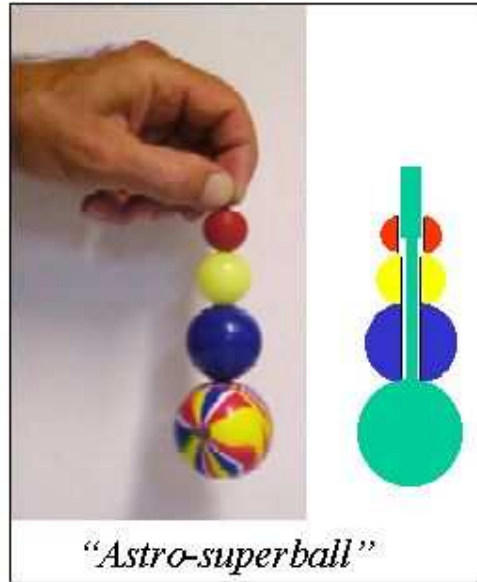


Superballs

Aim: Showing that when a superball of small mass resting on top of a superball of large mass is dropped from a low height, the small ball ideally rebounds to nearly nine times its original height.

Subjects: 1E10 (Moving Reference Frames)
1N20 (Conservation of Linear Momentum)

Diagram:



Equipment:

- 1 superball of large mass (basketball).
- 1 superball of small mass (table-tennis ball).
- ("Astro-superball".)

Superballs

Presentation: A superball of small mass is dropped and rebounds almost to the original dropping-height. Next the superball of small mass is held about 10cm above the superball of large mass. This combination is dropped simultaneously and now, after striking the floor, the small ball takes off and can reach a height nine times as high as the original dropping-height.

Explanation: Just before striking the floor both balls have a velocity v . Just after the combination hits the floor, the ball of large mass moves up with a velocity v whereas the ball of small mass is still moving down with a velocity v , making the two balls relative speed $2v$. So, the ball of small mass is approaching the ball of large mass with a velocity of $2v$. When the collision is elastic, the velocity of the ball of small mass after the collision is again $2v$, but now in the opposite direction. So the ball of small mass moves away from the ball of large mass with a velocity $2v$. Relative to the floor, the ball of large mass moves up with a velocity v , so the ball of small mass moves up with a velocity $3v$ relative to the floor. (See figures 1 to 5)

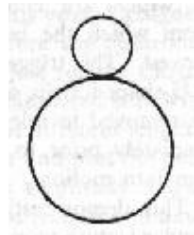


Figure 1

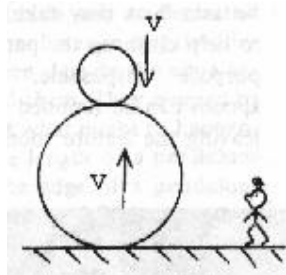


Figure 2

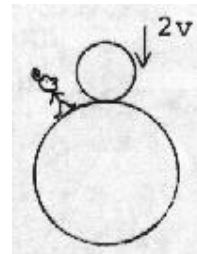


Figure 3

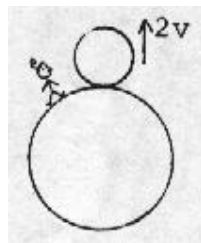


Figure 4

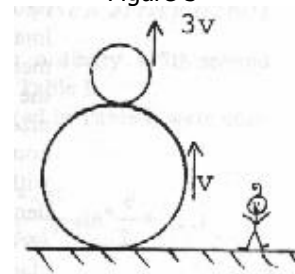


Figure 5

The small ball would have gone up with a velocity v if it had just hit the floor, but now it takes off with a velocity $3v$. Because $mgh = \frac{1}{2}mv^2$, a 3 times higher take-off velocity means that it goes 9 times higher.

Superballs

- Remarks:
- Do not rest the table-tennis ball on the basketball and drop it as such a combination. When this is done, the table-tennis ball stays fixed to the basketball (aerodynamic reason) and for this demonstration it is needed that on hitting the ground there is some distance between the two balls.
 - It is recommended that the dropping of the balls is practiced, especially dropping the small and large ball simultaneously.
 - An extension of the demonstration is to drop a stack of three or even more balls ("Astro-superball"; see Diagram). When a three-ball combination is dropped, the top ball approaches a maximum of 49 times the initial release height.
In order to drop the Astrobball-stack perfectly vertical, wetten your fingers holding the stack and slowly let it slip away.
 - The experiment does not perform very well on a wooden floor.
- Sources:
- [The Physics Teacher](#), vol. 21, no. 7, pag. 466, Superball problem, G. Stroink
 - [Ehrlich, Robert, Turning the World Inside Out and 174 Other Simple Physics Demonstrations](#), pag. 60
 - [Stark Verlag, Astro-Blaster 11938](#)