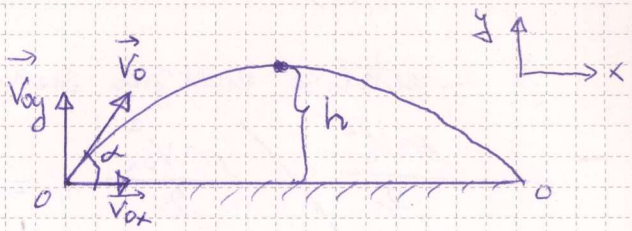
10. tunni ülesannete lahendused.

10-1 $\alpha = 60°$, $s = 6.0\,m$, v_0, h



Graafilt $v_0 = \frac{v_{oy}}{\sin\alpha}$, $v_0 = \frac{v_{ox}}{\cos\alpha}$, $v_{ox} = \frac{s}{t}$

(x-telje sihis liigub kivi ühtlase kiirusega)

y-telje sihis on liikumine kiirendusega g

1) Liikumis võrrand y-telje sihi

$$y = y_0 + v_{oy}\cdot t - \frac{gt^2}{2} \Rightarrow v_{oy}\cdot t = \frac{gt^2}{2} \Rightarrow$$

(y ja y_0 on 0, v_{oy} ja t on 0)

Kuna $v_{oy} = v_0 \sin\alpha$ ja $t = \frac{s}{v_{ox}} = \frac{s}{v_0\cos\alpha}$ siis

$$\Rightarrow \frac{v_0 \sin\alpha \cdot s}{v_0 \cos\alpha} = \frac{g s^2}{2 (v_0\cos\alpha)^2} \Rightarrow \frac{\sin\alpha}{\cos\alpha} = \frac{gs}{2 v_0^2 \cos^2\alpha} \Rightarrow$$

$$\Rightarrow \underline{v_0} = \sqrt{\frac{gs}{2\cos\alpha\cdot\sin\alpha}} = \underline{8.24\ m/s}$$

2) $h = ?$ Leian h energia jäävusest

$$E_p = E_k \Rightarrow mgh = \frac{m v_{oy}^2}{2} \Rightarrow$$

(v on kineetilise energia valemis v_{oy} !!!)

$$\Rightarrow \underline{h} = \frac{v_{oy}^2}{2g} = \frac{v_0^2 \sin^2\alpha}{2g} = \underline{2{,}60\ m}$$

(sest ta liigub v_{oy}-ga üles)

3) Kineetilise energia suhe

$$\frac{mv_0^2}{2} \Big/ \frac{mv_{0x}^2}{2} \Rightarrow$$

(korgusel h on tal ainult v_{0x} komponent)

$v_{0x} = v_0 \cos\alpha$

$$\Rightarrow \frac{v_0^2}{v_{0x}^2} = \frac{v_0^2}{v_0^2 \cos^2\alpha} = \frac{1}{\cos^2\alpha} = \underline{\underline{4,0}}$$

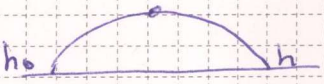
10-1 Teine võimalus leida h!

Liikumisvõrrand nr 3: $(v^2 - v_0^2 = 2as)$
y-telje suhtes:

Meie puhul: $v_{1y}^2 - v_{0y}^2 = -2gh \Rightarrow$
(v_{1y} = kiirus ülevalt kõrgusel h)

$v_{1y} = 0 \Rightarrow h = \dfrac{-v_{0y}^2}{-2g}$

v_{0y} leian 1. liikumisvõrrandist



$h = h_0 + v_{0y} \cdot t - \dfrac{gt^2}{2} \Rightarrow v_{0y} = \dfrac{gt}{2}$

(h ja h_0 on 0)

$t = \dfrac{s}{v_{0x}} = \dfrac{s}{v_0 \cos\alpha} = \dfrac{6}{8.24 \cdot \cos 60} = 1.46\,s$

$h = \dfrac{g^2 t^2}{4 \cdot 2 \cdot g} = \dfrac{gt^2}{8} = \dfrac{9.81 \cdot 1.46^2}{8} = 2.61\,m$

10-2 $m = 200g = 0.2kg$

$l = 30cm = 0,30m = r$

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f, $\frac{F_{alum}}{F_{paigal}}$

- Kaaluta oleki tekib siis, kui keha normaalkiirendus on võrdne raskuskiirendusega.

$mg = ma_n \Rightarrow g = a_n = \frac{v^2}{r} \Rightarrow v = \sqrt{gr}$

$T = \frac{1}{f} \Rightarrow f = \frac{1}{T}$, $T = \frac{t}{n}$

1 ringe ($n = 1$) $t = T$

$v = \frac{s}{t}$ ehk $v = \frac{s}{T}$, $s = 2\pi r$ (ringjoone pikkus)

$v = \frac{2\pi r}{T} \Rightarrow T = \frac{2\pi r}{v}$

$f = \frac{1}{T} = \frac{v}{2\pi r} = \frac{\sqrt{gr}}{2\pi r} = \frac{\sqrt{9,81 \cdot 0.30}}{2\pi \cdot 0.30} = 0,91 Hz$

- Paigalseisu korral $F_{paigal} = m \cdot g$ ($v = 0$, $F_{kt} = 0$)

Jõud alumises asendis:

$F_{alum} = F_r + ma_n = mg + \frac{mv^2}{r} =$

$= mg + \frac{mgr}{r} = 2mg$

$\Rightarrow$

$$\frac{F_{alum}}{F_{paigal}} = \frac{2\,mg}{mg} = 2$$

10-3 $m_1 = 100g = 0{,}1kg$

$v_1 = 2.4\ m/s$

$m_2 = 0{,}300\ kg$

$v_2 = 0\ m/s$

V, Mitu % energiast muundus põrkel siseenergiaks?

