

# Educational Innovations<sup>®</sup>

#MAG-400

## Magnetic Accelerator Paradox

Place three seemingly identical spheres on a horizontal track touching each other. Roll another sphere slowly into the spheres at rest. Wow! All of a sudden the last sphere takes off with tremendous velocity. The system seems to have gained energy!

Materials: Track, two wooden blocks, five metal spheres (2.0 cm), and one magnetic metal sphere (2.0 cm). (Safety glasses recommended, but not provided.)

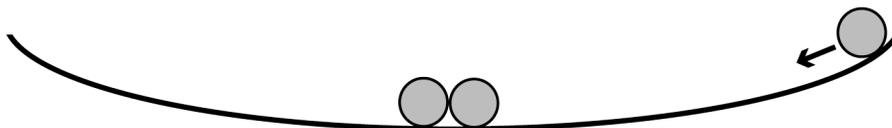
Note: The track can be used in several different orientations: straight; raised 4.0 cm on either or both ends; and raised 6.0 cm on either or both ends.

### Procedure A. Student Investigation

1. With the track raised 2.5 cm on each end, release one of the five metal spheres from one end of the track. What did you observe? At which point on the track does the sphere have the most Potential Energy? The most Kinetic?  
(Expected observations: How high did it roll up the opposite side? How many changes in direction occurred before it stopped? How long was it in motion?)



2. Place two of the spheres at the bottom and release a third one from the end. What did you observe?

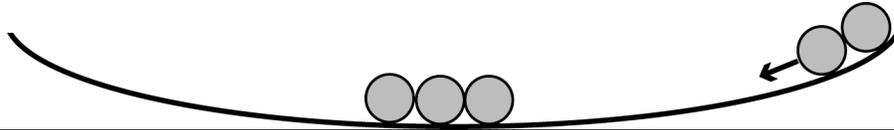


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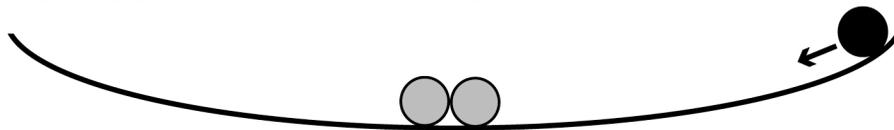
3. Experiment with different numbers of the five spheres at the bottom and releasing different numbers of spheres from the end of the curved track. What do you observe?



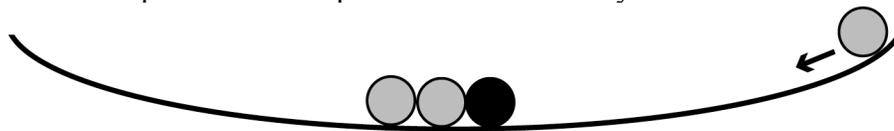
**Teacher Note:**

As with Newton's cradle (EI #NEW-100) both the kinetic energy and the momentum of the initial moving spheres are transferred to the final moving spheres. In this case, in order for both the Law of Conservation of Momentum ( $mv$ ) and the Law of Conservation of Kinetic Energy ( $1/2 mv^2$ ) to hold, the initial moving spheres must equal the final moving spheres. "What comes in is what goes out." Deviations are due to friction, and the slight magnetism of the spheres, causing them to stick together slightly and not roll well.

4. With two of the five spheres at the bottom of the curved track, release the special sphere given to you by your instructor. What did you observe?



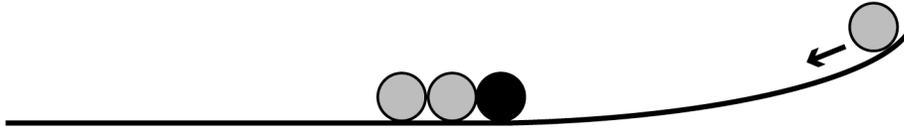
5. With two of the five spheres and the one special one at the bottom of the curved track, release another sphere into the special one. What did you observe?



**Teacher Note:**

As the released sphere gets closer to the stationary magnetic sphere at the bottom of the track, it becomes more and more attracted to the magnetic sphere. This causes a great increase in velocity. As a result, the sphere on the other end shoots out quickly. Notice that the final moving sphere is initially separated by another sphere from magnetic sphere. Consequently, it is attracted less to the magnetic sphere.

6. With only one end of the track raised and the other end near the edge of the table, set up the magnetic accelerator so that the final moving sphere travels the furthest. You can mark on floor with masking tape the final point of contact. **Caution: the strong magnetic sphere is ceramic and may crack if dropped onto a hard surface.**



7. With the track horizontal, place two of the five spheres and the one special one at the center as shown. With a pencil, slowly push a sphere from the end toward the special sphere. Observe.



**Procedure B.** Teacher Demo

Repeat steps 1 thru 5 from Procedure A in front of the class. Before each step, ask students to predict the result.

**Procedure C.** Open Ended

Provide students with all of the materials listed at the top. Ask them to experiment with the materials, carefully recording what they do and the results.

How does this activity demonstrate the Law of Conservation of energy?