Raziskovanje sil pri gibanju teles z uporabo mobilnega telefona

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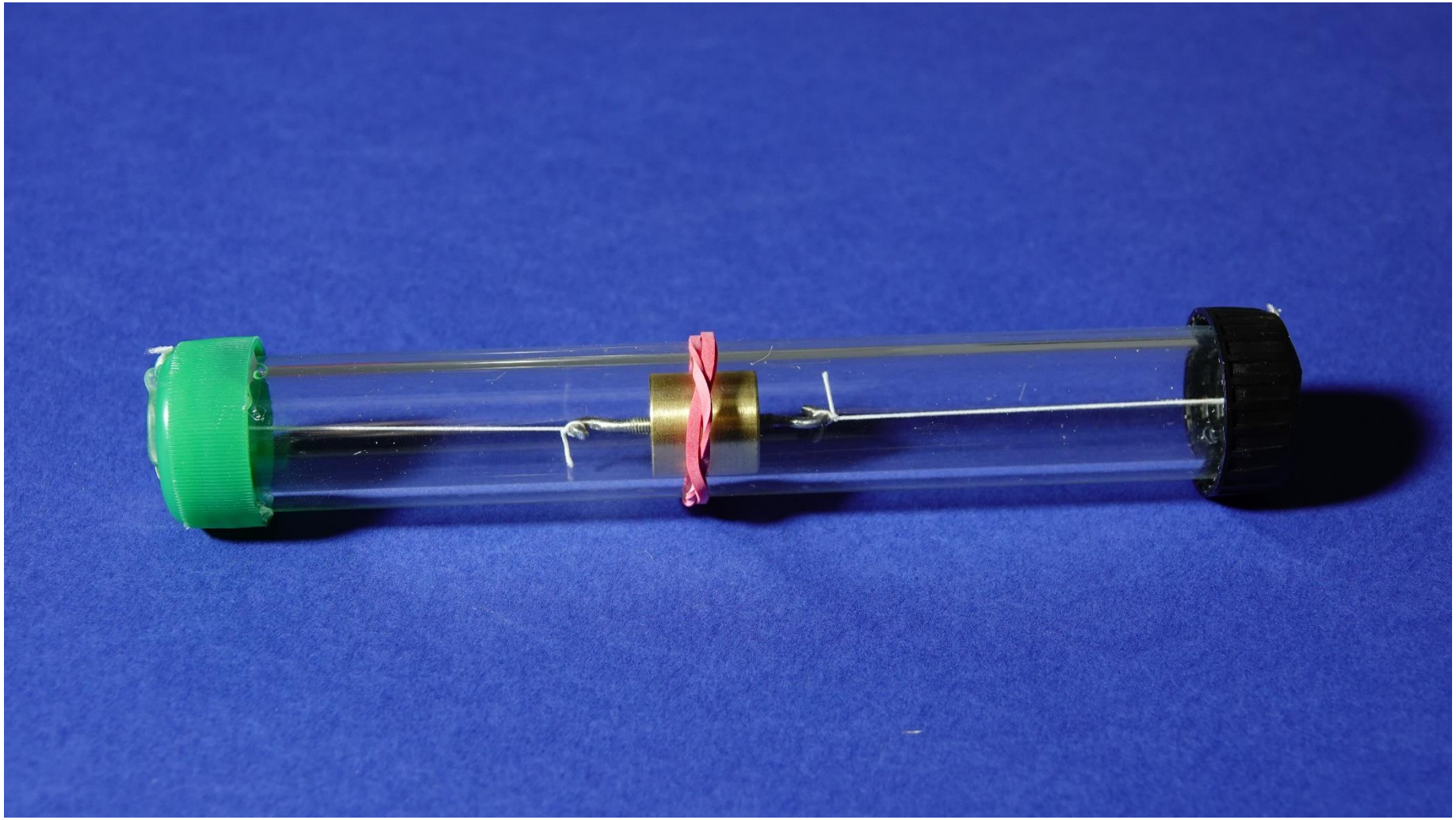
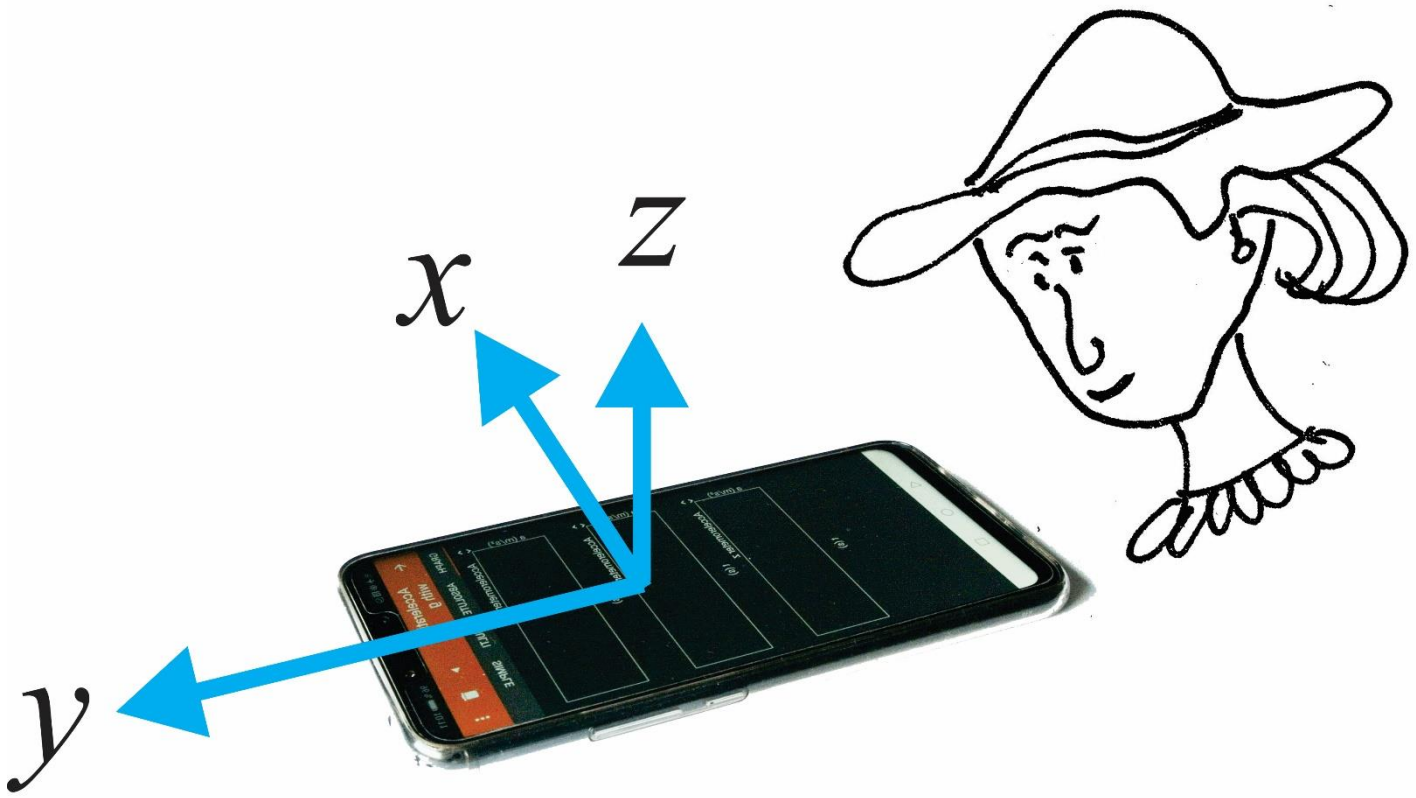
SSS 13.12.2019