- Impulsi jäävuse seadus $p_{enne} = p_{pärast}$

$$m_1 \cdot v_1 + 0 = (m_1 + m_2)\, V \Rightarrow$$

$$\Rightarrow V = \frac{m_1 v_1}{m_1 + m_2} = \frac{0.100 \cdot 2.4}{0.100 + 0.300} = 0.60\ m/s$$

- 1 keha $\Rightarrow E_{k_1} = \frac{m_1 v_1^2}{2}$

2 keha $\Rightarrow E_{k_2} = 0$

kahe keha koos $\Rightarrow E_k = \frac{(m_1 + m_2) V^2}{2}$

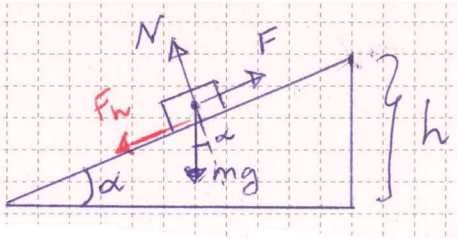
$$\frac{E_{k_1} - E_k}{E_{k_1}} = \frac{\frac{m_1 v_1^2}{2} - \frac{(m_1 + m_2) V^2}{2}}{\frac{m_1 v_1^2}{2}} \Rightarrow$$

$$1 - \frac{m_1}{m_1 + m_2} = 75\%$$

10-4 $\alpha = 30°$

$\mu = 0{,}25$

η



$\eta = \frac{A_{kas}}{A_k}$, A_{kas} = kasulik töö = mgh

A_k = kogutöö = $F \cdot s$

Leiame F!

Newtoni 2. seadus: $\Sigma F = m \cdot a$

$F - mg\sin\alpha - F_h = ma$ $\quad (a = 0)$, $F_h = N\mu =$

$F = mg\sin\alpha + mg\mu\cos\alpha$ $\quad = \mu mg\cos\alpha$

See jõud teeb tööd!

Jooniselt $\sin\alpha = \frac{h}{s}$ (s - kaldpinna pikkus)

$A_k = F \cdot s = mg[\sin\alpha + \mu\cos\alpha]\frac{h}{\sin\alpha} =$

$= mgh\left[1 + \frac{\mu\cos\alpha}{\sin\alpha}\right]$.

$\eta = \frac{A_{kas}}{A_k} = \frac{mgh}{mgh\left[1 + \frac{\mu\cos\alpha}{\sin\alpha}\right]} = \frac{1}{\left[1 + \frac{\mu\cos\alpha}{\sin\alpha}\right]} =$

$= 70\,\%$

10.5 $V_b = 18\,l = 18 \cdot 10^{-3}\,m^3$ (b - balloon)

$m_b = 9{,}3\,kg$

$\varrho_{tina} = 7{,}4 \cdot 10^3\,kg/m^3$

$\boxed{F_A = \varrho g V}$

$\varrho_{vesi} = 1000\,kg/m^3$

m_{tina} = ?

Tingimus $\boxed{F_r = F_A}$ (rasktus jõud = üleslükkejõud)

$F_r = (m_b + m_{tina}) \cdot g$

$F_A = \varrho_{vesi} \cdot g \cdot V_b + \varrho_{vesi} \cdot g \cdot V_{tina} =$

$= \varrho_{vesi} \cdot g \left(V_b + V_{tina}\right) = \varrho_{vesi} \cdot g \left(V_b + \frac{m_{tina}}{\varrho_{tina}}\right)$

$(m_b + m_{tina}) \cdot g = \varrho_{vesi} \cdot g \left(V_b + \frac{m_{tina}}{\varrho_{tina}}\right)$

$m_b + m_{tina} = \varrho_{vesi} \cdot V_b + \frac{\varrho_{vesi}}{\varrho_{tina}} m_{tina}$

$m_{tina}\left(1 - \frac{\varrho_{vesi}}{\varrho_{tina}}\right) = \varrho_{vesi} \cdot V_b - m_b$

$m_{tina} = \frac{\varrho_{vesi} \cdot V_b - m_b}{1 - \frac{\varrho_{vesi}}{\varrho_{tina}}} = 10{,}059\,kg$

$= \underline{10\,kg}$

10-6 $S = 12\ dm^2$, $m = 1{,}0\ t$ | p_0 - normaal õhk $= 1\ atm = 1013 \cdot 10^2\ Pa$

