Theoretical Mechanics, homework 1, done by Elina Murtazina

Task 1:

Tools: Calculator suite - GeoGebra

Link to the simulation: https://www.geogebra.org/calculator/jzrd6keu

Task description:

Task 1 (Coding)

You should find:

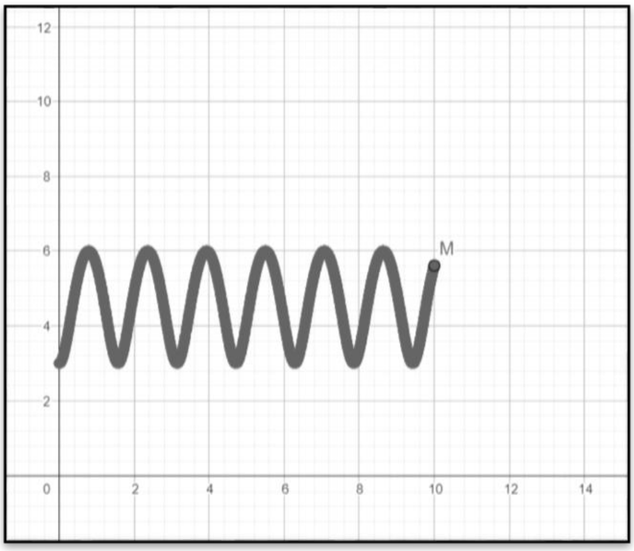
1. simulate the move of $\bar{O}$ for $t = [0..10]$;
2. find and draw plots $v,\ a,\ a_n,\ a_\tau,\ \kappa$ (Osculating circle) respect to t;
3. find $y(x)$, $\vec{v}$, $\vec{a}$, $\vec{a}_n$, $\vec{a}_\tau$ and show it on the simulation.

$$\bar{O} = \begin{cases} x = 3\cos(2t)\cos(t) + 0.82 \\ y = 3\cos(2t)\sin(t) + 0.82 \end{cases}$$

Task explanation:

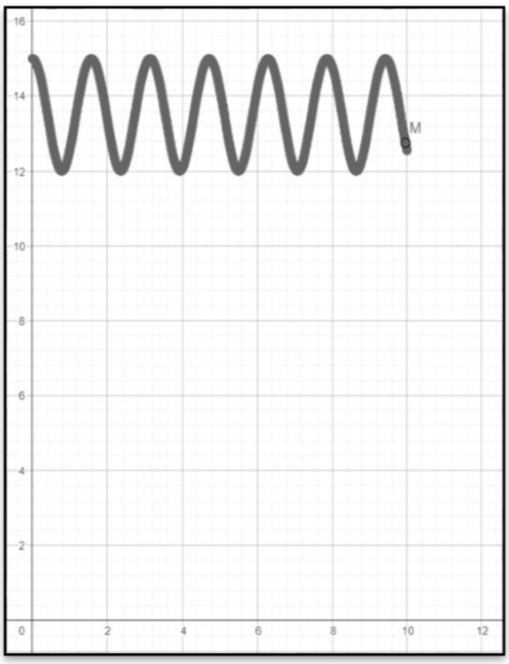
Firstly, we create time slider (t) with boundaries from 0 to 10. Then we create the curve with given x(t) and y(t) and also point moving along the curve as time passes by. By taking derivatives dx/dt and dy/dt we get Vx and Vy respectively, which gives us the opportunity to find the length of velocity vector by substituting current time t. Built velocity vector from current point on graph F (y(x)) (the graph built in the code only after velocity vector is a mistake done by my lack of geogebra usage, I'm sorry). Then, with the same procedure, we can find Ax and Ay so acceleration vector can be built. After that we use formulas an = $\frac{|a \times V|}{V}$ & a_τ = $\frac{(a \cdot V)}{V}$ for a_n and a_τ, there **a** and **V** are vectors, V – velocity vector length, "**×**" is a cross-product and "**·**" dot-product operations. Then we find τ and norm vectors, because before we found only values of vectors and now need to give them directions. After that we can simulate vectors **a_n** and **a_τ** for our moving point. And after all of that we can find k, which is value inversely proportional to the radius of the curve and can be found through formula k = $\frac{a\_n}{V^2}$.

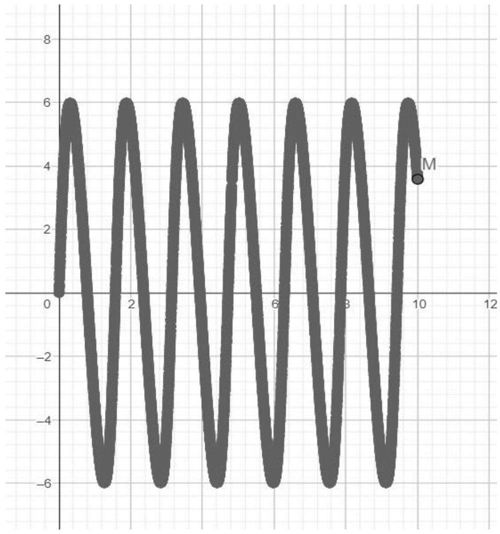
Plots:



