AKADEMIA EDUKACYJNO - INŻYNIERSKA

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MATURA STUDIA PRAKTYKA STAŻ PRACA BIZNES PRZEMYSŁ STEAM

KOMPLEKSOWE WSPARCIE EDUKACYJNE **ON – LINE** NA KAŻDYM ETAPIE KSZTAŁCENIA INŻYNIERSKIEGO

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MECHANIKA II

"DYNAMIKA PUNKTU MATERIALNEGO – KULKA W RURCE"

PROJEKT

Oblicz:

- prędkość liniową
- nacisk
- ugięcie sprężyny

w punktach charakterystycznych toru ruchu poruszającej się kulki.

DANE:

$m,\ V_A,\ \tau,\ R,\ \mu,\ \beta,\ h_0,\ c = OK$

SZUKAM:

$V_B,\ V_C,\ V_D = ?$
$N_C = ?$
$h = ?$

31) D: $m = 0{,}5\ [kg]$ $\mu = 0{,}1$

$v_A = 0{,}8\ [m/s]$ $\beta = 30°$

$\tau = 0{,}1\ [s]$ $h_0 = 0$

$R = 0{,}2\ [m]$ $c = 1000\ [N/m]$

$v_B,\ v_C,\ v_D = ?$

$N_C = ?$

$h = ?$

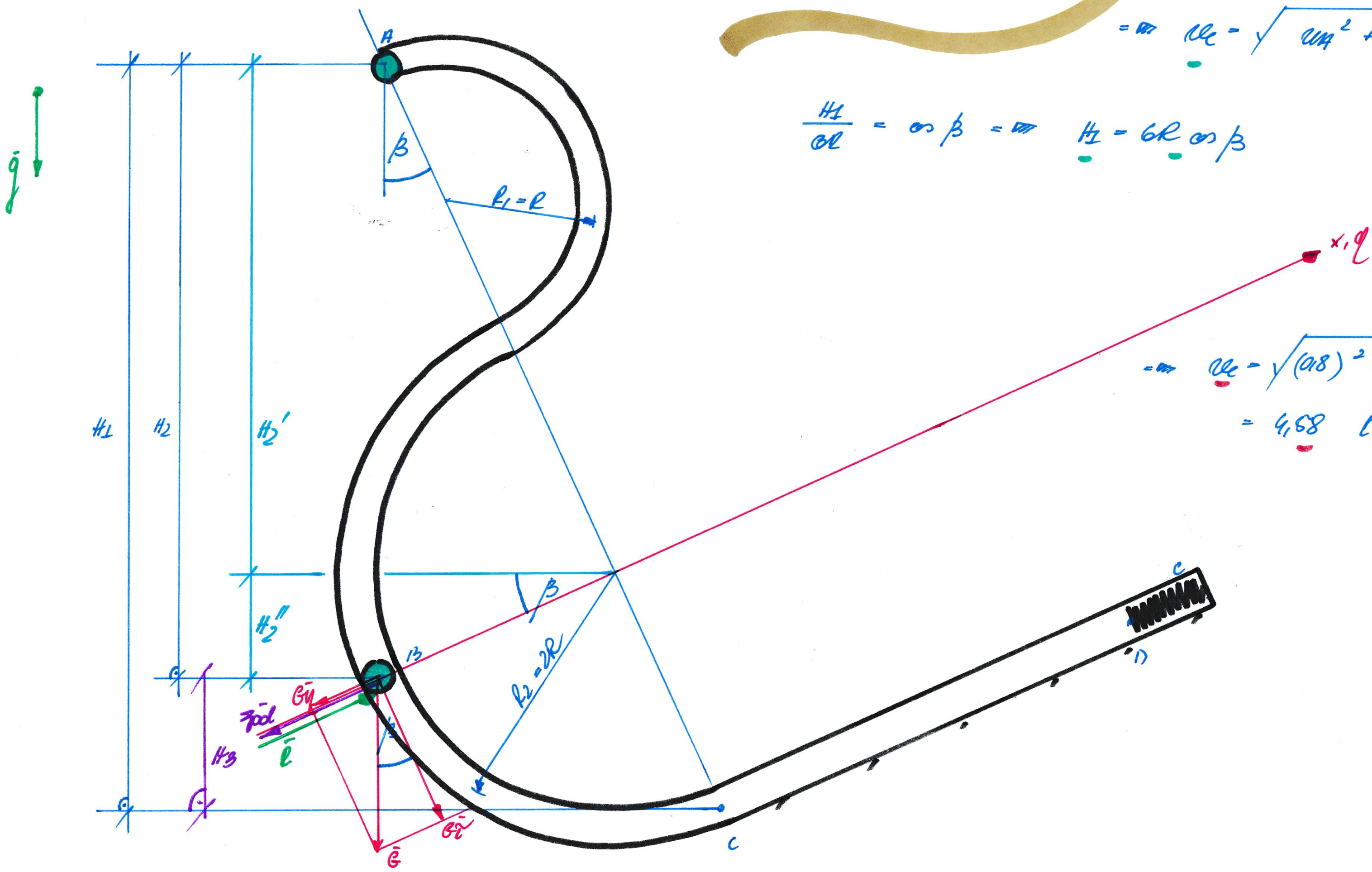
AC)