Glej tudi navodila za delavnico !

Preprost analogni model senzorja pospeška

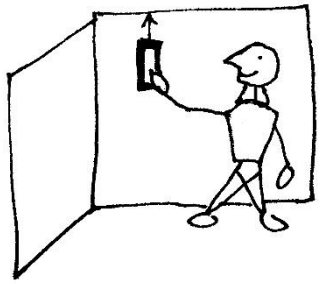


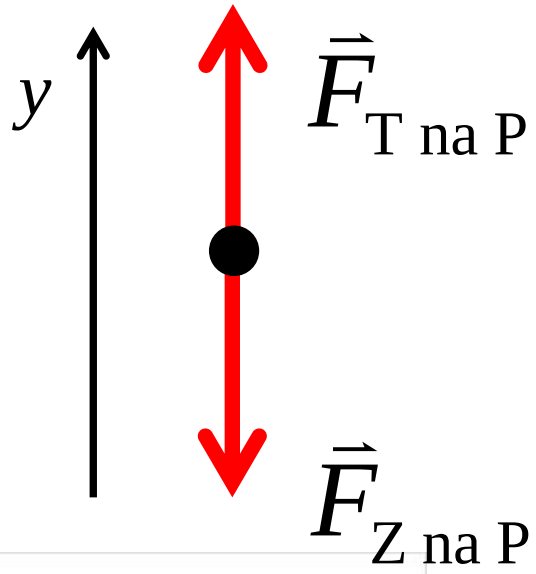
Smeri koordinatnih osi, ki jih uporablja program Phyphox

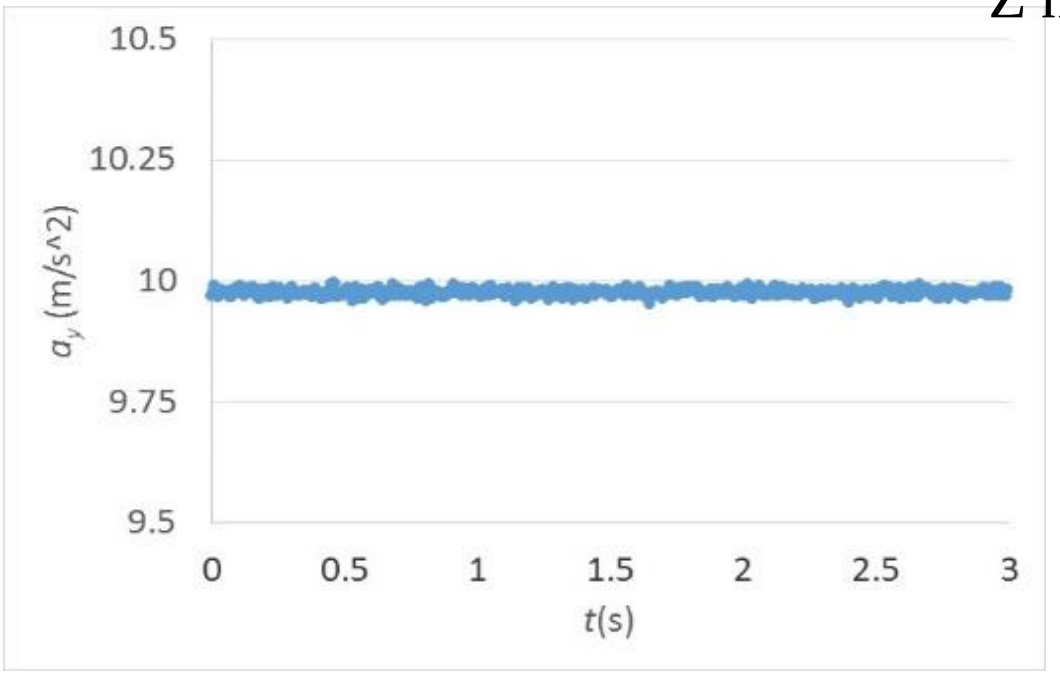


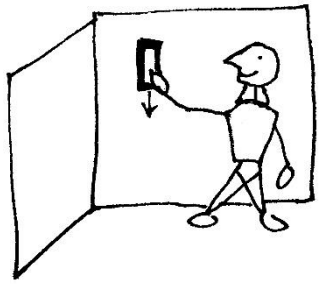
Pospešek a_x, ki ga prikaže telefon je enak sili F_x s katero deluje telefon na majhno telo v telefonu, deljeno z maso tega telesa (enako za y in z)

