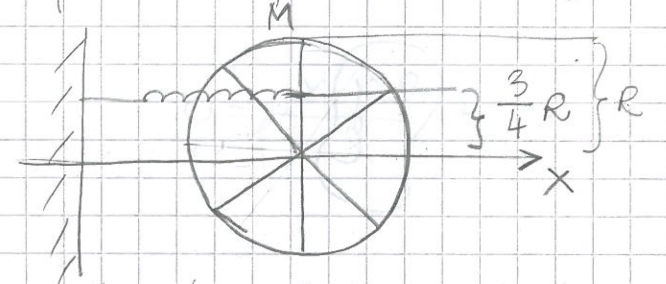
MASS IZ FIZIKE 2

26.10.11.
by queenm

ELASTIČNOST → TITRANJE → VALOVI

Metoda rješavanja zadataka

1. čitanje (ključne stvari)
2. čitanje (uz razumijevanje)
3. skica rješenja (dog. u realnosti)
4. rješavanje (formule i računski dio)
5. PROVJERA



1. MI 2010.

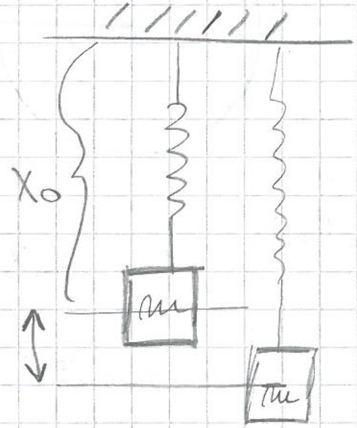
Kotač se sastoji od tankog homogenog obruča koji ima svoju masu (2,6 kg) polumjera r i 6 žbica. Svaki dio žbice je mase 0,1 kg. Na kotač je pričvršćena opruga konst. $k = 25 \frac{N}{m}$ na $r = \frac{3}{4}R$. Koliki je period malih titraja (MALA AMPLITUDA)

$M = 2{,}6\ kg$ $r = \frac{3}{4}R$ $N = 6$ žbica

$m = 0{,}1\ kg$

$k = 25 \frac{N}{m}$

	FIZ	MAT
	x	$x(t)$
DER.	$\dot{x}$	$x'(t)$
2. DER.	$\ddot{x}$	$x''(t)$



$m\ddot{x} = -kx$

$m\ddot{x} + kx = 0 \quad / : m$

$\ddot{x} + \boxed{\frac{k}{m}} x = 0$

$\hookrightarrow \omega^2$

FREKVENCIJA

DEF.

$\ddot{\varphi} + k \cdot \sin\varphi = 0$

$\sin\varphi \approx \varphi$ za male kuteve!

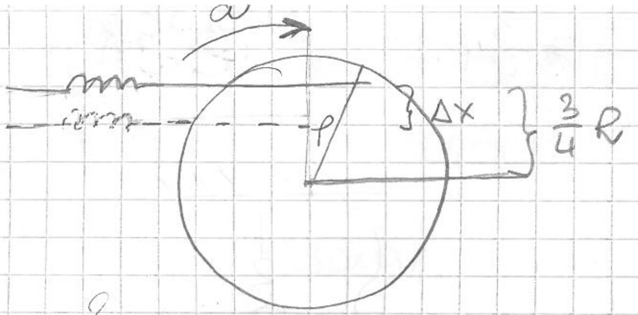
$\ddot{\varphi} + k \cdot \varphi = 0$

ZADATAK:

$E_{uk} = E_k + E_p$

$E_k = \frac{I\omega^2}{2} \qquad E_p = \frac{kx^2}{2}$

$E_{uk} = \frac{I\omega^2}{2} + \frac{kx^2}{2}$



$$\omega = \frac{d\varphi}{dt}$$ ↳ kutna brzina

?