F, n

$\boxed{p_0 = \frac{F}{S}} \Rightarrow F = p_0 \cdot S = 1013 \cdot 10^2\ Pa \cdot 12 \cdot 10^{-2}\ m^2 =$

$= 1{,}216 \cdot 10^4\ N$

Algul oli vaakum sees
Nüüd on õhk sees ja veel auto surumine peale + õhurõhk

Sees: $\frac{F}{S} + p_0$ (rõhk), väljas: $\frac{F_r}{S} + p_0$ (rõhk)

Sees = väljas

$\frac{F}{S} + p_0 = \frac{F_r}{S} + p_0 \Rightarrow F = F_r$

$F = n\,mg \Rightarrow n = \frac{F}{mg} = \frac{1{,}216 \cdot 10^4\ N}{1 \cdot 10^3\ kg \cdot 9{,}8\ N/kg} =$

$= 1{,}24$

Vastus: 1,2 sõidukitot

10-7 $p = 2.0\ atm$, $k = 43\ kN/m$, $S = 45\ cm^2$, $m = 1.2\ kg$, Δl

$p = \frac{F}{S} \Rightarrow F = pS$

F_e - elastsusjõud

F_r - raskusjõud

Tingimus $F = p \cdot S = F_e + F_r$

$pS = k \cdot \Delta l + mg \Rightarrow \Delta l = \frac{pS - mg}{k} =$

$= \frac{2 \cdot 101300\ Pa \cdot 45 \cdot 10^{-4}\ m^2 - 1{,}2\ kg \cdot 9{,}8\ N/kg}{43 \cdot 10^3\ N/m} =$

$= 0.021\ m$ ehk $2{,}1\ cm$

10-8 $h = 4{,}22\ m$ (kõrgus)

$\ell = 11{,}5\ m$ (laius)

$p = 47{,}2\ m$ (pikkus)

$m_p = 12{,}1\ t$ (praami mass)

$\Delta\ell = 1{,}00\ m$

m_{last} = ?

$\rho_{vesi} = 1000\ kg/m^3$

$\boxed{F_A = \rho g V}$

Püsijeht: $\boxed{F_r = F_A}$ raskusjõud = ülestõukejõud

$(m_p + m_{last}) \cdot g = \rho_{vesi} \cdot g \cdot V$

$m_{last} = \rho_{vesi} \cdot V - m_p$

$V = h \cdot \ell \cdot p$ tapsemalt $\Rightarrow V = (h - \Delta\ell) \cdot \ell \cdot p$

$V = (4{,}22 - 1{,}00) \cdot 11{,}5 \cdot 47{,}2 = 1747{,}87\ m^3$

a) järvel $m_{last} = 1000\ \frac{kg}{m^3} \cdot 1748\ m^3 - 12{,}1 \cdot 10^3\ kg$

$= 1736000\ kg = \underline{1{,}74 \cdot 10^3\ t}$

b) meres, kus ρ_{vesi} on 1,02 korda suurem

$m_{last} = 1000\ \frac{kg}{m^3} \cdot 1{,}02 \cdot 1748\ m^3 - 12{,}1 \cdot 10^3\ kg =$

$= \underline{1{,}77 \cdot 10^3\ t}$

10-9 $T_1 = 80\ °C$

$c = 4{,}2\ kJ/kg\,°C$

$T_2 = 60\ °C$

$C_{termos} = 1{,}0\ kJ/K$

$\rho_v = \rho_{tee} = 1000\ kg/m^3$

V_{tee}

$Q_1 = cm\Delta T_1$ } $Q_1 = Q_2$ Tasvaal

$Q_2 = C\Delta T_2$ }

$\Delta T = T_{opp} - T_{dlg}$ ↓

$\Delta T_1 = 80°C - 60°C = 20°C$ vo $20\ K$

$\Delta T_2 = 60 - 20 = 40\ K$ (toatemp.)

(Teeliikuht 60 − 80 = −20 jahtub)

$cm\Delta T_1 = C\Delta T_2$

$c m_{tee} \Delta T_1 = C_{termos} \Delta T_2 \Rightarrow c\rho V \Delta T_1 = C\Delta T_2$

$V_{tee} = \dfrac{C\Delta T_2}{c\rho_{tee}\Delta T_1} = 4{,}762 \cdot 10^{-4}\ m^3$ ehk $0{,}476\ l$

$(1\ l = 10^{-3}\ m^3 = 1\ dm^3)$

10-10

$p = 97{,}0\ \text{kPa}$
$Q = 563\ \text{kJ}$
$\Delta U = 68{,}3\ \text{kJ}$

ΔV

jäävad rõhud ehk isobaariline protsess

Termodünaamika I seadus $\Delta U = Q - A$

$A = p\Delta V$

$\Delta U = Q - p\Delta V \Rightarrow \underline{\Delta V} = \frac{Q - \Delta U}{p} =$

$= \frac{563 \cdot 10^3\ \text{J} - 68{,}3 \cdot 10^3\ \text{J}}{97{,}0 \cdot 10^3\ \text{Pa}} = \underline{5{,}1\ \text{m}^3}$