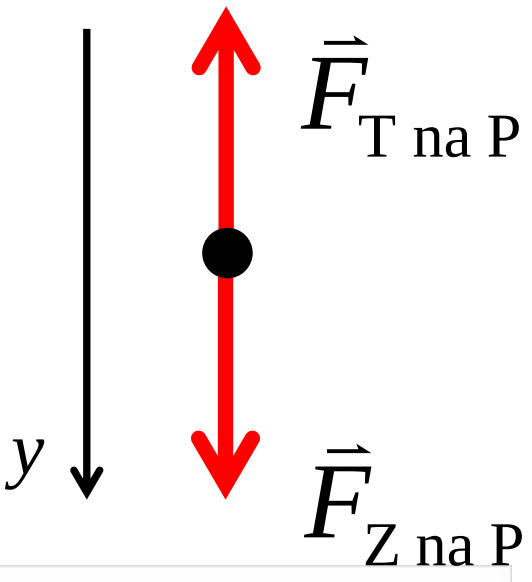
Privzamemo lahko, da so premiki merilnega telesa zanemarljivo majhni v primerjavi z velikostjo telesa (=vzmet s katero je vpeto telo na ohišje telefona je zelo trda).

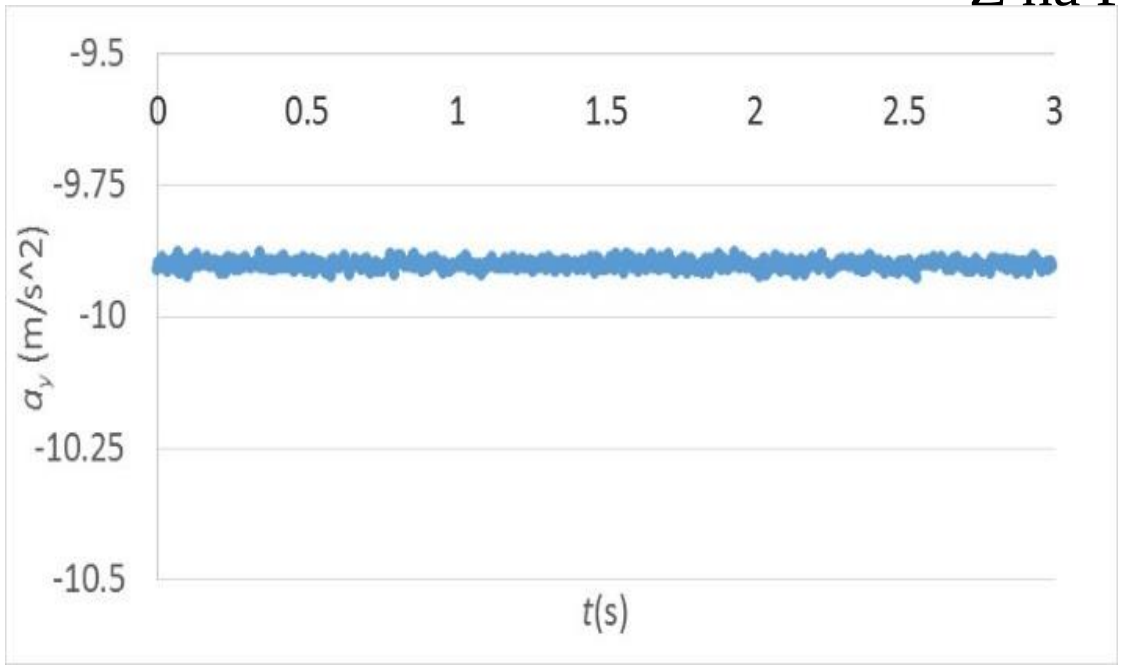


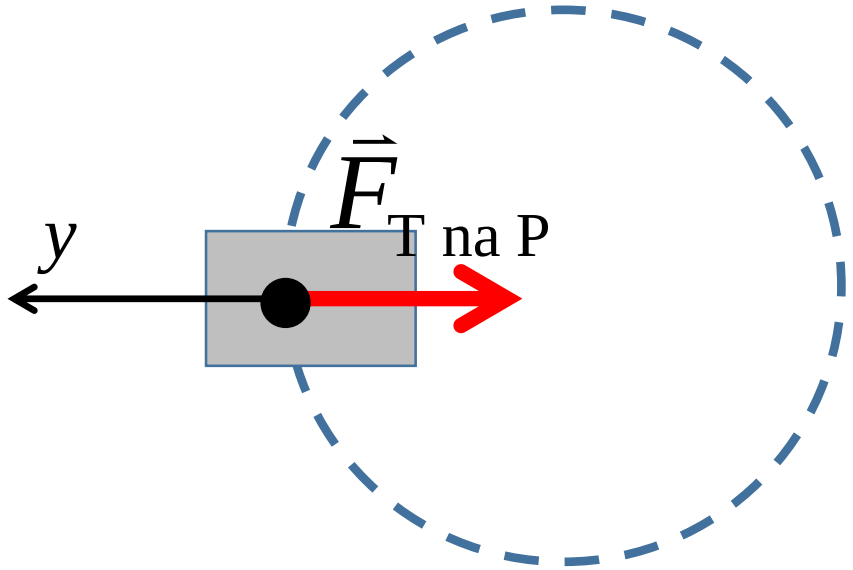

y
$\vec{F}_{T\ na\ P}$
$\vec{F}_{Z\ na\ P}$


10.5
10.25
10
9.75
9.5
a_y (m/s^2)
0
0.5
1
1.5
2
2.5
3
t(s)