$$l = \varphi \cdot R \Rightarrow \Delta x = d\varphi \cdot r$$

$$\left.\begin{aligned} \Rightarrow d\varphi &= \frac{dx}{r} \\ \omega &= \frac{d\varphi}{dt} \end{aligned}\right\} \omega = \frac{dx}{r \cdot dt}$$

$$\omega = \frac{dx \cdot 4}{3\, dt\, R} = \boxed{\frac{4}{3R} \cdot \frac{dx}{dt}}$$

$$\frac{I\omega^2}{2} + \frac{kx^2}{2} = Ek$$

$$\frac{kx^2}{2} + \frac{1}{2} \cdot \left(\frac{4}{3} \cdot \frac{1}{R} \frac{dx}{dt}\right)^2 = Ek$$

$$\frac{kx^2}{2} + \frac{1}{2} \cdot \left(\frac{4}{3} \cdot \frac{1}{R}\right)^2 \cdot (\dot{x})^2 = Ek \quad \Big/ \frac{d}{dx} \, !$$

$$\frac{k}{\cancel{2}} \cdot \cancel{2} \cdot x \cdot \dot{x} + \frac{1}{\cancel{2}} \cdot \cancel{2} \cdot \dot{x} \cdot \ddot{x} \cdot \frac{1}{r^2} = 0$$

$$\underline{\underline{x = f(t)}}$$

$$0 = kx\dot{x} + \frac{1}{r^2} \dot{x}\ddot{x}$$

$$0 = \dot{x}\underbrace{\left(kx + \frac{1}{r^2} \cdot \ddot{x}\right)}_{0}$$

$$\dot{x} = 0$$

$$kx + \frac{1}{r^2} \cdot \ddot{x} = 0$$

TITRANJE !!!
(MALI TITRAJI)!

$$x + \frac{1}{r^2 \cdot k} \ddot{x} = 0$$

$$\ddot{x} + \frac{r^2 \cdot k}{I} \cdot x = 0$$

$$\Rightarrow \omega = \sqrt{\frac{r^2 \cdot k}{I}} = r \cdot \sqrt{\frac{k}{I}}$$

$$\omega = \frac{3}{4} R \cdot \sqrt{\frac{k}{I}}$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{\frac{3R}{4} \frac{\sqrt{k}}{\sqrt{I}}} = \frac{2\pi \cdot 4\sqrt{I}}{3R\sqrt{k}} = \frac{8\pi}{3R}\sqrt{\frac{I}{k}}$$

$I = I_0 + I_{\check{s}}$

$$\boxed{I = 2 \cdot m_{\check{s}} + m_0}$$

masa štapa

$\Rightarrow T = \frac{8\pi}{3R} \sqrt{\frac{2m_{\check{s}} + m_0}{k}}$

1 štap = 2 žbice = 0.2 kg

$\Rightarrow \boxed{T = 2.8\ s}$

2. $m = 2\,kg$

$T_0 = 7\,s$

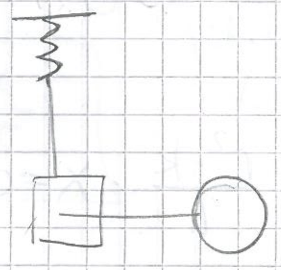
$A = \frac{1}{5} A_0$

$\omega_0 = \omega_R$

$A_r = 33\,cm$

$F_p = 0.3\,N$

$$A = \frac{f_p}{\sqrt{(\omega_0^2 - \omega^2) + 4\delta^2\omega^2}} = \frac{F_p/m}{\sqrt{(\omega_0^2-\omega^2) - 4\delta^2\omega^2}}$$



$X(t) = A_0 \sin \omega_0 t$ - jednadžba titranja

$x(t) = \left[A_0 \cdot e^{-\delta t}\right] \cdot \sin \omega_0 t$

PRIGUŠENJE $= A$

$\frac{1}{5} \cancel{A_0} = \cancel{A_0} \cdot e^{-\delta t}$ $\Rightarrow \delta = 0.23\ \frac{1}{s}$

