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 by **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.

The main task there are several possible ways of solving. We do not know which path you will eventually take, so we offer you several tasks, some of which may help you come to the cherished `Correct`. Do not send us solutions of the examples!

Example 1. Find the change in the potential energy of interaction of two point bodies with masses m and M when the distance between them changes twice. The initial distance is R.

Answer. $\Delta W = \frac{GMm}{2R}$.

Example 2. The speed of sound in gases depends on the pressure and density of the medium. Find the factor by which the speed of sound in gas differs in two states connected by equations $p_2 = 2p_1$, $\rho_2 = 4\rho_1$.

Answer. $\frac{v_1}{v_2} = \sqrt{2}$.

Example 3. A point body of mass m is located on a smooth horizontal surface and is attached to a vertical wall with a spring with a known constant k. By what factor will the period of body oscillations change if the amplitude is doubled?

Answer. Will not change.

Example 4. Two bodies of masses m_1 and m_2 are moving towards each other with speeds v_1 and v_2, respectively. Bodies experience an absolutely inelastic scattering. Find the amount of heat that is released in this collision.

Answer. $Q = \frac{\mu(v_1+v_2)^2}{2}$, where $\mu = \frac{m_1 m_2}{m_1+m_2}$.

Alternative Problem

1. *(2 points)* A point body of mass m is located on a smooth horizontal surface and is attached to a vertical wall by a «nonlinear» spring, such that the spring force is proportional to the square of its deformation. By what factor will the period of body oscillations change if the amplitude is doubled?

2. *(3 points)* Two point bodies with the same mass are kept at a distance a from each other. The bodies are released and the distance between them is halved in time T. Find in how long the distance will also halve if the bodies were at rest at a distance of $2a$ from each other.

3. *(5 points)* At a distance of $4a$ from a solid Cube with a side a and mass M on a line passing through its center and the center of one of its faces, a point-like cube of mass m is provided (see fig.). The initial velocities of the cubes are equal to zero. The cubes are released, and as a result, the distance between them changes twice in time t.

   Find the time it takes to change the distance twice between the same small cube and a solid Cube with side $2a$, mass M, if the small cube is located on a line passing through the center of the Cube and the center of one of its faces on a distance of $8a$ from the cube (see fig.). The initial velocities of the cubes are zero.

   Note. The distance between the cubes is measured from the center of the big Cube.