No need to build illusions, which
can end up in an emergency room
Carlin, «Kikoriki aka Smeshariki
The art of cutting and living»

Carom

In this problem, you will need to analyze partially elastic collisions of babyriki with a recovery factor k, which can be defined by the following equation.

$$k = 1 - \frac{E_p}{W},$$

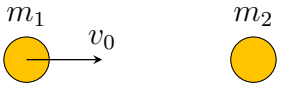
where E_p is an energy loss, and W is the maximum energy of the deformation during the collision.

For example, a babyriki is falling from the height H and hits the floor. The maximum energy of the deformation is mgH. If the recovery factor equals k, the babyriki energy after the collision is going to be equal to $mgHk$, and it lifts up to the height of Hk.

For all the parts of the problem consider babyriki as smooth spherical and homogeneous, and their motion should be considered translational only.

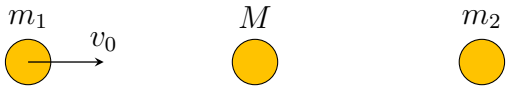
Part 1. Central collision

A. Wally with a fixed mass m_1 bumped into Krashy of mass m_2, so here is a central collision happened with a recovery factor k.



1. *(1 point)* Find the mass m_2 of Krashy so that his kinetic energy after the collision is maximum.

B. Between Wally and ChiChi with known masses m_1 and m_2, there is placed a subsidiary babyriki with a changeable mass M. The first babyriki was given a velocity v_0, and the other of babyriki ~~in rest in peace~~.



2. *(1,5 points)* At what mass value of the subsidiary babyriki kinetic energy of ChiChi with mass m_2 will be maximum?

All collisions are central, and all recovery factors equal k. The babyriki are placed in such a way that each adjacent pair collides only once.

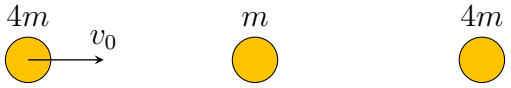
C. Between Wally and Rosy with known masses m_1 and m_2, there are N number of subsidiary babyriki with changeable masses. The first babyriki was given a velocity v_0, and all other kikoriki are resting.

3. *(1 point)* At what masses of the subsidiary babyriki will kinetic energy of Rosy with mass m_2 be maximum? All collisions are central, and all recovery factors equal k.

4. *(1,5 point)* At what value of k will the kinetic energy of Rosy be greater than it would be without those subsidiary babyriki?

We can change the masses of auxiliary babyriki independently of each other. The babyriki are placed in such a way that each adjacent pair collides only once.

D. As a particular example, let's consider the following situation. Three babyriki Wally, Krashy, and ChiChi with masses $4m$, m, and $4m$ respectively are placed in the named order along one straight line. Wally was given a velocity v_0 in direction of the other two babyriki that were resting. The recovery factor of all the collisions is equal to 0,5.



5. *(2 points)* How much heat will be produced for any long amount of time? The answer is correct with an inaccuracy of no more than 1%.

Part 2. Non-central collision

Two kikopucks with an identical radius R are placed on the horizontal plane. The surface friction coefficients of kikopucks are the same and equal to μ. Kikopuck with a mass m_1 bumped into the resting kikopuck with mass m_2. At the moment of collision with a recovery factor k the speed of the first kikopuck at the moment of contact is equal to v_0. After the collision, the second kikopuck before the stop moved to a distance L_2. Find:

6. *(1,5 points)* The amount of heat Q released during the collision;

7. *(1,5 points)* The distance L_1 traveled by the first after the collision.

First hint — 25.04.2022 14:00 (Moscow time)
Second hint — 27.04.2022 14:00 (Moscow time)

Final of the second round — 29.04.2022 22:00 (Moscow time)