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

Karrom

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

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

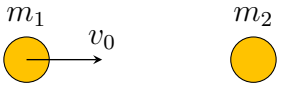
where E_p is an energy loss, and W is the maximum energy of the deformation during the collision.

For example, a kikoriki 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 kikoriki 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 kikoriki as smooth spherical and homogeneous, and their motion should be considered translational only.

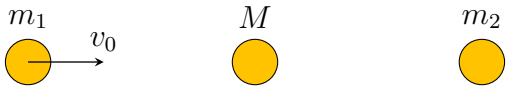
Part 1. Central collision

A. Barry with a fixed mass m_1 bumped into Krash 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 Krash so that his kinetic energy after the collision is maximum.

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



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

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

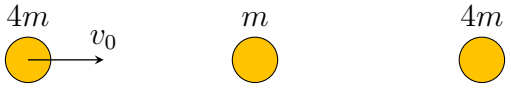
C. Between Barry and Olga with known masses m_1 and m_2, there are N number of subsidiary kikoriki with changeable masses. The first kikoriki was given a velocity v_0, all other kikoriki are resting.

3. *(1 point)* At what masses of the subsidiary kikoriki will kinetic energy of Olga 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 Olga be greater than it would be without those subsidiary kikoriki?

We can change the masses of auxiliary kikoriki independently of each other. The kikiroki 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 kikoriki Barry, Krash, and Dokko with masses $4m$, m, and $4m$ respectively are placed in the named order along one straight line. Barry was given a velocity v_0 in direction of the other two kikoriki 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)