Are you the kind of person who hears a tall tale—like the one about the boy whose tongue froze to a flagpole—and then tries to prove whether it’s true or not?

Congratulations! You’re a MythBuster!

After all, that’s how the pros, Jamie and Adam, got started. The guys didn’t have a giant warehouse full of fancy gadgets like they do today; they just made up experiments using whatever they found lying around their parents’ houses, kind of like the odds and ends they supplied for this kit. Let’s see what they’ve put in your toolbox:

**Toolbox:**
- 5 Track Sections
- 4 Connectors
- 3 Cars
- Clamp
- 6 Metal Weights
- 2 Buster Figures
- 4 Traffic Cones
- 3 Airfoil Rods
- 3 Road Signs
- Airfoil Templates

What you need from your house:
- Household items, as noted on experiments
- Tape Measure
- Scissors
- Tape

That’s some pretty weird stuff! Can you imagine how any of these things go together?

Don’t worry, Jamie and Adam sent a special assistant along to lend a hand. Say hello to Buster! You’re probably used to seeing him in pieces on the ground after he’s been smashed up, blown to bits or thrown off the roof of a tall building. But in secret, Buster’s always wanted to be part of the MythBusters Build Team. Now it’s his turn to watch something else go POP! or BOOM!

Here’s what Buster’s learned from years of experience: Not every experiment works the first time or turns out the way you thought it would. Some of the world’s greatest discoveries were the result of experiments gone “wrong.” The important thing is to use your imagination and keep trying!

Whenever Jamie and Adam are stumped, they go back to the beginning and try to figure out what they could have done differently—this is what scientists call a **variable**. A variable is the part of the experiment that you can change to affect the outcome. It’s like when you go for a ride in your family’s car—sometimes you go to the grocery store, sometimes to the mall, or sometimes to visit friends. The activity stays the same—you’re always riding in a car—but the route that you take changes. The difference in the route is the variable.

There will be tons of variables to test in the myths Jamie and Adam included in this kit, which try to prove some of the crazy stories the guys have heard about crashes and collisions. They’ve seen all kinds of things go bang, bump and smash. Why do some of these collisions end in minor scrapes and others lead to major crack-ups? That’s where the guys turn to science. Things like velocity (also known as speed), weight and friction all come into play. Let’s try some crash tests of our own and see what happens!

**Let’s start busting some myths!**
**Myth of the Heavy Weight**

When it comes to building up speed for a crash, sometimes it helps to weigh more than less.

Buster doesn’t actually eat, so he couldn’t pack on the pounds to test this myth himself. He looked in the toolbox and came up with a clever way to bust or confirm the Myth of the Heavy Weight.

**Components:**
- 5 Track Sections
- 3 Metal Weights
- 4 Connectors
- 4 Traffic Cones
- 2 Clamp
- 1 Test Chart

**Additional items you’ll need:**
- Tape Measure

**All right, Build Team, let’s get to work!**

**Phase 1: Assembling the Track**

Step 1: We’re going to be testing this first myth several times, setting up the track at different heights (high, medium, and low). You’ll be clamping the track to common items around your house—countertop, table, chair, coffee table, etc.—to reach these various heights. Choose your starting point—do you want to start with the highest or lowest point, or in the middle? It’s up to you.

Step 2: Now that you’ve chosen your height (or slope), attach the clamp to the edge of the object—counter, table, chair, whatever. Twist the screw on the bottom of the clamp to create a wide opening and fit the edge of your object (table, chair, etc.) inside this space. Now twist the screw in the opposite direction to tighten the clamp on the object, keeping twisting until the clamp fits securely—no wobbling.

Step 3: Take a piece of track and attach it to the top of the clamp—the grooves on the bottom of the track should slide into the tab on the top of the clamp.

Step 4: Continue assembling your track using pieces of track and connectors. Place a connector between two pieces of track, sliding each piece of track halfway onto the grooves of the connector. When you’ve used up all your track and connector pieces, you’re ready for the next phase of this experiment.

**Phase 2: Testing Weight**

Step 1: Take one of the plastic cars and place it at the top of the track—we’re roll!

How far did the car go? Did it seem fast or slow? Place a traffic cone where the car stopped. Test 3-5 more times. Do you get similar results?

Step 2: Now take one of the weights and slip it over the post on the top of the car.

Place the car at the top of the track and watch it roll. What happened this time? Did it go farther with the weight? Did it seem to move faster or slower than without the weight? Test 3-5 more times. Do you get similar results? (NOTE: No two rolls will ever be the same. Things like friction and air resistance—even temperature and humidity—will make each roll slightly different. You’re not looking to see whether you get the exact same result—exact same speed, exact same distance—just similar. Does it seem to always go farther with the weight? Faster or slower?) Place a different traffic cone to show where this second car usually landed.