$\Delta E_K = \Delta E_P$

$\frac{1}{2}\cancel{m} v_C^2 - \frac{1}{2}\cancel{m} v_A^2 = \cancel{m} g H_1 \quad /\cdot 2$

$\Rightarrow v_C = \sqrt{v_A^2 + 2gH_1}$

$\Rightarrow v_C = \sqrt{v_A^2 + 12gR\cos\beta}$



$\frac{H_1}{6R} = \cos\beta \Rightarrow H_1 = 6R\cos\beta$

$\Rightarrow v_C = \sqrt{(0{,}8)^2 + 12 \cdot 9{,}81 \cdot 0{,}2 \cdot \cos 30°} =$

$= 4{,}68\ [m/s]$

AB)

$\Delta E_k = \Delta E_p$

$$\frac{1}{2}\cancel{m}v_B^2 - \frac{1}{2}\cancel{m}v_A^2 = \cancel{m}gH_2 \quad |\cdot 2$$

$$v_B = \sqrt{v_A^2 + 2gH_2}$$

$H_2 = H_2' + H_2''$

$$\frac{H_2'}{4R} = \cos\beta \Rightarrow H_2' = 4R\cos\beta$$

$$\frac{H_2''}{2R} = \operatorname{sen}\beta \Rightarrow H_2'' = 2R\operatorname{sen}\beta$$

$$\Rightarrow v_B = \sqrt{v_A^2 + 4gR(\operatorname{sen}\beta + 2\cos\beta)}$$

$$\Rightarrow v_B = \sqrt{(0{,}8)^2 + 4\cdot 9{,}81\cdot 0{,}2(\operatorname{sen}30^\circ + 2\cos30^\circ)} =$$

$$= 4{,}26 \quad [m/s]$$

CB)

$\Delta E_k = -\Delta E_p$

$$\frac{1}{2}\cancel{m}v_B^2 - \frac{1}{2}\cancel{m}v_C^2 = -\cancel{m}gH_3 \quad |\cdot 2$$

$$v_B = \sqrt{v_C^2 - 2gH_3}$$

$H_3 = H_1 - H_2$

$$H_3 = 6R\cos\beta - (2R\operatorname{sen}\beta + 4R\cos\beta) =$$

$$= 6R\cos\beta - 2R\operatorname{sen}\beta - 4R\cos\beta =$$

$$= -2R\operatorname{sen}\beta + 2R\cos\beta = 2R(-\operatorname{sen}\beta + \cos\beta)$$

$$\Rightarrow v_B = \sqrt{v_C^2 - 4gR(-\operatorname{sen}\beta + \cos\beta)}$$

$$\Rightarrow v_B = \sqrt{(4{,}58)^2 - 4\cdot 9{,}81\cdot 0{,}2(-\operatorname{sen}30^\circ + \cos30^\circ)} = 4{,}25 \quad [m/s]$$

$$v_D = \frac{m v_C - (G_x + T)\tilde{t}}{m}$$

$$\frac{G_x}{G} = \sin\beta \Rightarrow G_x = mg\sin\beta$$

$$\frac{G_y}{G} = \cos\beta \Rightarrow G_y = mg\cos\beta$$

$$\mu = \frac{F_T}{F_N} \Rightarrow T = \mu \cdot R = \mu G_y = \mu m g \cos\beta$$

$$\Rightarrow v_D = \frac{\cancel{m} v_C - \cancel{m}(\sin\beta + \mu\cos\beta) g \tilde{t}}{\cancel{m}}$$

$$v_D = v_C - (\sin\beta + \mu\cos\beta) g\tilde{t}$$

$$\Rightarrow v_D = 4{,}68 - (\sin 30^\circ + 0{,}1 \cos 30^\circ)\cdot 9{,}81 \cdot 0{,}1 =$$

$$= 4{,}58 - 0{,}58 = 4{,}00 \quad [m/s]$$

$$\sum F_{ix} = m\ddot{x} = -G_x - T$$

$$m\ddot{x} = -mg\sin\beta - \mu mg\cos\beta \quad |:m$$

$$\ddot{x}(t) = \overbrace{-g(\sin\beta + \mu\cos\beta)}^{=A}$$

$$\begin{cases} \text{I)}\ \ddot{x}(t) = A \\ \text{II)}\ \dot{x}(t) = At + C_1 \\ \text{III)}\ x(t) = \frac{1}{2}At^2 + C_1 + C_2 \end{cases}$$

$$\begin{cases} \text{II)}\ \dot{x}(t=0) = v_C \\ \text{III)}\ x(t=0) = x_C = 0 \end{cases}$$

$$\begin{cases} \text{II)}\ v_C = A(0) + C_1 \\ \text{III)}\ 0 = \frac{1}{2}A(0)^2 + C_1(0) + C_2 \end{cases}$$

$$\begin{cases} \text{II)}\ C_1 = v_C \\ \text{III)}\ C_2 = 0 \end{cases}$$

$$\Rightarrow \begin{cases} \text{I)}\ \ddot{x}(t) = A \\ \text{II)}\ \dot{x}(t) = At + v_C \\ \text{III)}\ x(t) = \frac{1}{2}At^2 + v_C t \end{cases}$$

$\tilde{t}$ – TIME of MOTION

$$\begin{cases} \text{II)}\ \dot{x}(t=\tilde{t}) = v_D \\ \text{III)}\ x(t=\tilde{t}) = |CD| \end{cases} \Rightarrow \begin{cases} \text{II)}\ v_D = A\tilde{t} + v_C \\ \text{III)}\ |CD| = \frac{1}{2}A\tilde{t}^2 + v_C\tilde{t} \end{cases} \quad 2?$$

e)

$\sum \bar{F}_{iy} = m \bar{a}_y^{\,0} = -\bar{G}_y - \bar{F}_{od} + \bar{e}$

$0 = -G_y - F_{od} + e$

$e = G_y + F_{od}$

$\Rightarrow \quad e = mg \cos\beta + \dfrac{m v_\beta^2}{l_2} =$

$= m\left(g\cos\beta + \dfrac{v_A^2 + 4gR(\sin\beta + 2\cos\beta)}{2R}\right)$

$\Delta E_K = -\Delta E_P$

$\frac{1}{2}\cancel{m} v_D^2 - \frac{1}{2}\cancel{m} v_C^2 = -\cancel{m} g H_3 \quad / \cdot 2$

