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. 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 2. 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 3. 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 identical point charges fly away from each other from a state of rest. After a time t, the distance between them doubles in comparison with the initial one. Determine how this time will change if the initial distance between charges is doubled.

3. *(5 points)* At a distance of $4a$ from a solid Cube uniformly charged over the volume with side a, and charge Q, a point-charge q is located on a line passing through the center of the Cube and the center of one of its faces (see fig.). The Cube's mass is M, the mass of the charge is m. The initial velocities of the Cand the charge are zero. The Cube and the charge are released, as a result of which the distance between them changes twice in time t.

   Find the time it takes to change the distance twice between the same point-charge and uniformly charged Cube with side $2a$, charge $3Q$, and mass M, if the charge is located on a line passing through the center of the Cube and the center of one of its faces at a distance of $8a$ (see fig.). The initial velocities of the Cube and the charge are zero.

   Note. The distance between the Cube and the point-charge is measured from the center of the Cube. Neglect gravitational and magnetic interactions.