Step 3: Repeat the experiment adding the second weight and then the third. What do you notice? Place traffic cones for the second and third weight distances. What effect does the extra weight have on speed and distance?

Use the tape measure to measure the distance from the clamp and chart these distances on the test chart and the 4 different weight scenarios.

**Phase 3: Testing Height**

Step 1: Now that you’ve seen how weight affects speed and distance, let’s see what height can do. Repeat Phase 1, clamping and assembling your track at a different height. If you started at the highest point, switch to medium or low.

Step 2: Repeat Phase 2, adding weights to the car as you send it hurtling down the new track. What happens? Does weight have the same effect at this height? More or less?

Step 3: Repeat Phases 1 and 2 at the remaining height. Compare your results with the other heights. When did the car seem to fall the fastest? When did it travel the farthest after leaving...
**WARNING: science content!**

There are lots of opportunities for you to think like a scientist here, like when you tested the relationship of mass to movement. Let’s start with weight. Why did adding weight help the car go further? You might think it would be the just the opposite—that something lighter would be easier to move. Well, there are a lot of forces at work to keep an object from moving: air resistance, friction (the rubbing of one surface against another—like a car on a track) and inertia, which is the tendency of an object to stay at rest unless it’s given a push at the start by an external force. The heavier a moving object is—like a car or a boulder—the more energy it has to overcome those forces. (Note: Mass and weight are two different scientific terms, but on Earth, their measurements are pretty much the same. We’re assuming you’re not doing this experiment in outer space.)

Now let’s talk about speed. The higher the starting point of the track, the faster an object will start moving. This is due to gravity, which is the attraction between two objects that pulls them toward each other. Here, gravity is pulling the car toward the ground—the higher the car starts, the more time gravity has to do its job. The longer an object falls, the faster it falls.

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**Buster Flashback**

Buster went back to check his work with Jamie and Adam. They suggested a few ways he could change the experiment. Can you think of some of your own?

- What happens if you set up the track on a different surface? Try a hard wood, carpet, or anything you can think of. Does this make a difference? How?
- Try starting the car with different weights at different points on the track somewhere below the top, midway, or the bottom. What happens?

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**Fun Facts**

- The heaviest car ever made was a Soviet-built limousine. It weighed six tons (12,000 pounds) and had three-inch thick armor-plated steel.
- The lightest car was built in Great Britain. It only weighed 21 pounds and its maximum speed was 15 miles per hour.
- The smallest car measured four feet, five inches long and the biggest car was more than 22 feet long! Get out a tape measure—how does this compare with your car?

Speaking of weight, this got Buster thinking about a myth. Jamie and Adam tested out the movie. They wanted to see if a bus making a sharp turn at 50 miles per hour would really need all the passengers to shift their weight to the inside of the turn to keep the bus from flipping over.

First they filled a bunch of barrels with water to match the weight of passengers on the bus. Then they put all of the barrels on the right side of the bus and made a fast, sharp right-hand turn. The bus did not flip. Next they shifted the barrels—half on the right side, half on the left—and made another sharp, fast right-hand turn. Again, the bus didn’t flip. To get the bus to flip, the guys had to shift all the weight to the outer side of the bus, make the roof top heavy and deflate the suspension. None of that happened in the movie. Myth busted!
Myth of the Hidden Energy
Cars don't need gas, battery or electric power to move.

Buster wasn't sure how to test something you can't see. Then he had a genius idea; here's how he decided to prove the Myth of the Hidden Energy.

Components:
- Track Sections
- Connectors
- Cars
- Clips
- Metal Weights
- Traffic Cones
- Road Signs
- Test Chart

Additional items you'll need:
- Common household items such as plastic drinking straws, cotton balls, sponges, etc.
- Tape Measure

Step 1: Assemble your track just like in Phase 1 of the previous activity, choosing to start at high, low or medium height.

Step 2: Place one car at the top of the slope and a second car at the bottom of the track, with the front of the bottom car facing away from the track. Mark the starting location of the second car with a stop sign so you can place it at the same spot each time.

Step 3: Send the first car rolling down the track. Crash! What happens to the second car? Does it move? How far? Repeat the experiment 3-5 times to see if you get similar results. Place a traffic cone marker to show where the second car typically landed.

Step 4: Repeat Steps 2 and 3, only this time, add weight to the first car. Does this change what happens to the second car? Does it move farther? Try the experiment a few more times — do you get the same results?