$v_D = \sqrt{v_C^2 - 2gH_3}$

$\bar{F} = m \cdot \bar{a}$

$F = m \cdot \dfrac{dv}{dt} \quad / \cdot dt$

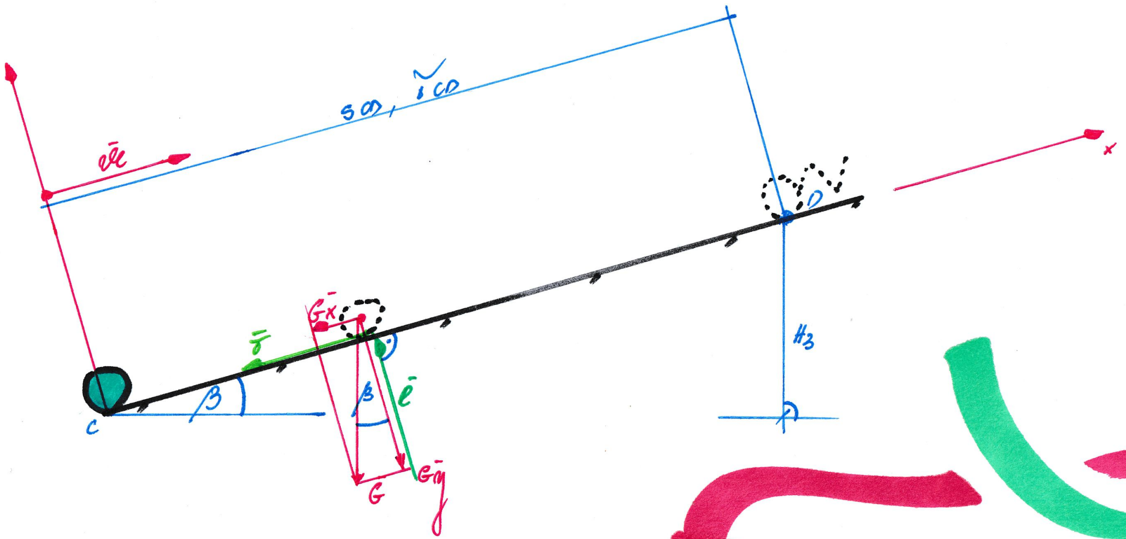
$F \cdot dt = m \cdot dv \quad / \int$

$F \int dt = m \int dv$

$F \cdot t = m \cdot v$

$\sum F_{ix} \cdot t = \Delta m v$

d)



$(-F - G_x)\tilde{t} = m v_D - m v_C \quad \Rightarrow \quad v_D = \dfrac{m v_C - (F + G_x)\tilde{t}}{m}$

$$\text{II)}\quad v_D = -g(\sin\beta + \mu\cos\beta)\tau + v_C$$

$$\text{III)}\quad |CD| = -\frac{1}{2}g(\sin\beta + \mu\cos\beta)\tau^2 + v_C\tau$$

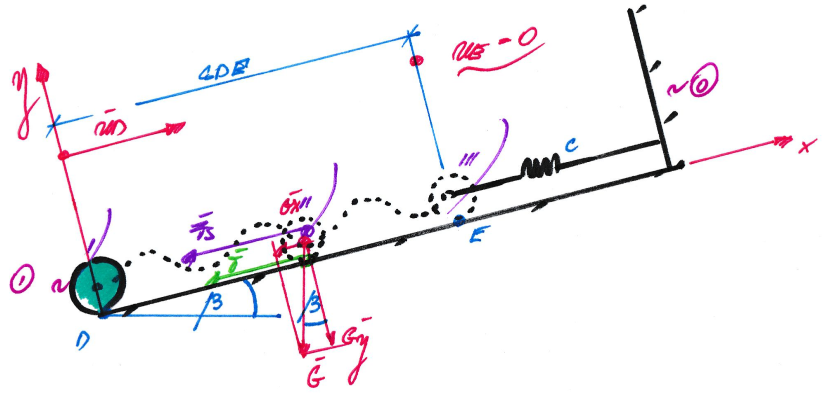
$$v_D = -9{,}81(\sin 30^\circ + 0{,}1\cos 30^\circ)\cdot 0{,}1 + 4{,}58$$

$$|CD| = -\frac{1}{2}\cdot 9{,}81(\sin 30^\circ + 0{,}1\cos 30^\circ)(0{,}1)^2 + 4{,}58\cdot 0{,}1$$

$$v_D = 4{,}00 \ [m/s]$$

$$|CD| = 0{,}42 \ [m]$$

DE)



