"CRASH COURSE" ACTIVITY

Penny for Your Thoughts on Inertia

TEACHER LESSON 1

Key Question(s)

- How do magicians pull a tablecloth out from under an entire set of dishes? Is it magic or science?
- How is a magician's tablecloth trick related to a crash dummy falling off the tailgate of a pickup truck as the truck accelerates?

Grade levels: 9–12
Time required: 5–10 minutes

Objectives

Students will:

- learn and apply Newton's First Law of Motion
- recognize inertial mass as a physical property of matter

National Science Education Standards

Standard A: Science as Inquiry

- Identify questions and concepts that guide scientific investigations

Standard B: Physical Science

- Motion and forces

Standard G: History & Nature of Science

- Science as a human endeavor
- Historical perspectives

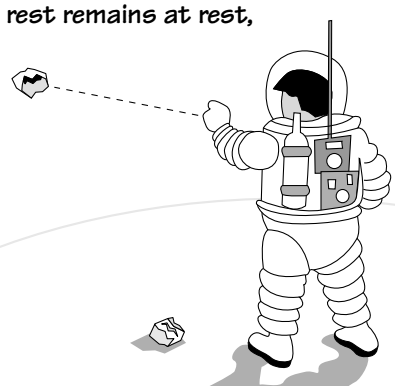
Background information

The origins of **Newton's Laws of Motion** began with the Italian philosopher Galileo Galilei (1564–1642). Galileo broke from the teachings of Aristotle that had been accepted as truth for more than 1,000 years. Where Aristotle and his followers believed moving objects must be steadily pushed or pulled to keep moving, Galileo showed with his experiments that moving things, once moving, continued in motion without being pushed or pulled (forces applied). He called the property of objects to behave this way **inertia**, which is Latin for "lazy" or "inert."

Isaac Newton, born in England on Christmas day in 1642 (the year Galileo died) refined Galileo's Principle of Inertia in terms of unbalanced forces and made it his first law of motion.

Newton's First Law of Motion

In the absence of an unbalanced force, an object at rest remains at rest, and an object already in motion remains in motion at constant speed on a straight line path.



Crash Course Definitions

inertia: property of an object to resist any change in its state of motion

mass: quantity of matter in an object; measure of an object's inertia

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Materials needed

For each group:

- 3"x 5" index card
- plastic cup or beaker
- 1–10 pennies
- (optional) mix of dimes, nickels, quarters, half dollars

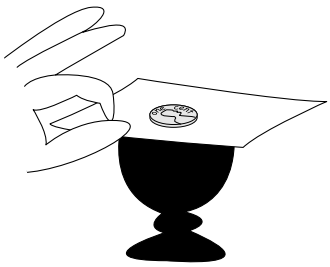
Getting ready

Assemble the materials for each group. You may wish to consider having other coins available for the groups to try. Their results may vary with the mass of the coins used. More mass results in more inertia.

Procedure

1. Cover the cup with the index card and put the penny on top of the card.
2. Challenge the students to get the penny in the cup without lifting the card and only touching it with one finger.

   Best method "Flick" the card horizontally with your forefinger.
3. After students have succeeded with one penny, challenge them to try multiple pennies and other coins.



Answers to Analysis questions

1. Describe a successful technique.
   Answers will vary. See above for best method, Step 2 Procedure.
2. Why does the penny drop in the cup when the card is "flicked" away? **Very little of the sudden horizontal force from your flicking finger is transferred upward to the penny, so the inertia of the penny keeps it over the mouth of the cup. With the card no longer providing support force, the force of gravity pulls it straight down into the cup.**
3. How did the total mass of the coins used affect your success?
   They should have been more successful with more mass. More mass equals more inertia, which equates to a greater resistance to movement. But too much mass increases the force of friction beyond your horizontal flicking force and the card cannot move out from under the coins.
4. Should magicians select lighter or heavier dishes for their tablecloth trick? Why?
   The heavier the plates the greater the inertia, and the better the magician's chance for success. But too much mass increases the force of friction beyond the horizontal pulling force and the tablecloth cannot move out easily from under the dishes. With too little mass, even a small external net force would cause the plates to accelerate across the table.

Answers to Crash questions

How is a magician's tablecloth trick related to a crash dummy falling off the tailgate of a pickup truck as the truck accelerates?

Both apply the concept of inertia. Just as inertia keeps the plates at rest as the magician pulls the tablecloth our from under them, inertia keeps the crash dummy at rest as the tailgate moves out from under it.

Name _____Period_____ Date_____

STUDENT ACTIVITY 1

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Crash test question

- How is a magician's tablecloth trick related to a crash dummy falling off the tailgate of a pickup truck as the truck accelerates?

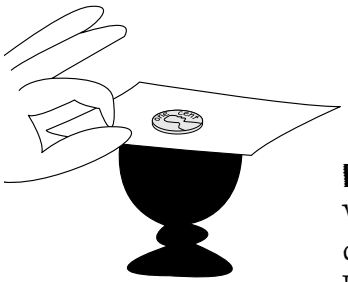
Purpose

To explore the concept of inertia.

Materials needed

For each group:

- 3"x 5" index card
- plastic cup or beaker
- 1–10 pennies
- (optional) mix of dimes, nickels, quarters, half dollars



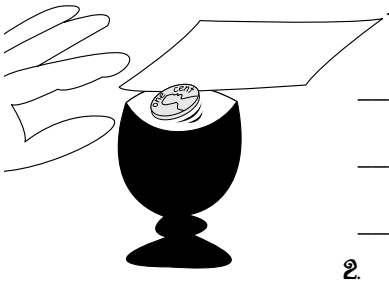
Discussion

Whether you are attempting the magician's tablecloth trick or slamming on your car brakes to avoid an accident, the laws of nature apply. Understanding nature's basic rules or PHYSICS can help improve your chances of success in either situation.

Procedure

1. Cover the cup with the index card and put the penny on top of the card.
2. The challenge is to get the penny into the cup without lifting the card and only touching the card with one finger.
3. After you have succeeded with one penny, try it with multiple pennies and other coins.

Analysis



1. Describe a successful technique.

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2. Why does the penny drop in the cup when the card is "flicked" away?

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STUDENT ACTIVITY 1

3. How did the total mass of the coins affect your success?

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4. Should magicians select lighter or heavier dishes for their tablecloth trick? Why?

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Crash question

How is the magician's tablecloth trick related to a crash dummy falling off the tailgate of an accelerating pickup truck?

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