Chicken and Clam

Overview: Next time you watch a car race, notice the wheels. Are they solid metal discs, or do they have holes drilled through the rims? I came up with this somewhat silly, but incredibly powerful quick science demonstration to show my university students how a good set of rims could really make a difference on the racetrack (with all other things being equal).

What to Learn: You're going to learn about inertia, what it is and how to measure it and its effects.

Materials

- clam chowder (1 can)
- chicken broth (1 can)
- long table
- books to prop up one end of the table so it becomes a long ramp
- optional: different kinds of cans of soup (note you must have the two mentioned above)

Lab Time

1. Prop up one end of a long table about 6-12″ (you can experiment with the height later).
2. You're going to roll both soup cans down the table at the same time.
3. Which do you expect to reach to bottom first – the chicken or the clam? Write down your guess in your data table.
4. Not only do my college students need to figure out which one will win, they also have to tell me *why*. The secret is in how you calculate the inertia of each. Take a guess, then do the activity.
5. Place the two cans together at the top of your ramp and release them at the same time so that they roll down together.
6. Do you think the can with more inertia will win or lose?
7. Try this experiment two more times in order to validate your results.
8. Try this with different kinds of soup cans. See if you can figure out a pattern and predict the results of more trial runs for this experiment.

Chicken and Clam Data Table

Soup Can #1	Soup Can #2	Guess: Who Will Win?	Who Won?

Reading

Inertia is a quality of an object that determines how difficult it is to get that object to move, to stop moving, or to change directions. Generally, the heavier an object is, the more inertia it has. An elephant has more inertia than a mushroom. A sumo wrestler has more inertia than a baby. Inertia is made from the Latin word "inert," which means "lacking the ability to move." Inertia isn't something people have a grasp of, though, as it's something you must mathematically calculate from an object's mass and size.

When riding in a wagon that suddenly stops, you go flying out. Why? Because an object in motion tends to stay in motion unless acted upon by an outside force (Newton's First Law). When you hit the pavement, your motion is stopped by the sidewalk (external force). Seat belts in a car are designed to keep you in place and counteract inertia if the car suddenly stops.

Did you know that Newton had help figuring out this First Law? Galileo rolled bronze balls down a wood ramp and recorded how far each rolled during a one-second interval to discover gravitational acceleration. And René Descartes (the great French philosopher) proposed three laws of nature, all of which Newton studied and used in his published work.

All of these men had to overcome the longstanding publicly accepted theories that stemmed from the Greek philosopher Aristotle (which was no small feat in those days). Aristotle had completely rejected the idea of inertia. He also had thought that weight affected falling objects, which we now know to be false. But remember that back then, people argued and talked about ideas rather than performing actual experiments to discover the truth about nature. They used words and reason to navigate through their world more than scientific experimentation.

In this experiment, the chicken soup wins for a very simple reason. Imagine that the cans are transparent, so you can see what goes on inside the cans as they roll down the ramp. Which one has just the can rolling down the ramp, and which has the entire contents locked together as it rolls? The can of the chicken soup will rotate around the soup itself, while the clam chowder acts as a solid cylinder and rotates together. So the inertial mass of the clam is much greater than the inertial mass of the soup, even though the cans weigh the same.

How do you calculate the inertia of the chicken soup and the clam? Here's the mathematical formulae from the back of a dynamics textbook (a typical course that all engineers take during their 2nd year of college).

Inertia of a solid cylinder = $1/2 * (mr^2)$
Inertia of a cylindrical shell = $1/12 * (mr^2)$

If the radius of the soup can is 6.5 cm and the mass for both is the same (345 grams, or 0.345kg), and the mass of an empty can is 45 grams, then:

(CLAM) Inertia of a solid cylinder = $1/2 * (mr^2) = 1/2 * (0.345\text{kg})*(6.5\text{cm})^2 = 7.29 \text{ kg cm}^2$
(CHICKEN) Inertia of a cylindrical shell = $1/12 * (mr^2) = 1/12 * (0.045\text{kg}) *(6.5\text{cm})^2 = 0.158 \text{ kg cm}^2$

The numerical value for the solid cylinder is larger than the shell, which tells us that it has a greater resistance to rolling and will start to rotate much slower than the shell. This makes logical sense, as it's easier to get the shell alone to rotate than move a solid cylinder. Remember, you must use the mass of the cylinder shell (empty can) when calculating the chicken's inertia, as the broth itself does not rotate and this does not have a "rolling resistance!"

Exercises Answer the questions below:

1. What is inertia (in your own words)?

2. Why does one soup can always win?

Answers to Exercises : Chicken and Clam

1. What is inertia (in your own words)? (The resistance something has to changing its motion.)
2. Why does one soup can always win? (The can of the chicken soup will rotate around the soup itself, while the clam chowder acts as a solid cylinder and rotates together. So the inertial mass of the clam is much greater than the inertial mass of the soup, even though the cans weigh the same. This means that the clam chowder has more rolling resistance than the chicken broth.)