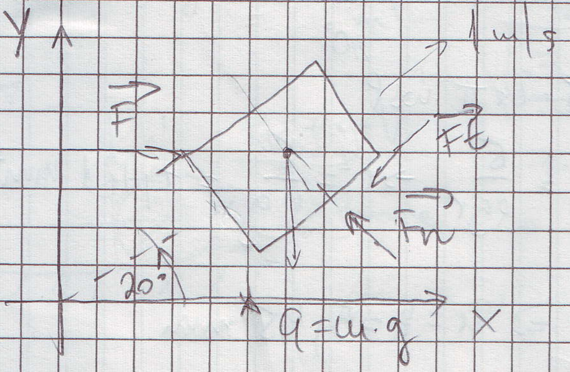
1. Blok mase 100 kg, duljine 50 cm, širine 20 cm, visine 30 cm, gura se konstantnom brzinom od 1 m/s po ravnoj nagnutoj površini, slika. Ukoliko je između bloka i površine sloj ulja debljine 0,4 mm, kolika je sila F? Dinamička žilavost ulja 0,012 Pas, $g = 9,81\ m/s^2$.
Težinu ulja zanemarite.



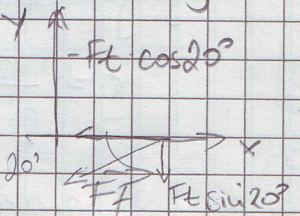
Suma svih sila mora biti 0.

$c = konst\ (=0) \Leftrightarrow \sum \vec{F_i} = 0$

? Sile → „slobodno tijelo"

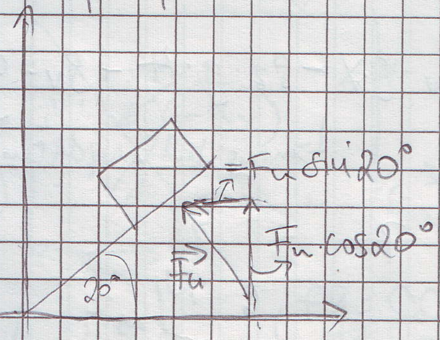


a) sila trenja



20° u suprotnom smjeru od x

b) reakcija podloge



$\sum F_x = 0 \rightarrow$

$F - F_t \cos 20° - F_n \sin 20° = 0$

$\sum F_y = 0$

$\rightarrow F_n \cos 20° - F_t \sin 20° - G = 0$

$F_t = \tau A = \mu \cdot \frac{c}{d} = \ldots = \boxed{3\ N}$

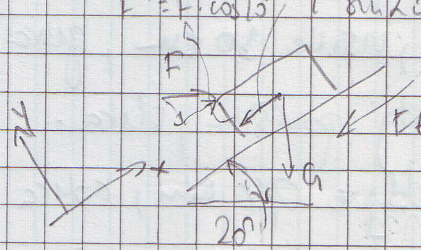
(A – površina, μ – din. viskoznost)

$$F_n = \frac{F_t \cdot \sin 20° + G}{\cos 20°} = \frac{3 \cdot \sin 20° + 981}{\cos 20°} = 1045,1\ N$$

$$F = F_t \cos 20° + F_n \sin 20° = 3 \cdot \cos 20° + 1045,1 \cdot \sin 20° = \boxed{360,3\ N}$$

2. način:

$F' = F \cdot \cos 20^\circ, \; G \cdot \sin 20^\circ$



$F' = F \cdot \cos 20^\circ = F_t + G \sin 20^\circ = 3 + 981 \sin 20$

$= 338{,}52\ N$

$F = \frac{338{,}52}{\cos 20^\circ} = \boxed{360{,}3\ N}$

KRAĆI POSTUPAK

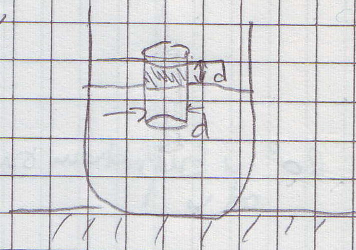
$F_t = \tau \cdot A = 3N$

$F_t = \tau \cdot A = \mu \cdot \frac{dc}{dt}$

kad se ono odnosi na težinu tijela $\Rightarrow \frac{c}{d} \cdot A$

$\frac{1}{4 \cdot 10^{-4}}$

(2.)