$\Delta E_K = -\Delta E_P$

$$\frac{1}{2}\cancel{m}v_D^2 - \frac{1}{2}\cancel{m}v_C^2 = -\cancel{m}gH_3 \quad /\cdot 2$$

$$v_D = \sqrt{v_C^2 - 2gH_3}$$

$$\frac{H_3}{|CD|} = \sin\beta \Rightarrow H_3 = |CD|\sin\beta$$

$$\Rightarrow v_D = \sqrt{v_C^2 - 2g|CD|\sin\beta}$$

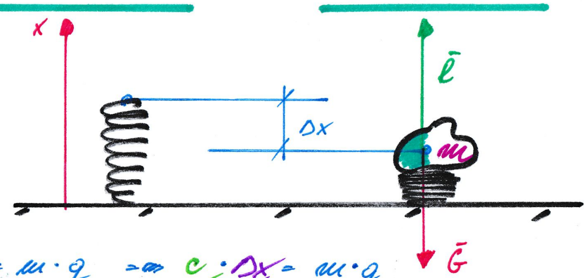
$$\Rightarrow v_D = \sqrt{(4{,}58)^2 - 2\cdot 9{,}81\cdot 0{,}42\cdot\sin 30^\circ} = 4{,}00 \ [m/s]$$

$\Delta E_K = \Delta W(x)$

$$\frac{1}{2}m v_E^2 - \frac{1}{2}m v_D^2 = (-G_x - \bar{T} - \bar{F}_S)\cdot |DE| \quad /(-1)$$

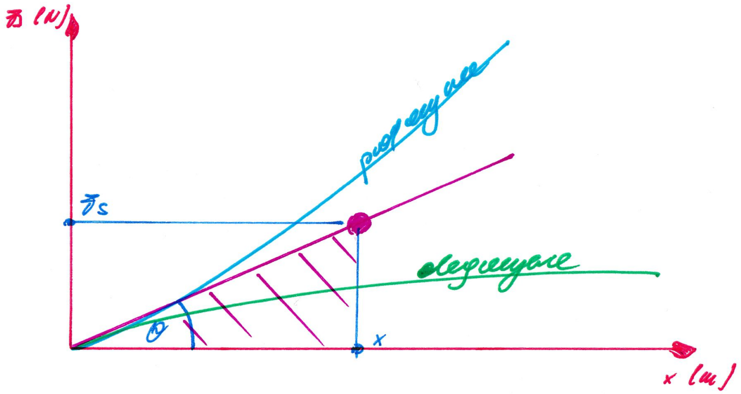
$$\Rightarrow |DE| = \frac{m v_D^2}{2(G_x + T + F_S)}$$

$\Sigma F_{ix} = 0 \Rightarrow R - G = 0$



$$\Rightarrow R = m\cdot g \Rightarrow c\cdot\Delta x = m\cdot g$$

$$\frac{1}{2} m v_0^2 = (G_x + T + F_s) \cdot h$$



$$\overset{k}{\frac{F_s}{x}} = \operatorname{tg}\theta$$

$$W = \frac{1}{2} \cdot F_s \cdot x = \frac{1}{2} k \cdot x \cdot x = \frac{1}{2} k x^2$$

$$\Rightarrow \frac{1}{2} m v_0^2 = \Big(mg \sin\beta + \mu mg \cos\beta + \overset{\frac{1}{2}kh^2}{(k \cdot h) \cdot h}\Big)$$

$$\frac{1}{2} m v_0^2 = mg \sin\beta \cdot h + \mu mg \cos\beta \cdot h + \frac{1}{2} k h^2$$

$$\overset{A}{\frac{1}{2} k} h^2 + \overset{B}{(mg \sin\beta + \mu mg \cos\beta)} h \overset{C}{\left(- \frac{1}{2} m v_0^2\right)} = 0$$

$$h = \ldots$$