

Getting out beads

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1 The purpose of investigation

Many of us played with string of Christmas beads in childhood. When we took long enough part of the beads out of the container, we could observe the beads rushing down, making a lot of noise. However did we see that the beads sometimes detached from the container's edge? It certainly proves to be a very interesting phenomenon. I have tried to explain it and investigate as widely as I can.

2 Theoretical work

In the beginning I have investigated the phenomenon from a theoretical side.

So the first relatively easy question to answer is:
What forces act on the beads in its move?

There are gravity, friction and centrifugal forces.

The cause of beads movement is difference of weights of the beads hanging from each side of the beaker. Their net force must be bigger than the resistance force.

In my research I tried to find the time dependent speed and position functions.

The reason of beads detachment is centrifugal force. This force can be decomposed into components, which bear different meaning in the beads movement.

I calculated the speed which is needed to observe detachments.

$$V \geq \sqrt{\frac{\pi R g}{2}}$$

I also recognize that the bead's shape and the length of gaps between them are very important, because beads hooks to the beaker and when it does so after detachment it results with another detachment. Following detachments are even higher.

3 Experimental work

I used different sized beads. I also used containers of different heights.

My next step was recording a lot of movies. Using computer program I watched them all in slow motion. It was big breakthrough in my research and helped me draw many interesting conclusions.

4 My first research

I used 3-meters beads. Measured parameters were: time of the fall, average speed, average acceleration, influence of vertical component of Centrifugal force on movement.

Beaker height was $h=0,05\text{m}$ and beads fell from height of $H=0,75\text{m}$.



5 Conclusions

If the height of beaker is too big, chain does not detach or it does it for very small heights.

The highest speed is achieved by the heaviest beads.

The highest number of detachments in a unit of time occurs when we use the smallest beads.

The chain detaches at the biggest height, when we use the biggest beads.

Vertical component of centrifugal force can significantly influence beads' motion.

References

- [1] David Halliday, Robert Resnick, Jearl Walker, "Fundamentals of Physics", tom 1
- [2] Hugh D. Young, Roger A. Freedman, "University Physics with Modern Physics with Mastering Physics"