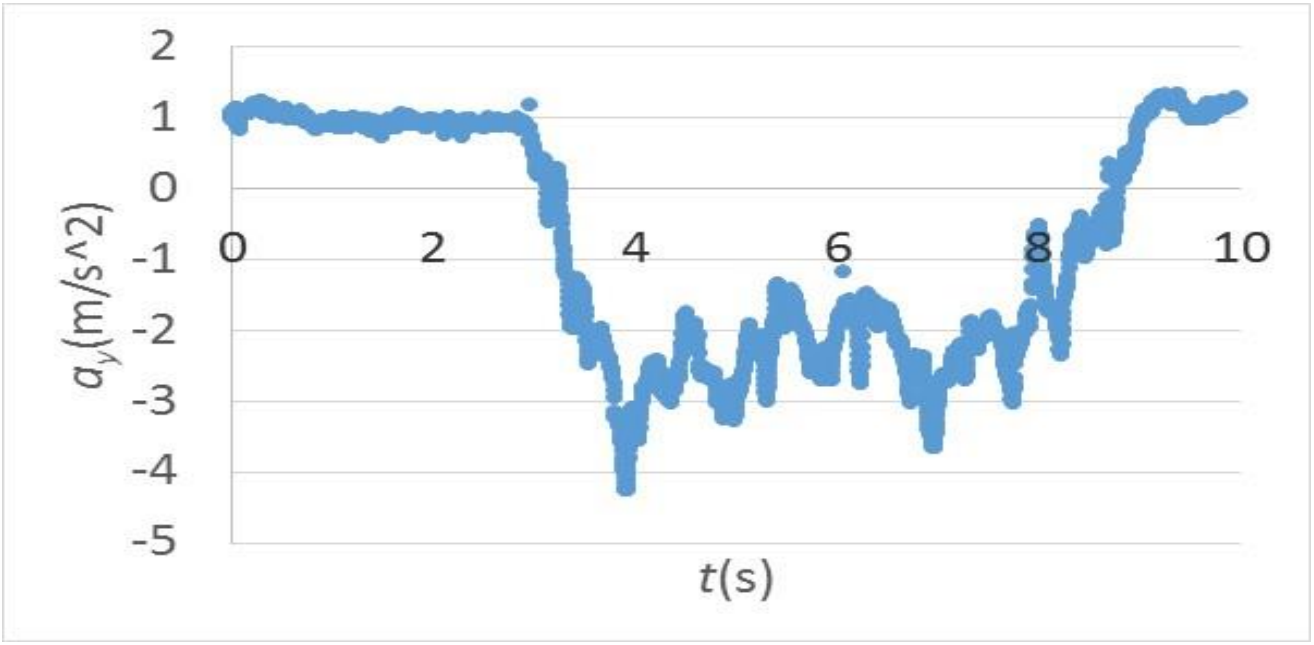



y
$\vec{F}_{T\ na\ P}$
$\vec{F}_{Z\ na\ P}$


-9.5
-9.75
-10
-10.25
-10.5
a_y (m/s^2)
0
0.5
1
1.5
2
2.5
3
t(s)



