Magnetic Accelerator

P4-1365

INSTRUCTIONAL GUIDE

Contents

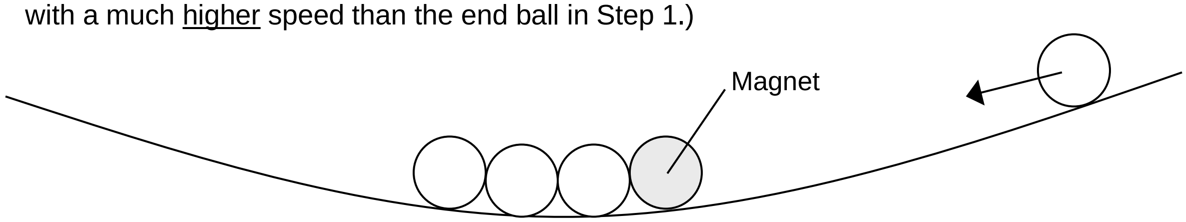
- Wooden Ramp 22''
- 4 Steel Balls ¾ ''
- Neodymium Magnet Sphere ¾ “”

Introduction

This demo is a great attention-getter. The demo setup looks familiar – a single ball colliding with a row of stationary balls. But there’s a twist! See if your students can explain this discrepant event.

1. Release a single ball from one upper end of the track. It rolls down and across the track until is collides with a stationary line of balls. As expected, the last ball in the line moves out with slightly less speed then the incoming ball.

2. Now repeat the demonstration, secretly replacing the first stationary ball in the line with the **magnetic** ball and the result is quite different. (The end ball opposite the magnetic ball shoots out with a much higher speed than the end ball in Step 1.)



3. This resulting higher speed may seem to violate the basic conservation laws of physics! Ask your students to explain, repeating the demonstration as needed for more observations. Discuss both momentum and energy.

Safety & Storage

The magnetic sphere included in this set is a very strong magnet, and should not be handled by young children. It is extremely easy to pinch skin between the magnet and the steel spheres.

Store your set with the magnetic sphere away from the steel spheres. Exposure to the strong magnetic field can quickly magnetize the steel. Also, please be advised that after many trials, the plated coating on the magnetic sphere may chip. Replacement magnetic spheres are available. Order **0.75” diameter Chrome Steel Sphere (P8-1136)**.

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Explanation

Conservation of Energy:

The kinetic energy of the exiting ball in Step 2 is much greater that of the exiting ball in Step 1, due to its greater speed. Where does the increase in energy come from?

When the incoming ball starts at rest at the top of the curved ramp it has stored potential energy (PE). This energy can be thought of as bonding energy between the earth's mass and that of the ball. By rolling down the ramp it loses some of this stored bonding energy, which is converted into kinetic energy (KE). But there is another type of bonding energy involved here. Like the gravitational force mentioned there is the magnetic force between the stationary magnetic ball and the incoming ball. This magnetic attraction results in magnetic bonding energy between the balls. Much of this stored magnetic energy is converted into kinetic energy which is mostly transferred to the ball that shoots out.

$$PE_{gravity} + PE_{magnet} = KE$$

The incoming ball in Step 2 has a higher speed at the moment of collision, but this is difficult to observe. The additional kinetic energy is transferred to the exiting ball in the collision.

Conservation of Momentum:

A close inspection of the before and after position of the stationary balls shows they have moved opposite the direction of the incoming ball. (If the incoming ball is moving to the right before collision, the stationary balls move to the left during the collision.) This increase in momentum of the four balls (with four times the mass) to the left before the collision is balanced by higher speed and momentum of the end ball that shoots out to the right. Using the vector nature of momentum, it can be shown that the total momentum of system before the collisions is equal to the momentum after.

Related Products

Newtonian Demonstrator - Newton's Cradle (P1-6001) dramatizes Newton's Third Law, which states that for every action, there is an equal and opposite reaction. Use to illustrate that momentum and kinetic energy are conserved.

Collision in Two Dimensions Apparatus (P2-8450) allows students to experience the conservation of momentum and kinetic energy by investigating the difference between elastic, inelastic, and partially elastic collisions.

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