11.s04.e04

Hint 2

IMPORTANT! The next task is both a hint and an alternative to the main task. Three important points:

1. You can continue to send the solution to the main problem.
2. At any moment before the final deadline you can start to solve the Alternative problem. If you do so, at the beginning of the solution write: *I am doing the Alternative problem!* In this case a penalty coefficient for the Alternative problem is

$$0{,}7 \cdot \sum_i \frac{k_i \cdot p_i}{10},$$

where p_i is a point for the problem item, and k_i is a penalty coefficient for the corresponding problem's item at the moment of moving to the Alternative problem. In other words, maximal points for the alternative problem equals to the maximal points you can gain at the moment of moving to the alternative one multiplied by 0,7. Also, we remind you that a penalty coefficient can't be less than 0,1. Solutions of the main problems from that moment will not be checked. Be careful!

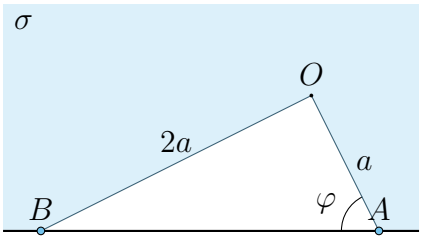
3. The task consists of several items. The penalty multiplier earned **before** is applied to all points. In the future, each item is evaluated as a separate task. If you send a solution without any item, this item's solution is considered as Incorrect. For more information about scoring points for composite tasks, see the rules of the Cup. **Since switching to an alternative selection, there is no opportunity to return to solving the main task.** Also, after switching to an alternative task **the points for the main task are reset**.

Alternative problem

Task 1. *(2 points)* The sharp ends of the scissors were connected with a stretchable short elastic band with a coefficient of elasticity k, which has zero length when it is unstretched. The scissors were fully immersed in a soap solution with a surface tension coefficient σ. Then the scissors were taken out and opened at an angle of $\alpha < 90°$. How much work was done in the process, if the distance from the intersection point of the halves of the scissors to their sharp ends is equal to L?

Task 2. *(2 points)* There are n identical mercury balls in zero gravity. Find out the ratio between the total energy of the surface tension forces of mercury after and before these balls clump together into one big Ball.

Task 3. At the ends of the weightless rods OA and OB, connected pivotally and having lengths a and $2a$, respectively, point weights of mass m are fixed. The weights can slide along a long straight spoke without friction. The rods are surrounded by a film with a surface tension of σ. The film does not leak into the area between the rods and the spoke. Denote by φ the angle OAB.



1. *(1 point)* What is the angle φ in the equilibrium position of the system?

In the following parts of the problem we consider the oscillations of such a system near this position. Assume that the center of mass of the weights is at rest.

2. *(2 points)* Express the kinetic energy of the weights W_k in terms of m, a and $\dot{\varphi}$.
3. *(2 points)* Let the increment of the angle φ be equal to $\Delta\varphi \ll 1$. Find the increment of the surface tension energy ΔW_σ. Express the answer in terms of σ, a and $\Delta\varphi$ (you need to find the first non-vanishing term).
4. *(1 point)* Find the period of the oscillations of the system near the equilibrium position. Express the answer using σ and m.