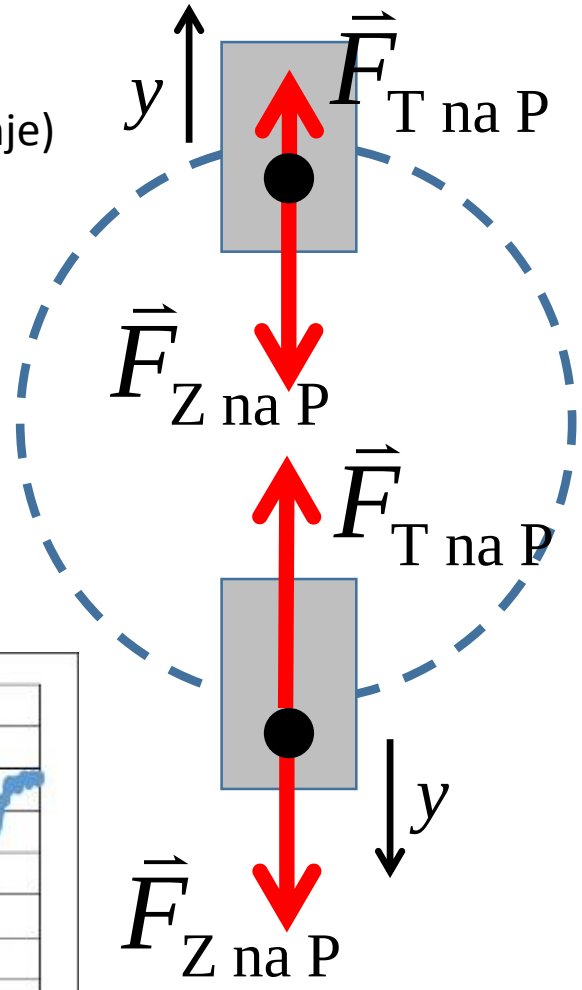
Pogled od zgoraj

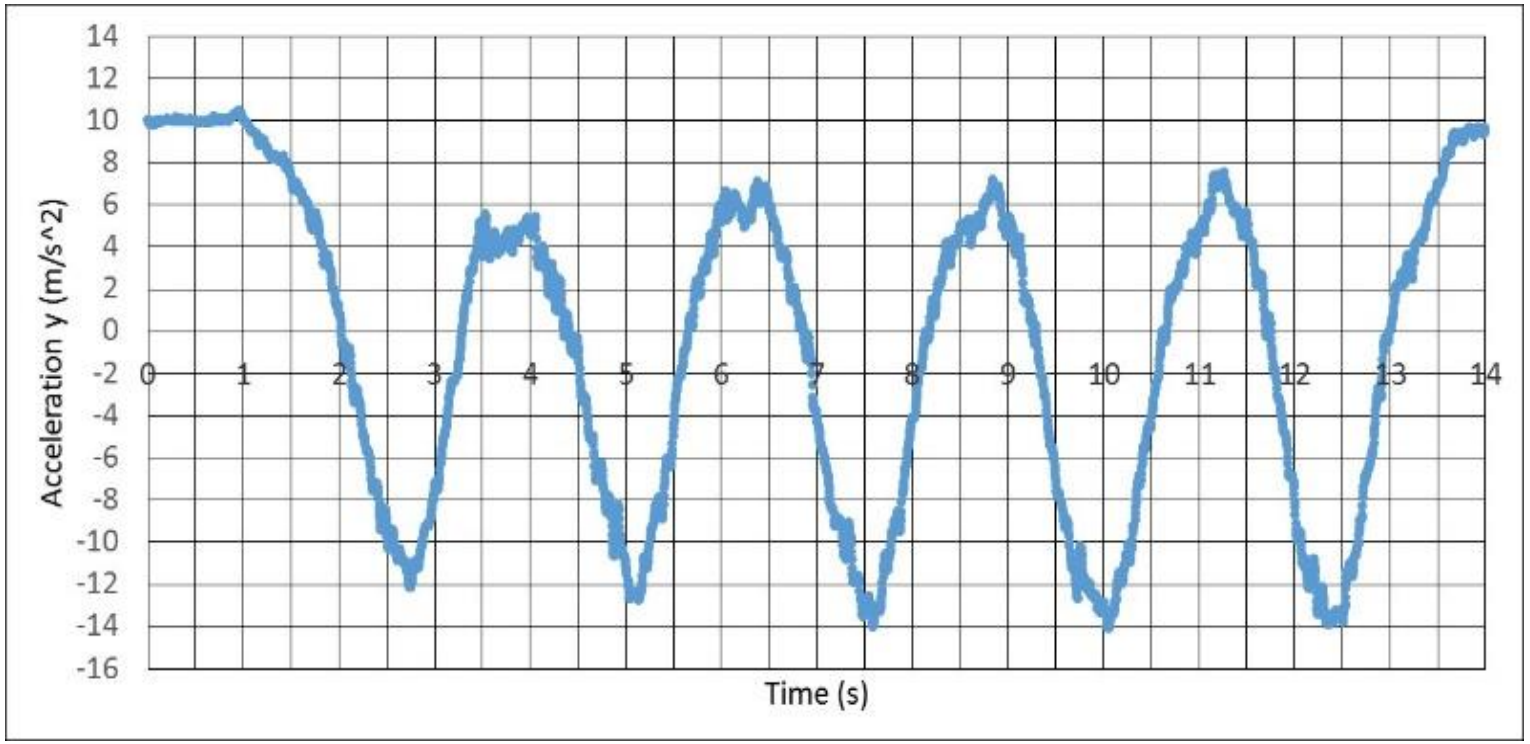


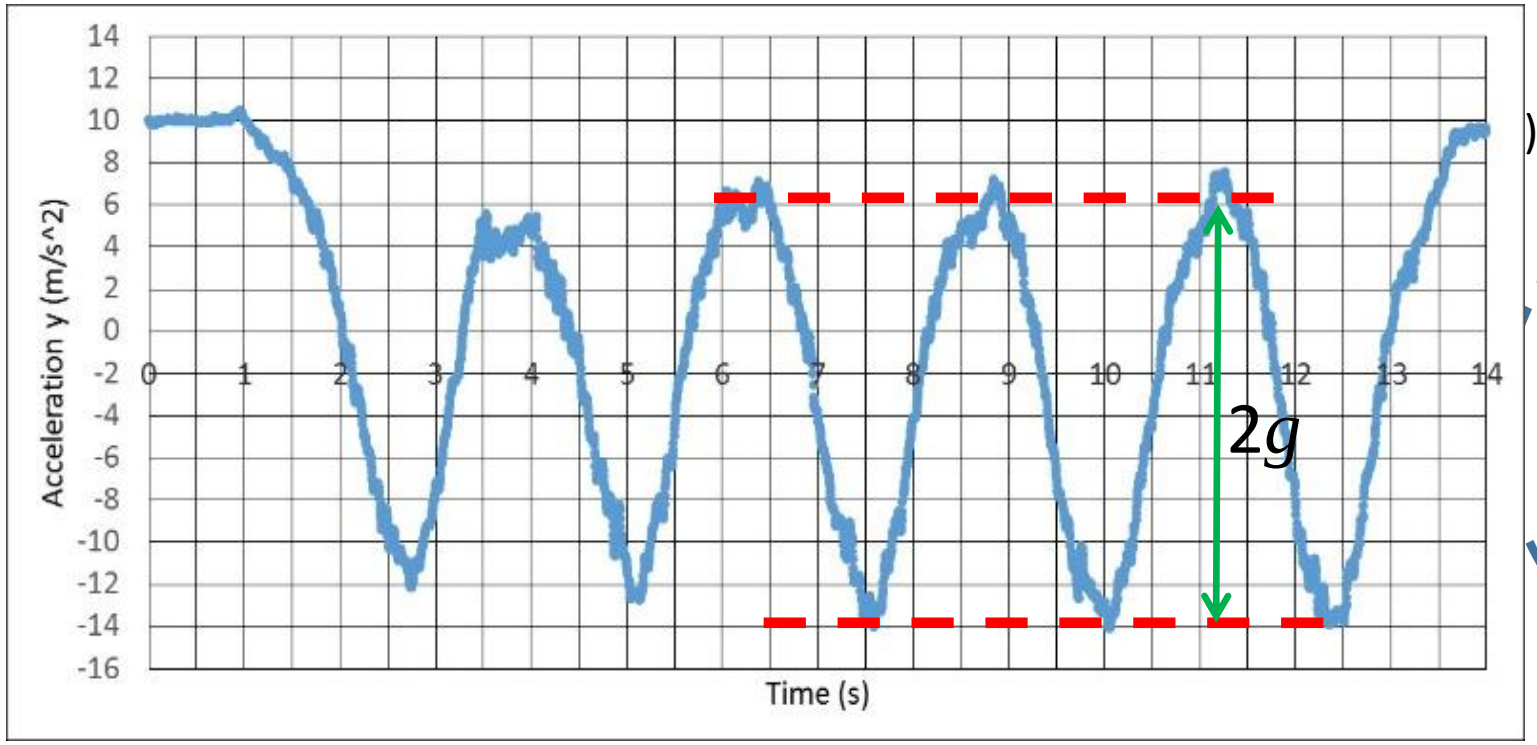
$$F_{\text{TnaP}} = m\frac{v^2}{R} \Rightarrow$$

