

Chapter 8: Momentum**Impulse**

23 Egg Toss

Purpose

To investigate the effect that stopping time has on stopping force

Required Equipment/Supplies

raw egg
garbage bag(s)
masking tape
safety goggles
football field or other playing field with distance measurements

Discussion

Drop an egg on a couch and chances are it won't break. Drop it on the carpet and it might. Drop an egg on a concrete floor and it will break for sure. You might say the couch and the carpet have more "give" than the concrete floor. In all three cases the egg comes to a complete stop, but what's different is the amount of time required to stop the egg in each case. The *change in momentum* or *impulse* stopping the egg is exactly the same in all three cases. What's different is the amount of *force and the time of impact*. More time results in less force. If the egg is dropped from the same height, it hits each surface with the same speed and the same momentum. However, as the time of impact is increased, the resulting force of impact is reduced in the same proportion.

Procedure

Divide the class up into teams of 3 or 4 members. The thrower will throw a raw egg to the catcher on their team. The catcher must catch the egg without letting it break. When the thrower and catcher are close, it's fairly easy. But as the distance increases, it becomes more challenging!

Step 1: The team must get prepared by first selecting their thrower, catcher, and one or two designated runners to retrieve and distribute eggs. Both the thrower and the catcher must only use their bare hands to handle the egg.

Step 2: The catcher must wear safety goggles and a plastic poncho. Use the garbage bag and masking tape to construct a plastic poncho. When the egg breaks, it can make a mess. Make sure the poncho covers any part of your clothes so that they are protected from raw egg.

Step 3: Go to the playing field and line up according to your teacher's instructions. The throwers and catchers should be facing each other and should start about 3 meters apart from each other.

Step 4: When the teacher gives the signal, the thrower throws the egg to the catcher. If the catcher catches the egg and the egg remains intact, the team may proceed onto the next toss. If the egg breaks, the catcher must remove the poncho and use it to clean up the egg and a runner records the distance to last clean catch.

The runners retrieve the eggs from the catchers. The catchers move back 3 meters for each successive throw, while the throwers return to their original throwing line.

Step 5: Repeat until the last group breaks their egg.

Analysis

1. How far did your thrower and catcher get from each other before the egg broke? What was the longest distance achieved in the class?

2. What techniques were employed when making a successful catch? What do they have to do with stopping force and the time of impact?

3. Compare a sudden-stop catch with a gradual-stop catch.

- a. In which case is the mass of the egg greater? Or is it the same either way?

- b. In which case is the change in velocity of the egg greater? Or is it the same either way?

c. In which case is the change in momentum ($\Delta mv = m\Delta v$) of the egg greater? Or is it the same either way?

d. In which case is the stopping time greater? Or is it the same either way?

e. In which case is the stopping force greater? Or is it the same either way?

4. How do your findings explain the purpose of airbags in cars? Refrain from using words like “cushion” or “absorb.” Do use words like “stopping time,” “stopping force,” or “changes in momentum.”

5. Suppose a baseball pitcher throws the ball to his catcher.

a. In the change in the speed of the ball thrown by the pitcher different than the change in the speed of the ball caught by the catcher? Or is it the same?

b. Is the magnitude of the change in momentum greater for the ball thrown by the pitcher or the ball caught by the catcher? Or is it the same?

c. In which case is the impulse greater? Or is it the same?

d. Does it take longer to throw the ball or to catch it?

e. Does it take more force to throw the ball or to catch it?