<<= Velocity

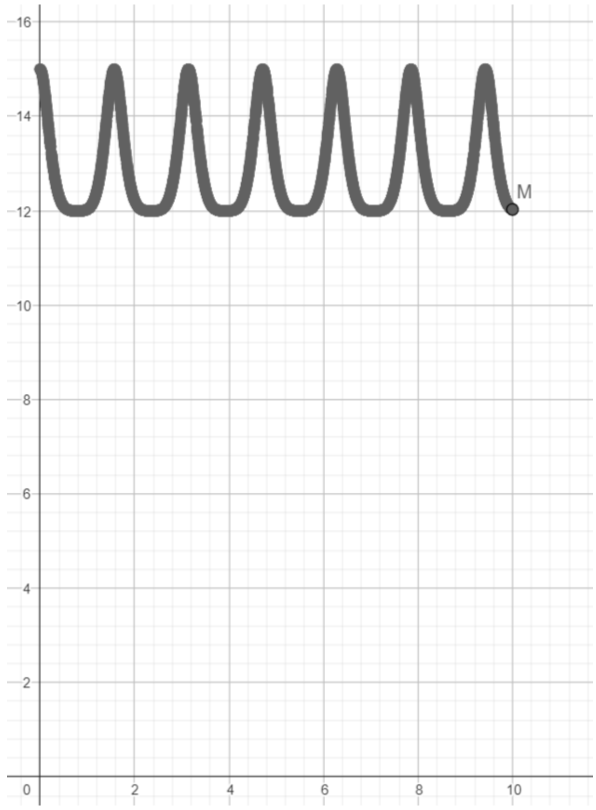
Acceleration =>>

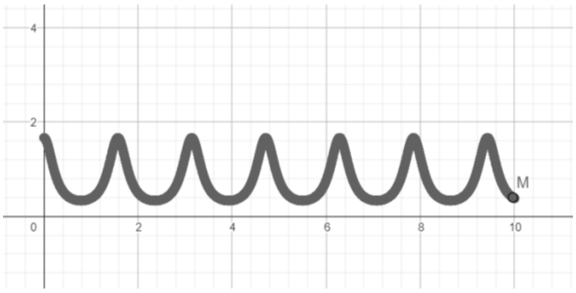




≪= a_τ

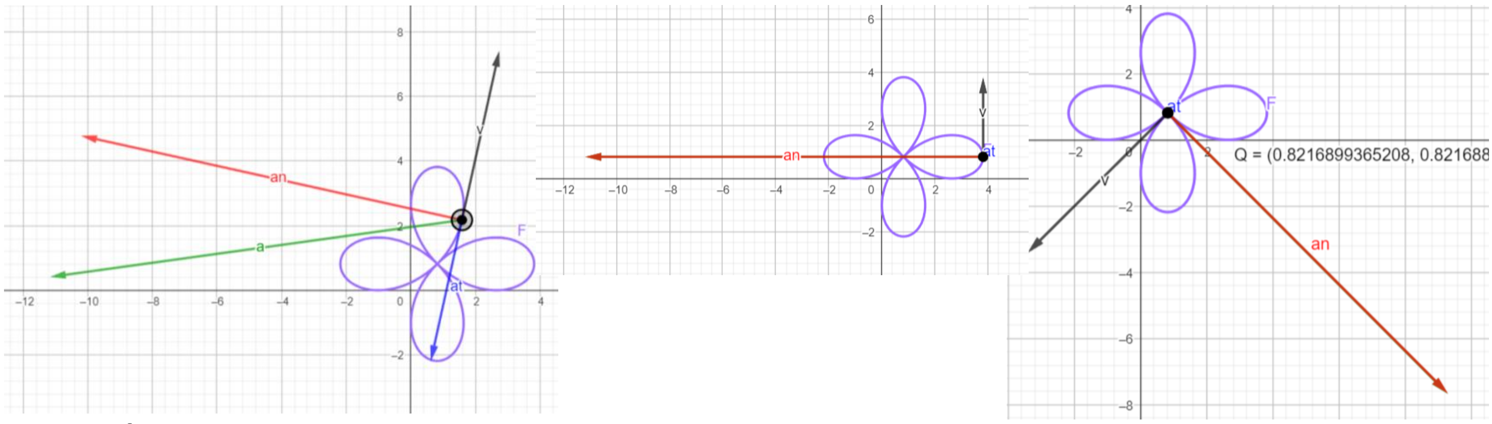
a_n =≫





≪= k

Screenshots:



Task 3:

Tools: Calculator suite - GeoGebra

Link to the simulation: https://www.geogebra.org/calculator/sggjwkr5

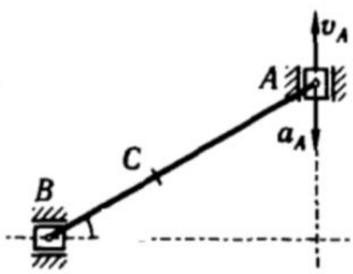
Task description:

Task 3 (Coding)

You should find:

1. simulate this mechanism (obtain all positions.) ($x_i(t)$, $y_i(t)$, where i is A, B, C point)
2. velocities for B, C (draw plots for magnitudes and show vectors on simulation);
3. accelerations for B and C (draw plots for magnitudes and show vectors on simulation);
4. draw a plot of angular velocity of body BA.

If $y_A(t) = 22.5 + 10sin(\frac{\pi}{5}t)$; $t = [0..10]$ $sec.$;
$AB = 45$, $AC = 30$.



Task 3
(Yablonskii (rus) K3)

Task explanation:

As we may see in the picture and understand from given y_A point A is moving up and down and does not make moves along X axis. This means that only up & down movements determine movements of point B, which also moves only along 1 axis – x. So, it's easy to simulate, make point A move along Y axis, with the usage of Pythagorean proposition and knowledge of Y-coordinated of point A we can find X-coordinates of point B. Make a segment which connects them and through vectors u and v find position of point C (AC=30, AB = 45 ➔ BC/AB = ¼). Now we have problem of how to find velocities of other points. We cannot claim that point B moves with the same velocity as a point A, because that's not the case. And I think I failed in the method of finding velocities and especially acceleration, so task is left uncomplete, I'm sorry.

Next time I probably won't use geogebra since it failed to save certain files.

Meme for this week: