Soal UAS Fisika Teknik 2020/2021

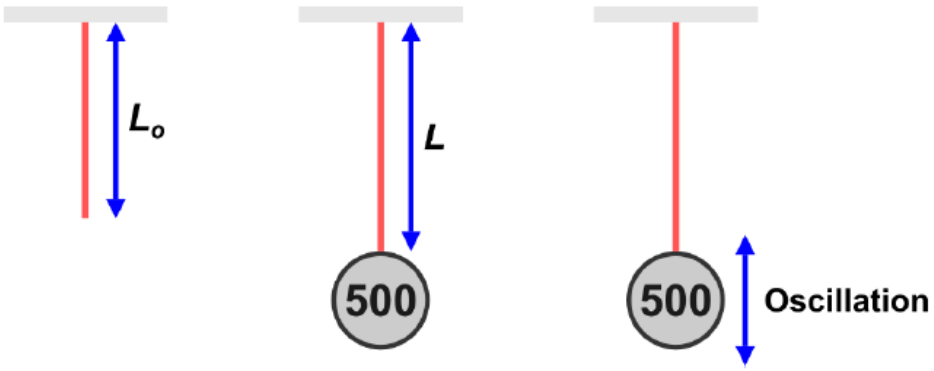
[25 points] Measuring Acceleration of Gravity

It is known that the oscillation period of a spring-mass system put on a horizontal table is given by

$$T = 2\pi\sqrt{\frac{m}{k}}$$

However, when the system is in vertical position, it can be proved that the oscillation period will be the same as the one in a horizontal position.

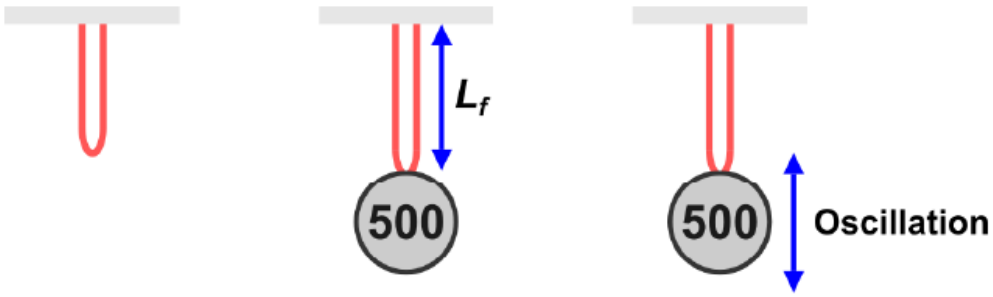
Based on this knowledge, Im Na-Yeon (임나연) performs an experiment to determine the acceleration of gravity inside her apartment. She only has a rubber band, 3 coins (500 Korean Won each), a cello tape, a ruler, and stopwatch from her smartphone. She then uses the cello tape to attach the coins to rubber band, and starts performing her experiment. **Experimental Data**



Initially, the rubber band has length $L_o = 10\ cm$. She then puts the rubber band and coin system in a vertical position, and then measures the rubber band's length L. Finally, she gives a small displacement to the coins, so that the system is oscillating up and down, and then she measures the oscillation period T. She then performs this experiment for different number of coins N, and the experimental data is shown in the table below.

N	L (cm)	T (s)
1	17.3	0.551
2	24.6	0.780
3	31.9	0.955

a) **[15 points]** Based on this experimental data, please help *Noona* Na-Yeon to determine the acceleration of gravity g inside her apartment!



She then performs one final experiment by folding the rubber band in half, and then once again attach all coins to the rubber band.

b) **[5 points]** Determine the rubber band's length (L_f) in this position!

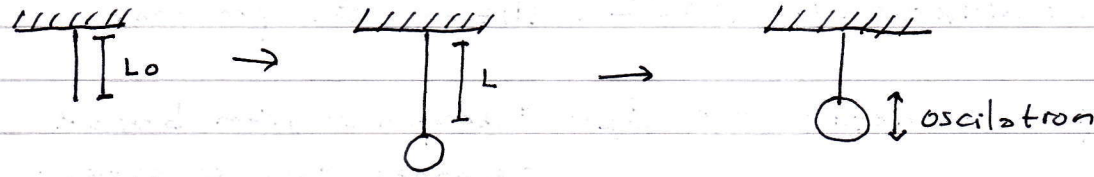
c) **[5 points]** Determine also its oscillation period when it is given a small displacement!

Pembahasan Soal UAS
Fistek 2020/2021
'Gravitasi dan Gerak Periodis'

Diketahui : Panjang karet → $L_0 = 10$ cm

$T = 2\pi\sqrt{\frac{m}{k}}$ ① → persamaan umum gerak periodis sistem pegas

Memiliki tiga koin dengan massa masing-masing tidak diketahui



N	L (cm)	T (s)
1	17.3	0,551
2	24.6	0,780
3	31.9	0,955

Kita tahu bahwa yang menyebabkan karet berubah panjang adalah berat dari koin, sehingga perubahan panjang karet disebabkan gaya

$F = m \cdot g$ ② → di mana g adalah percepatan gravitasi dan m adalah massa koin

Sementara itu, kita tahu juga bahwa pegas (karet) yang diberi tarikan akan memberikan gaya reaksi untuk melawan gaya berat dari koin tersebut. Gaya tersebut sebesar $F = -k \cdot \Delta x$ ③ di mana k adalah konstanta pegas dan Δx adalah perubahan panjang pegas.

Sehingga jika ② dan ③ digabung → $m \cdot g = k \cdot \Delta x$

atau dalam kasus ini $m \cdot g = k \cdot \Delta L \rightarrow m = \frac{k \cdot \Delta L}{g}$ ④

Masukkan persamaan ④ ke persamaan ①, sehingga

$T = 2\pi\sqrt{\frac{\Delta L}{g}}$ // → ubah bentuknya !!

$\frac{1}{g} = \left(\frac{T}{2\pi}\right)^2 \cdot \frac{1}{\Delta L} \rightarrow g = \Delta L \cdot \left(\frac{2\pi}{T}\right)^2$

2. Percepatan gravitasi pada masing-masing percobaan.

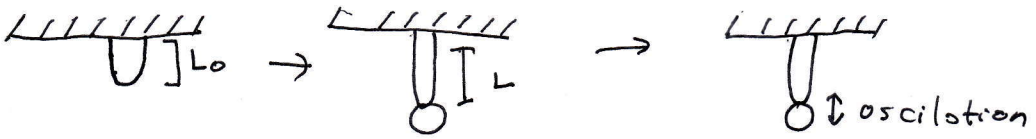
$N = 1 \rightarrow \Delta L = 7,3$; $T = 0,551 \rightarrow g = 7,3 \times 10^{-2} \left(\frac{2\pi}{0,551}\right)^2 = 9,49\ m/s^2$

$N = 2 \rightarrow \Delta L = 14,6$; $T = 0,780 \rightarrow g = 14,6 \times 10^{-2} \left(\frac{2\pi}{0,780}\right)^2 = 9,47\ m/s^2$

$N = 3 \rightarrow \Delta L = 21,9$; $T = 0,955 \rightarrow g = 21,9 \times 10^{-2} \left(\frac{2\pi}{0,955}\right)^2 = 9,48\ m/s^2$

Rerata dari tiap percobaan → $g = 9,48\ m/s^2$ //

Saat karet dilipat menjadi dua, → Lo = 5 cm



Terlihat bahwa saat karet dilipat menjadi dua, konstanta pegas berubah
$K_p = K + K = 2K_{//}$

Sementara itu diketahui bahwa $mg = kx \rightarrow m.g = k.\Delta L \rightarrow k = \frac{m.g}{\Delta L}$
m dan g konstan. Saat k berubah menjadi 2k, maka ΔL akan menjadi setengah dari ΔL awal.

b. $N = 1 \longrightarrow \Delta L = \frac{7,3}{2} = 3,65$ cm $\rightarrow$ Lo = 8,65 cm
$N = 2 \longrightarrow \Delta L = \frac{14.6}{2} = 7,3$ cm $\rightarrow$ Lo = 12,3 cm
$N = 3 \longrightarrow \Delta L = \frac{21,9}{2} = 10,95$ cm $\rightarrow$ Lo = 15,95 cm

c. Diketahui bahwa $T = 2\pi\sqrt{\frac{\Delta L}{g}}$, maka ketika ΔL menjadi setengah sistem pertama, periode juga menjadi kurang dari sistem pertama.

$T \approx \sqrt{\Delta L} \longrightarrow T_{awal} \approx \sqrt{\Delta L} \longrightarrow T_{baru} \approx \sqrt{\frac{\Delta L}{2}}$

$\frac{T_{awal}}{T_{baru}} = \frac{\sqrt{\Delta L}}{\sqrt{\frac{\Delta L}{2}}} \rightarrow T_{baru} = \frac{T_{awal}}{\sqrt{2}}$

$N = 1 \rightarrow T = \frac{0,551}{\sqrt{2}} = 0,4$ s
$N = 2 \rightarrow T = \frac{0,780}{\sqrt{2}} = 0,551$ s
$N = 3 \rightarrow T = \frac{0,955}{\sqrt{2}} = 0,675$ s