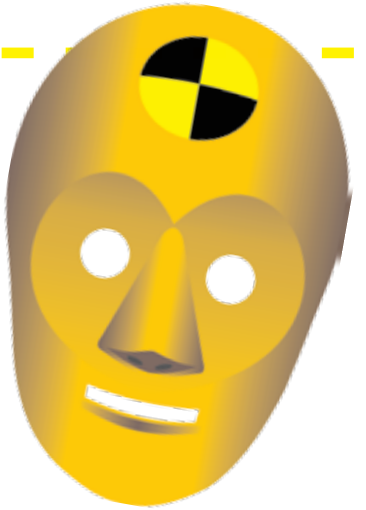
Crash Test Dummies
Inertia and That Sudden Stop



Think about This

Juan was in the highest gear on his bike as he tried to make the curve, but a little loose gravel caused him to lose his balance and tip over. He hit the ground at 15 miles per hour. Unfortunately, his body continued to travel straight ahead at 15 miles per hour until friction took over and finally stopped his movement. Knee pads, elbow pads, and a helmet minimized the damage. Juan just learned about inertia and Newton's first law of motion the hard way.

The Investigative Problem

Why is it hard to get things to start moving? Why is it hard to get moving things to stop?

Gather These Things:

- ✔ Skateboard
- ✔ 3 x 5 card
- ✔ Doll
- ✔ Long sheet of paper
- ✔ Plastic cup
- ✔ Small wooden blocks
- ✔ Toy car that rolls
- ✔ Board for ramp
- ✔ Small ruler
- ✔ Ball
- ✔ Penny
- ✔ Tape

Procedure and Observations

Part A.

Push the skateboard with your hand. Continue to hold the skateboard with your hand to keep it moving. What keeps it moving?

Push the skateboard and let go. Does it keep on moving?

Place the ball in the center of the board and give the board a push from the back. Be sure the block is taped to the back of the board. What happens to the ball?

Now place the ball at the back of the board and push the board toward the wall. What happens?

Put the doll on the back of the board and push the board toward the wall. What happens?

Discuss what happens in Part A before doing Part B.

Part B.

Try these activities. Tell what happens and give an explanation for what happens in terms of Newton's first law of motion.

(1) Put a penny on a card. Put the card over the opening of a plastic cup. Flick the card with your finger.

(2) Place a long piece of paper near the edge of a table and let about half the paper hang over the table. Stack some blocks on the paper. Hold the paper up with one hand and hit the paper quickly with a ruler.

(3) Place a penny on the top of a toy car. Let the car roll down a ramp that has a barrier at the end of the ramp.

Making Connections

Have you ever been standing in a bus or a train when it starts moving? Your body's inertia tends to keep you in the same place, but the place where you were standing moved away, dragging you with it.

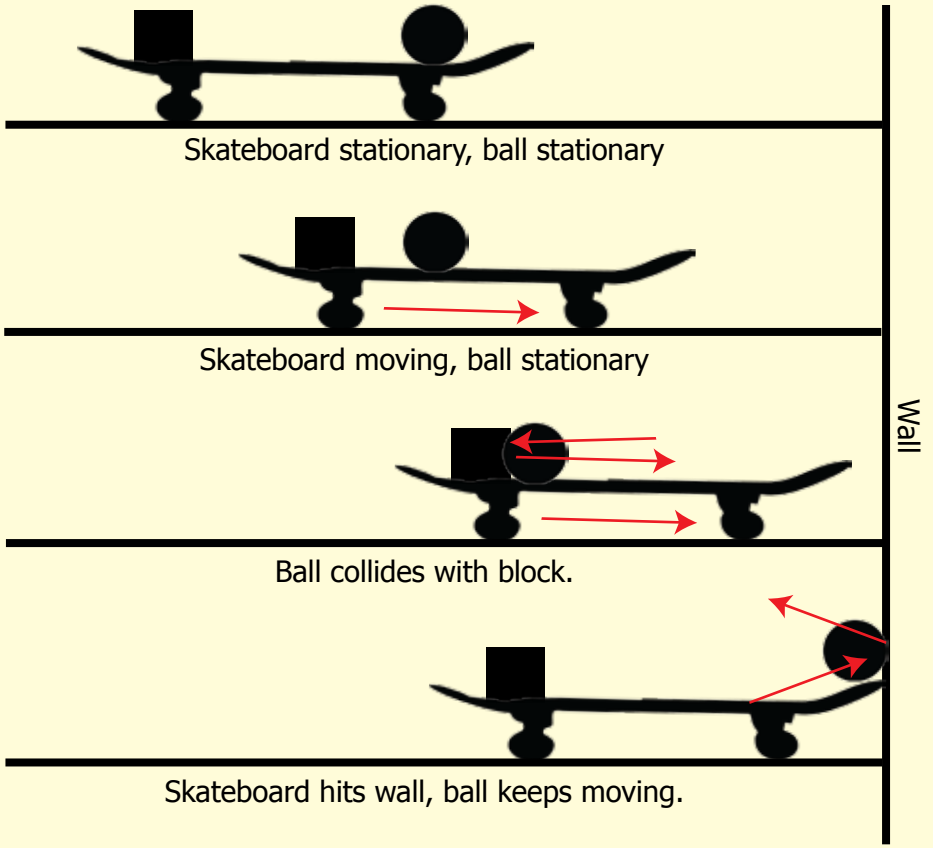
The Science Stuff

Part A.