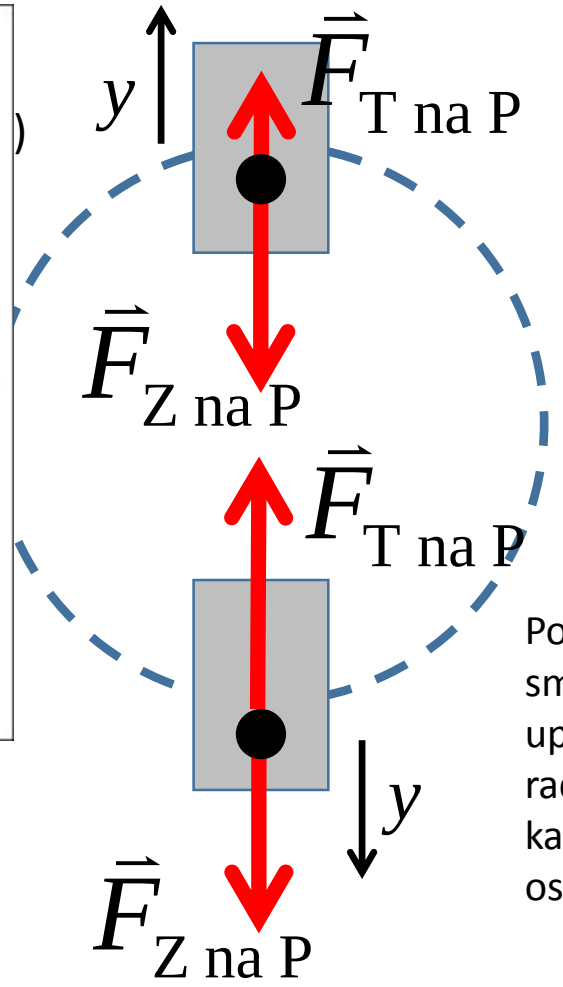
$$a_y = \frac{F_{\text{TnaP}}}{m} = \frac{v^2}{R} = \left(\frac{2\pi}{T_0}\right)^2 R$$

Pogled od strani
(počasno kroženje)









Pozitivni vrednosti sta smiselni, saj smo na začetku upoštevali kam mora kazati radialni pospešek in kam kaže sila teže (glede na smer osi *y*)

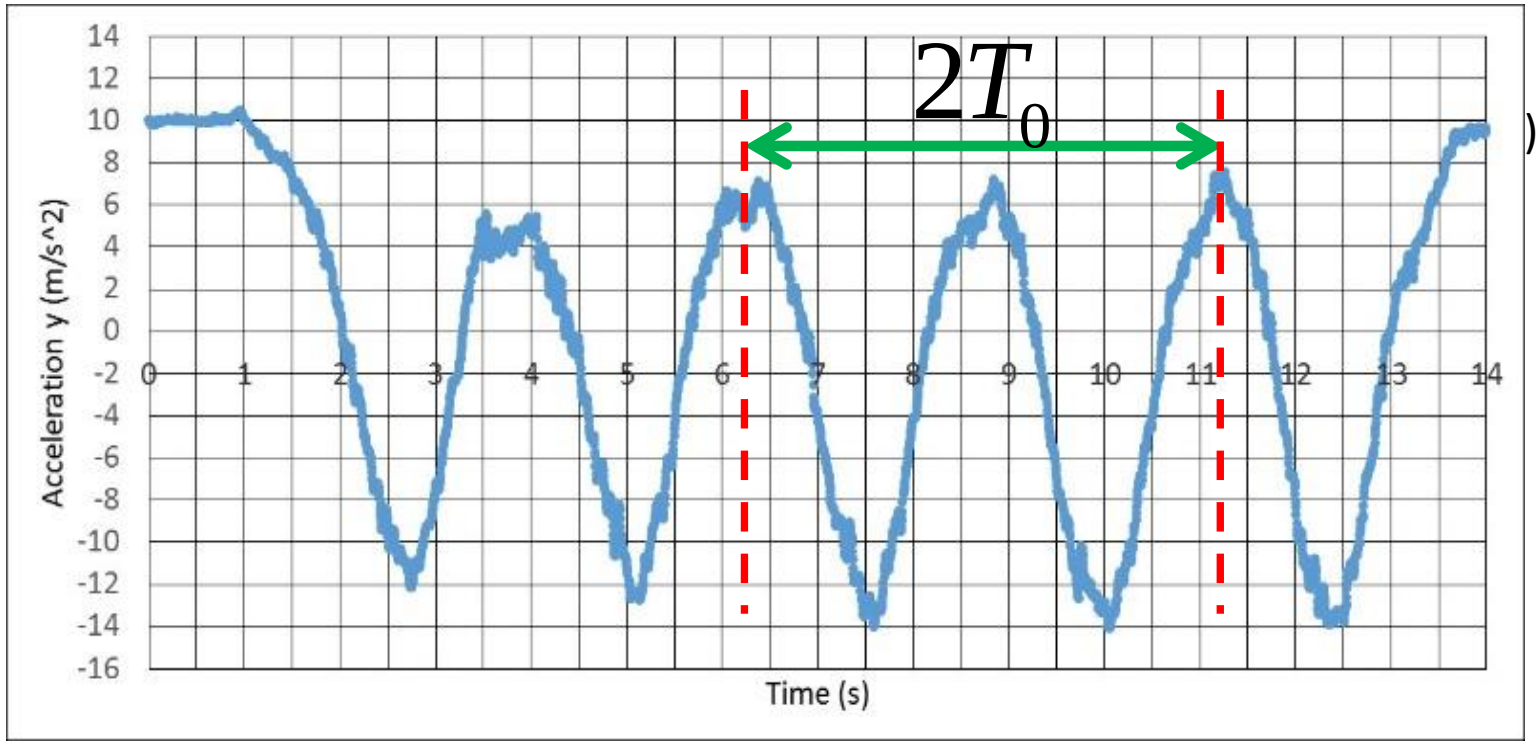
Če je kroženje enakomerno, velja za sile v zgornji/spodnji legi (pri določanju predznakov dosledno upoštevamo smeri glede na os y):