- za prigušenje

$$\omega = \sqrt{\omega_0^2 - 2\delta^2}$$

- vanjska sila: ima istu frekv. kao i ω_0

$$\Rightarrow A_r = \frac{F_p/m}{2\delta\sqrt{\omega_0^2 - \delta^2}}$$

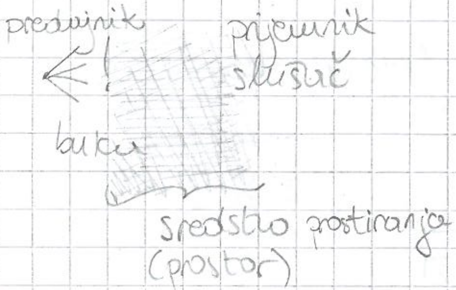
$\Rightarrow \omega_0 = \ldots$

$$\omega = \sqrt{\omega_0^2 - 2\delta^2} = 0.153\ Hz$$

$$\boxed{\omega = 2\pi f}$$

DOPLEROV EFEKT

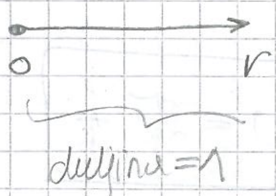
- razlika: SREDSTVO



- relativistički doplerov efekt

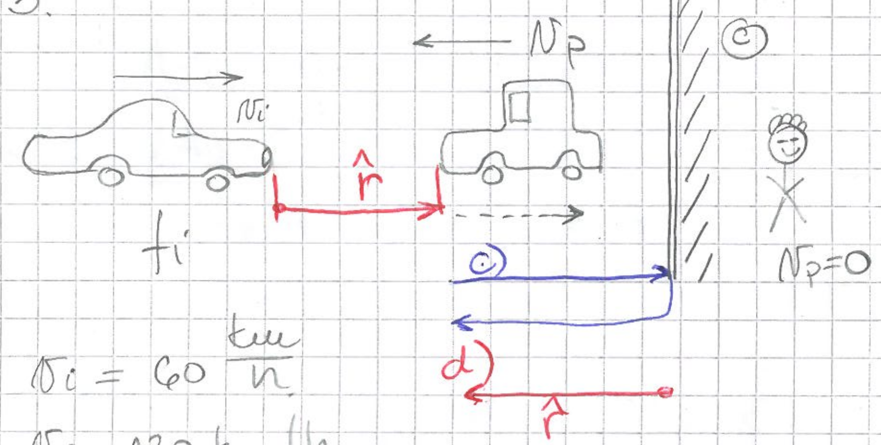
ne postoje sredstvo kroz koje se val prostire

$$f_p = f_i \frac{v_z + \hat{r}\,\vec{v_i}}{v_z - \hat{r}\,\vec{v_i}}$$



1. ODREDITI VEKTOR!!

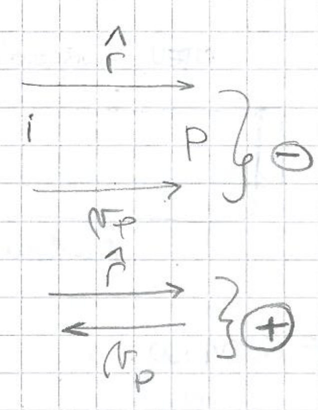
3.

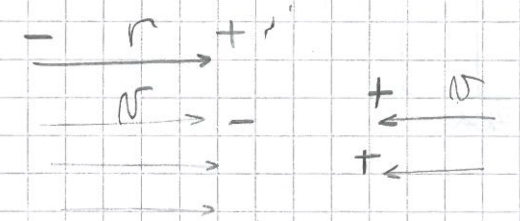


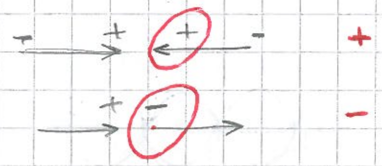
$v_i = 60 \frac{km}{h}$

$v_p = 120$ km/h

a) $f_p = f_i \frac{v_z + v_p}{v_z - v_i}$







b) $f_p = f_i \frac{v_z - v_p}{v_z + v_i} = 215\ Hz$

c) $v_p = 0$

$f_{zid} = f_i \frac{v_z - 0}{v_z - v_i} = 263\ Hz$

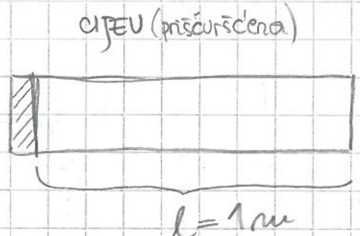
↳ prijamni frekv.

d) v

f_{zid}: predajna frekvencija!