Step 5: Now perform the opposite: no weight on the first car and add weights to the second car. How was this different than step 4?

Step 6: Go crazy with the variables! You can change the height of your track — make it higher or lower. You can add more weight to the first car. You can add weight to the second car. Each the different scenarios — the height of the track and the weight of the cars — and compare your results. When does the second car travel the farthest? If the second car weighs more, what happens? What combination of height and weight produces the most damaging crash? (the second car moves the farthest) The least damaging? This is a very important part of the scientific process — recording data, repeating trials and drawing conclusions. What conclusions did you come to?
Fun Facts:
- Automobile airbags were invented by an American in the 1950s but didn’t become common in cars until the 1980s.
- Airbags have been used by NASA in spacecraft. They were part of the landing system of the Mars Pathfinder.
- When is it legal to crash? When you’re in bumper cars at an amusement park! They sprinkle graphite on the floor to reduce friction and cause more collisions.

You crashed your car on purpose, but most crashes are accidents. Buster was reminded that sometimes, like when roads are icy, it’s almost impossible to avoid a collision. Cars slip and slide all over the road. That’s why Jamie and Adam decided to test the myth that it’s safer to drive backwards on icy roads than forwards. They discovered that while it’s true that cars get better traction on ice when driving in reverse (traction is like friction—it’s the resistance between tires and the ground, the way the tires do or don’t grip the road), it’s super hard to steer the car going backwards. Everyone on the Build Team drove a car through an icy course, and they all had more trouble steering in reverse than keeping the car on the road going forward. Myth busted!

The Myth of the Hidden Energy is...
- Busted
- Confirmed
- Plausible

Myth of the Double Hit

In a crash, it’s better to be the last hit than the first.

Buster doesn’t like getting hit at all! He looked in the toolbox and here’s how he decided to test the Myth of the Double Hit.

Components:
- 5 Track Sections
- 4 Traffic Cones
- 4 Connectors
- 2 Road Signs
- 3 Cars
- Climber
- Obstacle
- 6 Metal Weights

All right, Build Team, let’s get to work!

Step 1. Assemble your track just like in Phase 1 of the Heavy Weight activity, choosing to start at high, low or medium height.

Step 2. Place one car at the top of the slope and a second car at the bottom of the track, and a third car in front of the second car. Mark the starting location of the second and third cars with traffic cones or road signs.

Step 3. Send the first car rolling down the track. Crash! What happens to the second car? What about the third? Does it move? How far? Repeat the experiment 3-5 times to see if you get similar results.

Step 4. Repeat Steps 2 and 3, only this time, add weight to the first car. What happens to the second and third cars? Try the experiment a few more times—do you get the same results?

Step 5. Repeat Steps 2 and 3 but add weights to the third car this time. How does this change what happens?

Step 6. It’s time for some variables! You can change the height of your track—make it higher or lower. You can add different amounts of weight to the cars—one weight on each car, all the weight on one car, etc. You can place the second and third cars closer together or farther apart. Can you come up with 10 different ways to run this experiment? How about 20? How about 100? Chart the different scenarios—the height of the track and the weight of the cars—and compare your results. How did you transfer the most energy to the third car? The least? What were your conclusions?

Did Buster get it right? He thought that increased friction and weight would make for softer crashes among three cars than two. Did you get the same result? Is the myth Busted or Confirmed?
WARNING: science content!

Hey, are you getting complicated? Remember all those things—friction, air resistance, resting inertia—that slow down objects? Well, the more cars you use in an experiment, the harder it gets to overcome those forces. In the first activity, you only had to overcome those forces once; in the third activity, you had to overcome them three times—one with each car. So there's less energy to transfer to the third car, which can make for safer crashes, especially if all the weight (and a lot of the energy) is in the third car. The lightweight first and second cars will have a harder time getting the third to budge. You wind up with way too many massive crashes than when you just used two cars.

Buster had Jamie and Adam look over his scientific method. They gave him some helpful hints on changes he might make. Can you come up with some of your own?

* What happens when you try the experiment on different surfaces such as grass, concrete, or tile?
* What if the second or third car is facing sideways?
* What if you change the placement of the second car on the track—moving it closer to the first car?

FUN FACTS

- One of the first crash test dummies was named "Sierra Sam."
- Crash test dummies were first widely used to help develop and test seat belt designs.
- During crash tests, dummies are dressed all in yellow.