Delimo z *m*

$$-F_{\text{r}} = -F_{\text{Z na P}} + F_{\text{T na P (zgoraj)}} \Rightarrow -a_{\text{r}} = -g + 6\ \text{m/s}^2 \qquad a_{\text{r}} = 4\ \text{m/s}^2$$

$$-F_{r} = F_{\text{Z na P}} + F_{\text{T na P (spodaj)}} \Rightarrow -a_{\text{r}} = g - 14\ \text{m/s}^2 \qquad g = 10\ \text{m/s}^2$$

Ugotovitev: pri enakomernem kroženju v navpični ravnini je razlika med največjim in najmanjšim pospeškom, ki ga izmeri telefon enaka $2g$

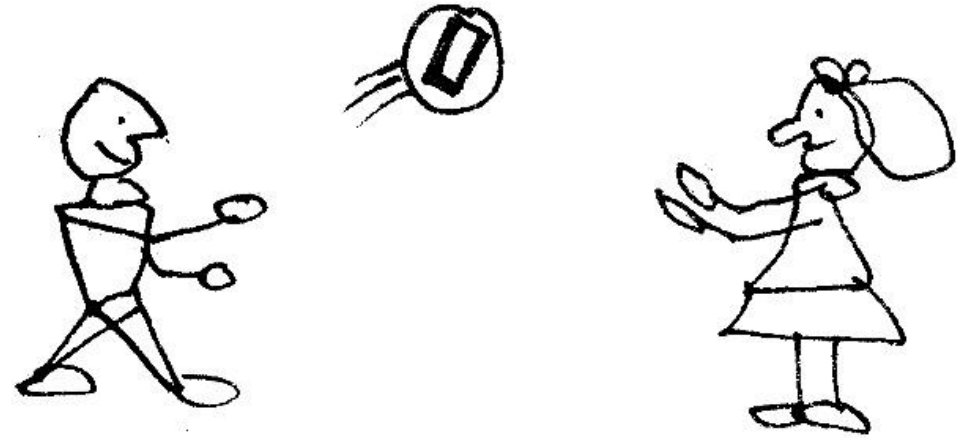


$$a_r = 4\ \mathrm{m/s^2}$$

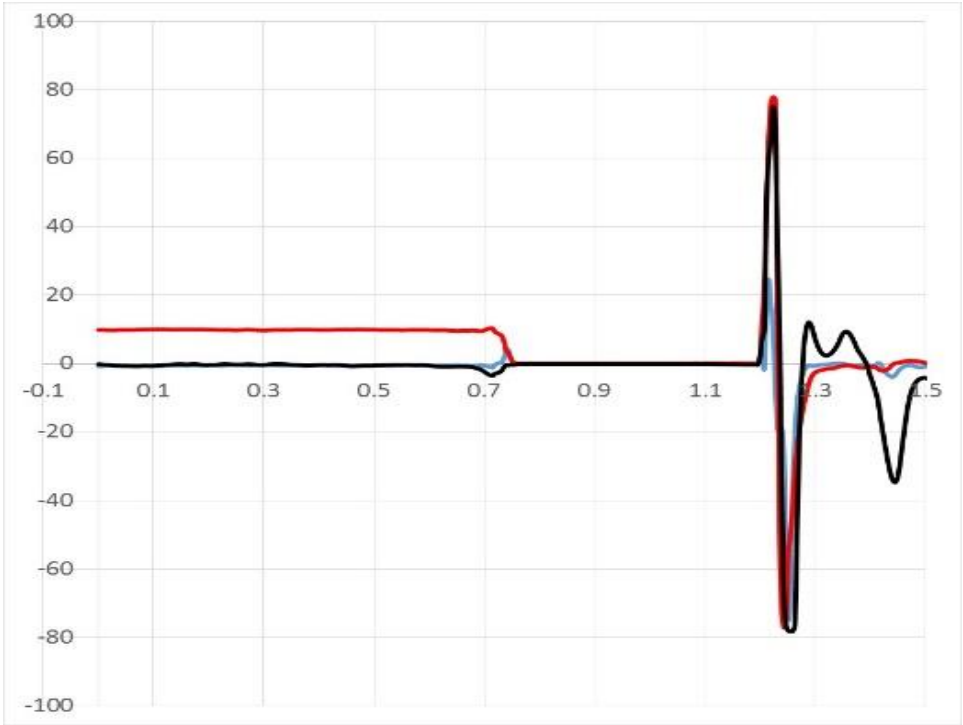