When you pushed the skateboard with your hand, the force of your hand kept it in motion. When you pushed the skateboard and let go, the skateboard's inertia kept it in motion.

Why did the ball move to the back of the board? The skateboard moved forward when you pushed on the back. There was no force put on the ball. It may have seemed that the ball rolled to the back of the board, but actually the back of the board came forward and met the ball while the ball remained in place. Once the block on the back of the board came in contact with the ball, it exerted a force on the ball and then the ball moved.

Why did the ball continue to move toward the wall even though the skateboard stopped? When the skateboard hit the wall, it stopped because the wall acted on the skateboard and caused it to stop. When the board stopped, the ball continued moving until it also hit the wall. This is the same reason the doll hit the wall, and why you should always wear your seat belt.



Skateboard stationary, ball stationary

Skateboard moving, ball stationary

Ball collides with block.

Skateboard hits wall, ball keeps moving.

Part B.

(1) When you flicked the card with your finger, you exerted a force on the card, but not on the penny. The penny was not in motion, and the friction between the card and the penny was too small to cause the penny to move. The penny remained at rest until gravity pulled it down.

(2) When you hit the paper quickly with a ruler, the paper moved, but the blocks remained where they were stacked. A force moved the paper, but not the blocks. The friction between the paper and the blocks was very small. The blocks remained at rest throughout this activity, because they were not acted upon by an unbalanced force.

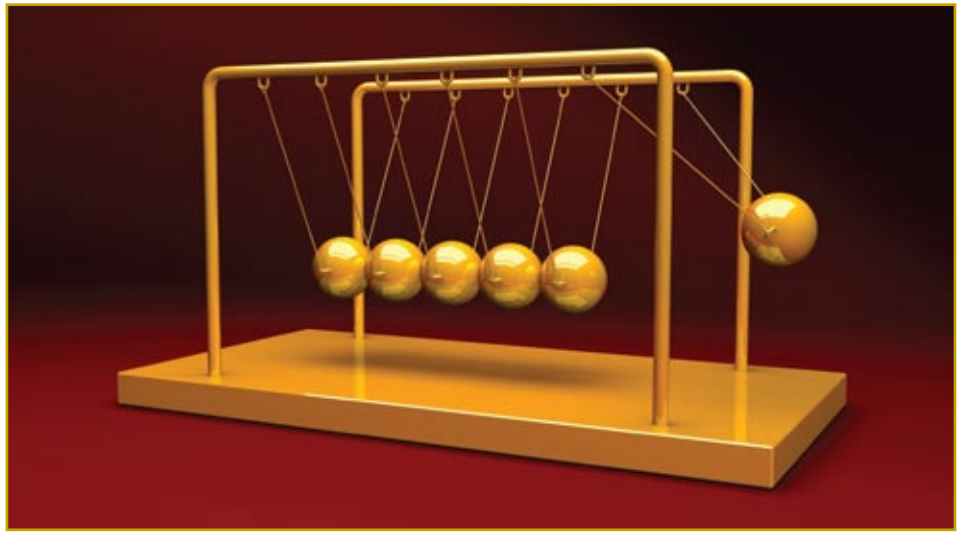
(3) A barrier stopped the car that was traveling down the ramp, but the penny on the car continued to travel straight ahead. A force stopped the car, but the penny was in motion and it continued to move forward at the same speed. Eventually the unbalanced forces of gravity and friction caused it to stop.

Toy car and penny are in motion.

Toy car stops, penny keeps moving.

Dig Deeper

Try to find at least five other examples of how an object's inertia affects its ability to stop or start (such as the newton cradle pendulums below). You may include hypothetical (but realistic) examples of how things would move in space.



A True Story

A lady was driving to a church supper with her chocolate cream pie sitting in the rear window ledge. On the way, she collided with another car. Her car suddenly stopped, her safety belt stopped her motion, but there was nothing holding the chocolate cream pie, which continued to move at the same speed and in the same direction until it hit the poor woman in the back of her head. This is another example of Newton's first law of motion.

What Did You Learn?

1. Objects in motion tend to stay in motion at the same speed and direction. What is this property of matter called?
2. Objects at rest tend to remain at rest. What is this property of matter called?
3. Suppose you placed a penny on top of a toy car and let the car roll down a ramp and hit a barrier. What would the penny do when the car stopped?
4. Would the penny (in #3) be given a push by anything when the car stopped?
5. The penny (in #3) would eventually stop moving. What would cause it to stop moving?
6. How fast would the chocolate cream pie (described in "A True Story") continue traveling if the car was going 30 miles per hour when it hit another object?
7. Was the pie (in #6) given a push to make it keep moving?
8. Why did the pie (in #6) continue to move?
9. A famous magic trick is to make a tall stack of breakable glassware on a table and then pull the tablecloth out from under the glass without disturbing it. Explain how the trick works.
10. Look up Newton's first law of motion in a science reference book and write it here.
11. What causes a moving object to stop moving?