Buster Flashback:

Buster has seen three vehicles crash before—when Jamie and Adam decided to test this myth:

If two big trucks crashed head on, with a compact car between them, would the trucks flatten the car and fuse together? The guys crashed a couple of trucks with a car, but the car wasn't flattened, it was pushed to the side instead, and the trucks weren't fused together. Knowing Jamie and Adam, they couldn't stop there. They crashed the car with a rocket sled, to see if it would flatten and fuse with the car. The sled hit the car at 648 miles per hour—way faster than a truck could possibly travel. The car totally disintegrated, but didn't fuse with the sled. To get metal to fuse together, they decided to use explosives, which worked, but trucks aren't usually crashing with explosives. Myth busted!

The Myth of the Double Hit is...

- Busted
- Confirmed
- Plausible

The Myth of the Double Hit is...

- Busted
- Confirmed
- Plausible
Myth of the Mighty Wind

Buster has been in so many crashes, he would love to know how to stop them. He looked through the toolbox and found the perfect way to test the Myth of the Mighty Wind.

Components:
- Track Sections
- Cars
- Connectors
- Metal weights
- Airfoil Rods
- Additional items you'll need:
  - Household items such as paper, aluminum foil, cloth, etc.
  - Scissors
  - Tape

All right, Build Team, let's get to work!

Step 1. Assemble your track as in previous activities.

Step 2. Cut out the airfoil templates from pages 15-16 of this guide. Select an airfoil template and cut out. Add airfoil to airfoil rod, with tape.

Step 3. Send the car rolling down the track. What happens? Does the airfoil make the car travel farther or not? Repeat the experiment 3-5 times. Do you get similar results?

Step 4. Add weights to the car and send it down the track. (Note: To add weights, you'll have to remove the airfoil and then reattach it.) Does this make a difference? How? Change the slope of the track. What happens?

Step 5. Play around with the position of the airfoil—place it in the center of the slot, move it to the left or right. Which position makes the car go farther? Which ones slow it down?

Step 6. Place a second car at the end of the track. Using what you've learned so far, how can you position your airfoil to keep the first car from crashing into the second when you send it down the track?

Did Buster get it right? He thought that you could use the airfoil to manipulate the wind to create more or less air resistance. Did you get the same result? Is the myth Busted or Confirmed?

WARNING: science content!

Your airfoil acts as either a parachute or a sail. Parachutes, which really backwards sails, are used to slow the motion of an object—like a person jumping out of an airplane—by creating drag. Drag is also known as air resistance, which acts against velocity, like a brake. You might have seen drag racing cars, which can reach speeds of 330 miles per hour, use parachutes to slow them down when they cross the finish line. Sails do the opposite. They gather air pressure and use it to propel an object forward. If a sail is moving with the wind, it traps the air behind it. If a sail is moving against the wind, it restricts the wind toward the sail. Depending on its shape and position, your airfoil either increased air resistance [parachute] or decreased it [sail]. Can you tell when your airfoil worked like a parachute or a sail?

Overall, Jamie and Adam thought Buster did a good job with the experiment. They did have a couple of ideas for variables. Can you think of any others?

- Try using different materials for your airfoil, like an index card, fabric, aluminum foil or plastic wrap. Does this make a difference? Why?
- Use a hair dryer set on cool and blow behind your air foil. What happens? Is too much wind a good or bad thing? Now blow from the front—what happens?
**MYTHBUSTERS**

**FUN FACTS**

- Leonardo da Vinci designed an early parachute in 1485; it was successfully tested in 2000.
- The world record for the highest parachute jump is 101,516 feet.
- The descent lasted 13 minutes and 45 seconds and reached a top speed of 854 miles per hour.
- Top fuel dragsters are the fastest accelerating vehicles on earth—they can go from 0 to 320 miles per hour in less than 5 seconds. They need parachutes to help slow them down.
- Seats look like a single piece of fabric but are actually made from a number of panels sewn together.

**Buster Flashback**

All this talk of parachutes reminds Buster of the time the MythBusters team tested to see whether one skydiver could catch up to another skydiver that had been given a head start, just by streamlining his body. First the Build Team confirmed that objects with a greater surface area do fall slower than objects with equal mass but smaller surface area. Then it was time for the real test! Tory jumped out of an airplane first, using the traditional skydiving position—belly to earth, with arms and legs outstretched (creating more surface area). After waiting 15 seconds, Nick, a professional skydiver, jumped out of the plane and streamlined his position (less surface area). Nick passed Tory in about 20 seconds, just as Tory was beginning to open his parachute. Myth confirmed!

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*Here are your airfoil templates. Cut them out and tape one onto the airfoil rod or car. Refer to the instructions on page 13 to see how each template assembles.*

![Airfoil templates](image)

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*The Myth of the Mighty Wind is...*

- Busted
- Confirmed
- Plausible

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*Tape this fin to the back center of the Airfoil shown to the left.*
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