$$T_0 \approx 2{,}5\ \mathrm{s}$$

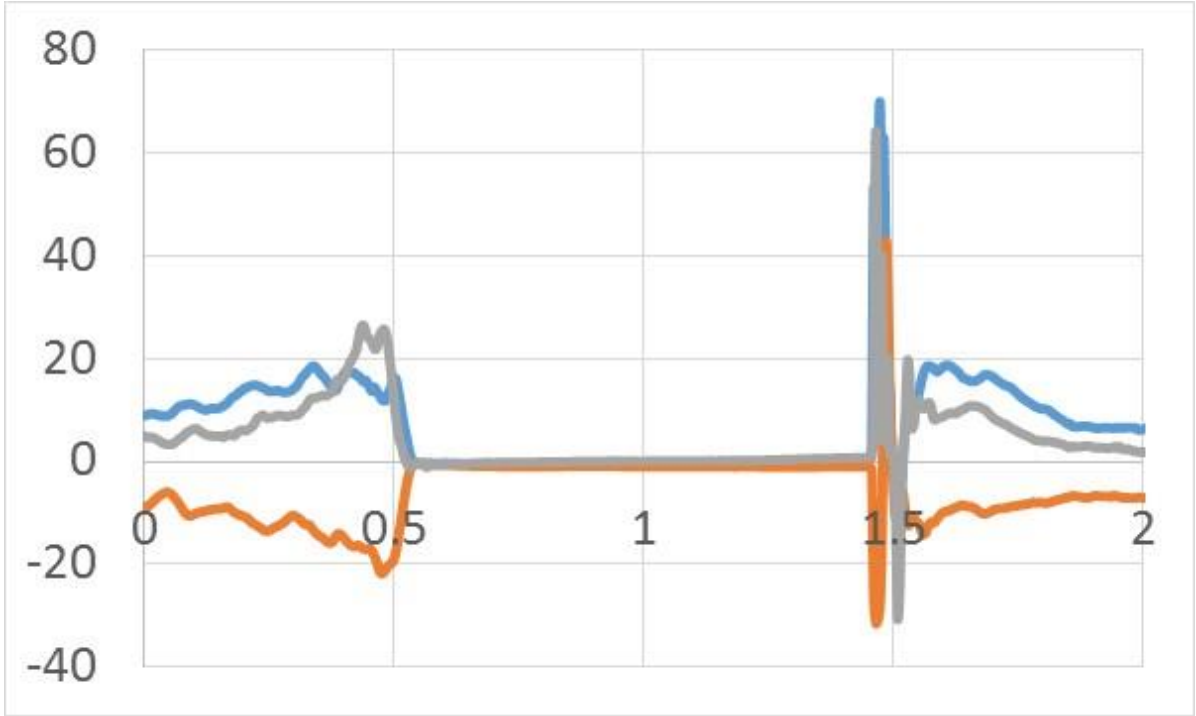
$$R = a_r \left(\frac{T_0}{2\pi} \right)^2 = 0{,}63\ \mathrm{m}$$

Rezultat se smiselno ujema s tipično dolžino roke (za odraslo osebo)

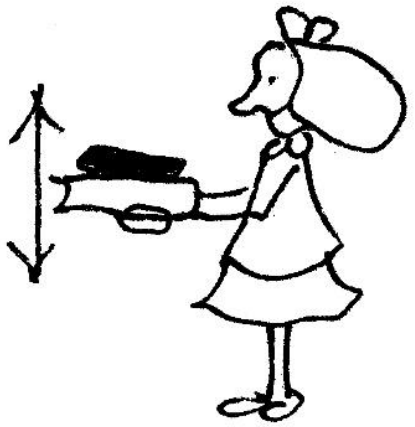


Poskus izvedemo s proženjem z zakasnitvijo ali z upravljanjem telefona na daljavo z računalnikom (*Remote access*)

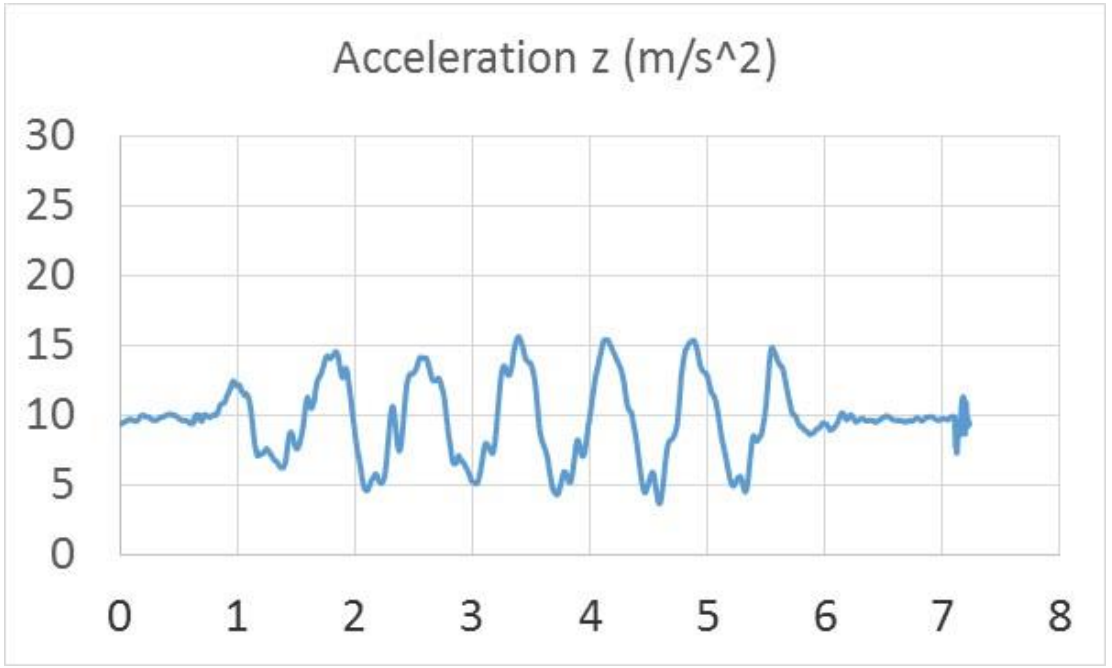




Povezava z zanimivim primerom: googlaj "*Vomit comet*"



Telefon ne poskakuje



Telefon je začel poskakovati pri cca t=8 s