$f_a = f_{zid} \frac{v_z - v_p}{v_z - 0} = 237\ Hz$

Z1 ② zadatak



$\boxed{n=1}$

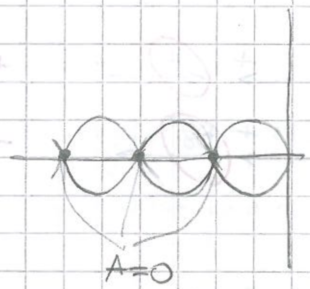
TITRA OSNOVNOM FREKV. → $\boxed{\lambda_c = \frac{\lambda}{4}}$

$m_ž = 0.01\,kg$

$v_ž = 340\,\frac{m}{s}$

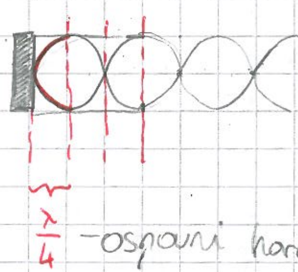
stojni val ⇒ zbroj 2 vala

- u točkama $A=0$



$L = \frac{\lambda}{2} \cdot n$ — koji je harmonik

BRZINA VALA



$\frac{\lambda}{4}$ - osnovni harmonik!

- brzina širenja deformacije

↑ brzina (titranja) čestice (POZICIJA STACIONARNA)

→ horizontalna brzina (VRIJEME STACIONARNO)

$L = \frac{\lambda}{4}\underbrace{(2n-1)}_{\text{NEPARNI HARMONICI}}$

* žičani zvuk. (žica titra i stvara stojni val unutar cijevi!)

$F = ?$ (napetost žice!)

$L = \frac{\lambda}{2} \Rightarrow \boxed{\lambda = 2L}$

$v_ž = \sqrt{\frac{F}{\mu}}$ - $\xrightarrow[\text{brzina vala}]{\text{horiz.}}$ širenje vala kroz VRIJEME

$\mu = \frac{m_ž}{L}$

$x(t) = A \sin \omega t$ |'

$x'(t) = A\omega \cos \omega t$ ↓↑ vertikalna brzina!

$V_ž = \lambda_ž f$ $f_c = f_ž$

$v_ž = \lambda_c \cdot f$ $\lambda_c \neq \lambda_ž$ (ZBOG BRZINE)

$\boxed{\lambda_c = \frac{\lambda}{4}}$ → brzina zvuka → brzina žice

$l = \frac{\lambda_c}{4}$

$v_z = \lambda_c \cdot f$

$\lambda_c = \frac{v_z}{f} \Rightarrow \boxed{l = \frac{v_z}{4 \cdot f}} \Rightarrow f = \frac{v_z}{4 \cdot l}$

$v_z = 2L \cdot \frac{1}{4} \cdot \frac{v_z}{l}$

$v_z = \sqrt{\frac{F}{\mu}} \Rightarrow F = \mu v_z^2$

$$\boxed{F = \mu \cdot \left(\cancel{2} \cdot \frac{L}{\cancel{4}} \cdot \frac{v_z}{l}\right)^2} = \mu \frac{L^2}{4} \frac{v_z^2}{l^2} = 86{,}7N$$

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* F-JE 2 varijabli $\underline{\underline{y[x,t]}}$
  prostora i vremena

A - ampl. 1 vala koji doleti da bi se form. stojni val

$A = 5cm = 2A$!

FORMULA: PR.

$y = 2A$ ... ampl. osnovnog vala !

ampl. stojnog vala

Formula iz podsjetnika:

STOJNI VAL $y[x,t] = A\cos[kx + \varphi_1]\cos[\omega t + \varphi_2]$

HARMONIČKI VAL:

$y[x,t] = A\cos[kx \pm \omega t + \varphi]$