INNOVATION GENERATION
Making an Impact

VOLUNTEER-LED ACTIVITY: INERTIAL IMPACT

ACTIVITY

# How are a magician's tablecloth trick and a vehicle's seat belt related?

## Objective

In this activity, students will apply the theory of inertia and Newton's First Law of Motion (as learned through a magician's table cloth trick) to create a seatbelt that protects an egg "passenger" during a crash test.

## Materials

For every group of 4 students:

- 4 wheels
- 2 1/8-inch dowels
- 2 straws
- 2 craft sticks
- Tape
- Plastic egg (if available)
- Hard-boiled egg

## For the class to share

- Extra craft sticks, 200
- Rubber bands, about 50
- 2-ounce plastic or paper cups, about 10
- Hot glue sticks and hot glue guns, at least 2

## For the presenter

- Downhill ramp (it may be beneficial to check with the teacher ahead of time to see if materials for this are already available in the classroom. Otherwise, any flat surface that is at least 5 feet long and can be tilted will do!)
- Tablet or laptop



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## Activity Prep

- Hard boil one dozen eggs. You can also use raw but that can be messy and challenging to run more than one trial.
- Watch this video so you can correctly envision and explain the wheel-building process explained in Step 5d.

## How-to

1. Get students curious by asking a series of questions (you can add in your own if you'd like!):
    - **a.** Think of an object in the classroom that is not moving. Why does it continue to stay still?
    - **b.** Think of a time when a moving object slowed down or stopped moving entirely. Why did it stop or slow down?
    - **c.** Have you ever seen this magic trick? (Use your device to show this video from 0:17–0:48 of a tablecloth being pulled out from dishes *or* draw a quick picture to show students what happens during this trick.) Have you ever wondered how or why the plates stay on the table?
2. Explain that the table cloth trick relies on inertia.
    - **a.** Elaborate by sharing a few facts about inertia:
        - i. Inertia is the scientific idea that objects resist changes in their state of motion. Objects like to keep doing what they are doing, which means they want to keep moving if they are moving, or stay still if they are still. They don't like change!
        - ii. The more mass an object has, the more inertia it has. In other words, the heavier an object is, the more it resists changes to its state of motion.
        - iii. Inertia aligns with Newton's First Law of Motion, which states that objects at rest stay at rest and objects in motions stay in motion (with the same speed and traveling in the same direction) unless acted upon by an outside force.
        - iv. A force must therefore be applied to overcome inertia. A force like a pull or a push can make something that is at rest start to move. Conversely, a force like friction can slow or stop something that is moving.
3. Have students think back to the table cloth trick for a minute. Now that we know a little more about inertia and Newton's First Law of Motion, let's think about how inertia may factor into this trick:
    - **a.** Objects at rest: In this magic trick, the plate, glass and silverware on the table are the "objects at rest".
    - **b.** Outside force: Newton's First Law states that objects at rest stay at rest unless acted upon by an outside force. In this magic trick, the table cloth that is pulled out from under the plates is the outside force.
    - **c.** Inertia: According to the concept of inertia, objects at rest don't *want* to move. Therefore, the outside force must be great enough to force this change in motion. In this magic trick, the unexpected outside force of the table cloth being quickly pulled wasn't enough to prompt motion. For this reason, the plates stay in place.

4. Now, it's time to get hands-on!
    a. Divide students into groups of four.
    b. Distribute the group materials listed above, except for the eggs.
    *Tip:* To save time, you can work with your educator to set up the classroom and distribute materials before students arrive.
    c. Tell students that the objective of the activity will be to apply what they have learned about motion to investigate another unexpected force: a car crash! Explain that each group will be building a model car that protects an egg "passenger" from cracking when it crashes.
    d. Guide students in preparing the base of their vehicle. Explain that every group will need two sets of wheels on an axle, so each group of four should split into pairs and follow along as you demonstrate the instructions:
        i. Stick the dowel through one wheel, leaving about an inch between the end of the dowel and the wheel.
        ii. Wrap tape around the very end of the dowel so the wheel can't slip off.
        iii. Slide a straw over the inside portion of the dowel. When the straw is against the wheel, there should be about an inch of the dowel showing out the other side of the straw. If an inch of the dowel is not showing, cut the straw to make it shorter.
        iv. Slip the second wheel onto the other side of the dowel, so it is close to the straw.
        v. Wrap the other end of the dowel with tape so this wheel doesn't come off. Don't make the tape too tight: Make sure the wheel is still able to turn!
        vi. Tape the craft stick to the straw, so it is flush with the length of the straw. This craft stick will provide a base when the students begin to build their car.
    e. Now that students have their four wheels complete, inform students that they should use the remaining materials to design a car with a seat/seatbelt that will hold an egg and protect it from cracking when it crashes. Quickly review the materials that are available for the groups to use and then allow them to get to work.
    *Note:* If the plastic eggs are available, distribute one for each group to use as a model as they build their car. If the plastic eggs are not available, students may use the real egg…but stress the importance of keeping this egg safe until the crash test!
    f. Give the students about 15–20 minutes to prepare their vehicle and seat belt. As students work:
        i. Set up the ramp in an area of the classroom where students will be able to gather. In front of the ramp, make sure there is something solid for the car to crash into. A wall or a stack of text books could both work well.
        ii. Use the remaining time to walk around the classroom to assist as needed. Try to provide students with words of encouragement but not specific answers!
5. Once 15–20 minutes have passed, instruct the students to gather around the ramp. One by one, call on groups to partake in the crash test: They should put the egg in their car, place their car go at the very top of the ramp, and then let it go and watch the results. Does the egg crack when their car crashes into the barrier?

As the test is performed, separate the cars into two groups: Those that protected their egg from cracking and those that did not. This will help the class easily compare the seatbelts once the test runs are done!

**6.** When the tests are complete, synthesize learning by asking students the following reflection questions:

   **a.** Why were some egg seatbelts successful while others were not?
   *Tip:* You may need to reword this question based on the results.

   **b.** Does Newton's First Law of Motion apply to this seatbelt challenge? How?

   **c.** When plates are sitting on a table, whipping a table cloth out from under them creates an unexpected force. When you are driving in a car with your seatbelt on, a crash also creates an unexpected force. What other scientific concepts connect these two unexpected events?

   - *Tip:* Ensure that the students explain that both of these unexpected events are connected through inertia:

      - When the car crashed, the egg passenger wanted to continue moving forward at the same speed because of inertia. Cars with seatbelts that couldn't adequately stop this inertia resulted in cracked eggs. Cars with seatbelts that could gently stop this inertia were able to prevent the eggs from moving and save the eggs. This is an example of an object in motion wanting to remain in motion, but being stopped by an outside force.

      - When the tablecloth was quickly pulled from under the plates, the force was small and the inertia of the plates kept them on the table. If the tablecloth had been pulled from under the plates in a different way, it may have exerted a stronger force on the plates and the plates may have moved. This is an example of an object at rest, remaining at rest, unless acted upon by an outside force (which, in this case, was a force that didn't succeed!).