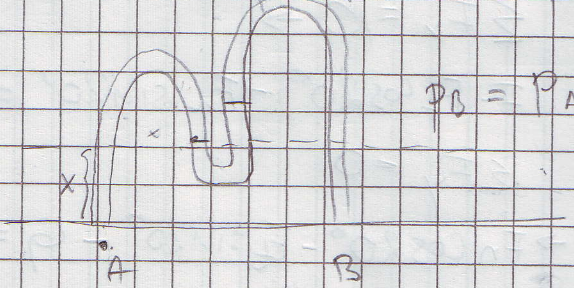
$H = d = 2r$

$\rho \cdot g \cdot r^2 \pi H = \sigma \cdot 2 r \pi \cos\theta^{\,0^\circ}$

$r = \frac{2\sigma}{\rho \cdot g \cdot H} = \frac{\sigma}{\rho g r} \Rightarrow r^2 = \frac{\sigma}{\rho \cdot g} = 7{,}421\ mm^2$

$r = 2{,}72\ mm \Rightarrow 2r = H = 5{,}45\ mm$

(3.) Kod uzdizanja tlak pada, kod spuštanja raste!

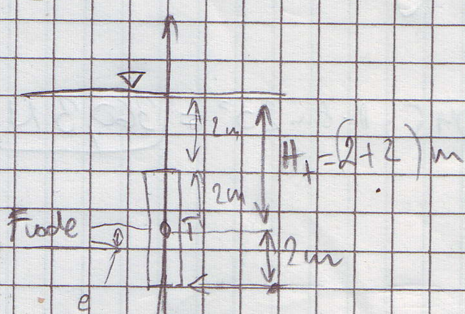


$p_B = p_A - \rho_v \cdot g X - \rho_z \cdot g \cdot H + \rho_v \cdot g (H + x)$

↳ minus kad se uzdižemo

$p_B = 150\,000 - (13\,600 - 1000) \cdot 9{,}81 \cdot 0{,}4 = \boxed{100\,557{,}6\ N/m^2}$

(4.) 1. ⇒ moment tromosti



$F_{vode} = \rho \cdot g \cdot H_t \cdot A = \rho \cdot g (2+2) \cdot \frac{\pi 4^2}{4}$

$= 493\,104{,}4\ N$

$e = \frac{I_0}{H_t \cdot A} = \left[I_0 = \frac{\pi \cdot r^4}{4} = \frac{\pi \frac{d^4}{16}}{4} = \boxed{\frac{\pi \cdot d^4}{64}} \right]$

$e = \frac{\frac{\pi d^4}{64}}{H_t \cdot A} = \frac{\frac{\pi d^{4\,2}}{64}}{\frac{4 \cdot \pi \cdot d^2}{4}} = \frac{4^2}{64} = \boxed{0{,}25\ m}$

$M_{F_{vode}} = F_{vode} \cdot e = 493104{,}4 \cdot 0{,}25 = 123276{,}1\ Nm$

$F \cdot 2 = 123276{,}1\ Nm \rightarrow \boxed{F = 61638{,}05\ N}$

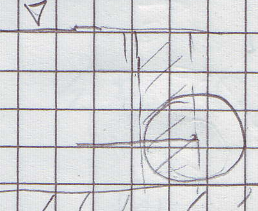
2m (koliki je krak ruke)

Drugi način: $M_{F_{vod}} = F_{vode} \cdot e = \rho g \cancel{h_T A} \cdot \frac{\frac{\pi d^4}{64}}{\cancel{h_T A}} = 1000 \cdot 9{,}81 \cdot \pi \cdot 4 = 123276{,}1\ Nm$

(5.) $F_{horiz.}$

$F_h = \rho \cdot g \cdot h_T \cdot A_x = \rho \cdot g \left(13 + \frac{2}{2}\right) \cdot 2 \cdot 10 = \boxed{2746{,}8\ kN}$

$F_{vert} = \rho \cdot g \cdot V = 1000\ \frac{kg}{m^3} \cdot 9{,}81\ m/s^2 \cdot \left(13 \cdot 2 \cdot 10 + \frac{1}{4} 2^2 \pi \cdot 10m\right) m^3 = \boxed{2858{,}79\ kN}$



$F_{vr} = \rho g V$

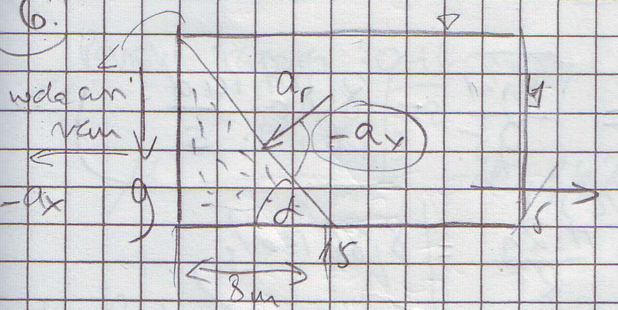
$\rho = \rho_{vode}$

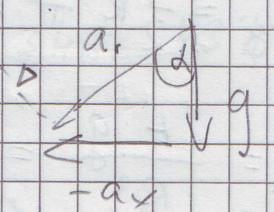
$F = \sqrt{F_h^2 + F_{vr}^2} = \boxed{3964{,}54\ kN}$

$tg\,\varphi = \frac{F_v}{F_h} = 1{,}041$

$\boxed{\varphi = 46{,}1^\circ}$

(6.)



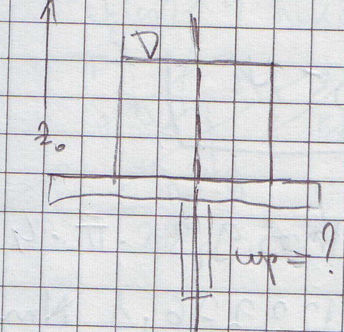


$a_x = 0{,}5\,g \qquad tg\,\alpha = \frac{a_x}{g} = 0{,}5$

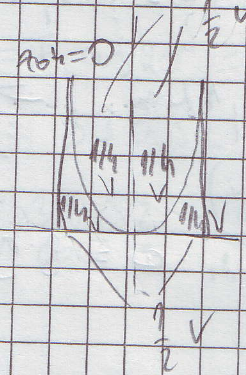
$x = \frac{4}{tg\,\alpha} = \frac{4}{0{,}5} = 8\ m$

$V = V_{uk} - V_{ost}$

$= 15 \cdot 5 \cdot 4 - \frac{1}{2} \cdot 8 \cdot 4 \cdot 5 = \boxed{220\ m^3}$

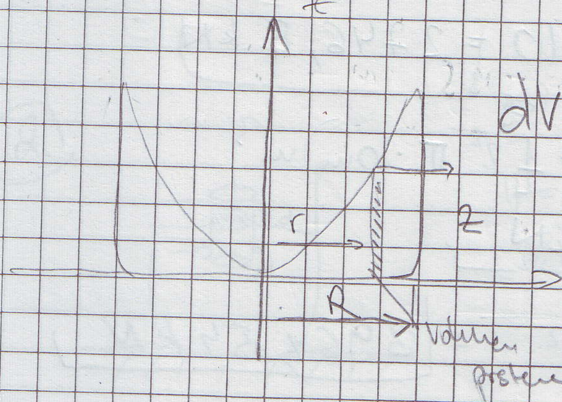


$\frac{1}{2}V$



$\omega_p \Leftrightarrow \frac{1}{2}V = ?$

manji R, manji z



$dV = 2r\pi \, dr \, z$

$z = \frac{r^2 \omega_p^2}{2g}$ jer je $z_{ok} = 0$

$V = \int_0^R 2\pi r \, dr \, \frac{r^2 \omega_p^2}{2g}$

$= \frac{\pi \omega_p^2 r^4}{4g}$

$V = \frac{1}{2} V_{mirujuće} = \frac{1}{2} R^2 \pi \cdot H = \frac{\pi \cdot \omega_p^2 \cdot r^4}{4g}$

$\omega_p^2 = \frac{2H \cdot g}{R^2} \Rightarrow \omega_p = \frac{\sqrt{2gH}}{R} = \frac{\sqrt{2g \cdot 1}}{0,5} = 8,86 \frac{rad}{s}$

Drugi način samo za ovaj slučaj (kad se radi o $V = 1/2$)

$z = \frac{\omega_p^2 r^2}{2g} \rightarrow z = H, \; r = R \quad \omega_p^2 = \frac{H \cdot 2g}{R^2} = 8,86 \, rad/s$

Betonske brane specif. težine

ZADATCI ostali koji nisu za ispit:

(1) $\gamma_B = \rho \cdot g = 23,6 \, kN/m^3$, slika, zadana je i razina vode. Koliki je minimalni koeficijent trenja između brane i podloge kako ne bi došlo do klizanja brane. Računajte s duljinom brane 1 m! Gustoća vode zadana.