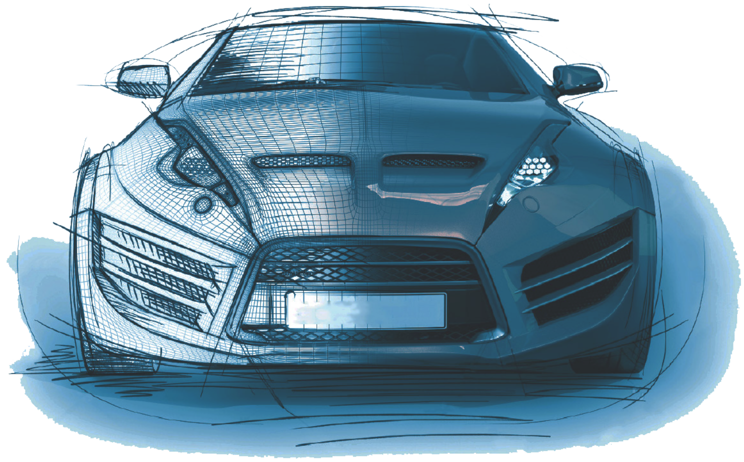
AMERICA'S CAR MUSEUM®

CRASH-TEST CARS

LESSON PLAN PACKET



INTRODUCTION:

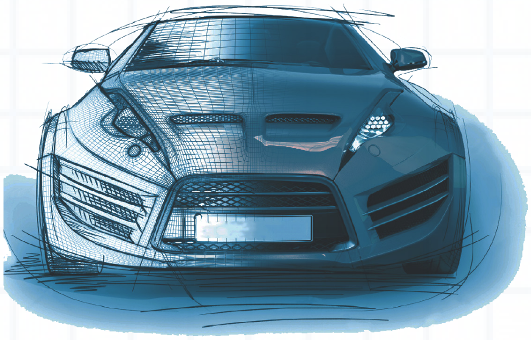
Vehicle Safety

Early cars could not reach the speeds of today's vehicles and safety wasn't a priority for many decades. In fact, people thought that if a car needed a seatbelt, then it must not be as safe as cars without seatbelts. More recently however, car safety has become a priority to protect people in crashes and even prevent crashes altogether. Modern cars are built with safety in mind, and in many ways, are built to crash. With design features like crumple zones, bumpers, roll cages, air bags, seat belts, soft, rounded interior elements etc. engineers work to ensure that if there is an accident, passengers in the car are able to walk away alive.

How are car accidents related to Newton's Laws?

According to Newton's first law, an object in motion continues in motion with the same speed and in the same direction unless acted upon by an unbalanced force. In the absence of an unbalanced force, an object in motion will maintain its state of motion. This is often called the law of inertia.

The law of inertia is most commonly experienced by passengers in a vehicle and is the main cause of injuries in a car accident. For example, if a car were to crash into a wall, an unbalanced force acts upon the car, causing it to abruptly stop. Any passengers in the car will also be stopped if they are strapped to the car by seat belts. Being strapped tightly to the car, the passengers share the same state of motion as the car. As the car accelerates, the passengers accelerate with it; as the car decelerates, the passengers decelerate with it; and as the car maintains a constant speed, the passengers maintain a constant speed as well. However, if the passengers are not wearing seat belts, they would not be attached the car when it abruptly stops. This means they will remain in motion until another object stops them—whether that be the steering wheel, the seat in front of them, or, worse, the windshield or the road on the other side.



LESSON PLAN

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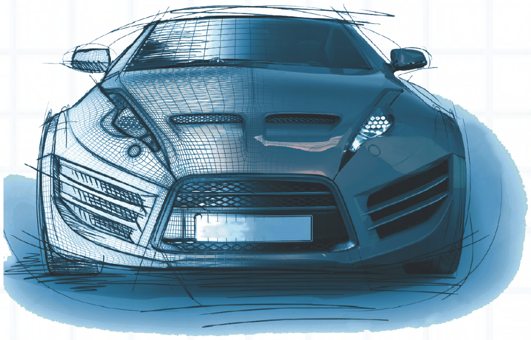
GOAL:
Students gain a basic understanding of vehicle safety features and how they relate to Newton's Laws as they plan, design, and problem-solve to successfully complete a design challenge.

OBJECTIVES:
- Students design and build a car to protect an egg in a crash car
- Students understand that, per Newton's First Law, the passengers in a car crash will remain in motion unless acted upon by an unbalanced force
- Students explore the design process as they experiment, test, and revise their designs

MATERIALS:
- Car Kits (Wooden Chassis, 2 Sets of Wheels in Each)***
- Scissors
- Hole Punchers
- Tape (Scotch and Masking)
- Glue
- Glue Sticks
- Hot Glue Guns and Glue Sticks
- Pencils
- Markers
- Scratch Paper for Sketching
- Popsicle Sticks/Skewers (various sizes)
- String
- Cardboard
- Pipe cleaners
- Cotton balls
- Paper (various colors and weights)
- Paper cups (various sizes)
- Paper Plates
- Cloth Scraps
- Recycled Materials
- Craft Materials
- Eggs and plastic baggies
- Other Materials as Available

***If you do not have access to car kits, you can make your own!
- Some ideas for car chassis: sturdy cardboard, cardboard boxes, paper towel rolls, toilet paper rolls, popsicle sticks, scrap wood/metal/plastic.
- Some ideas for axels: toothpicks, straws, small dowels, chopsticks
- Some ideas for wheels: buttons, spools, bottle caps with holes punched in them, CDs, empty cans



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SET-UP:

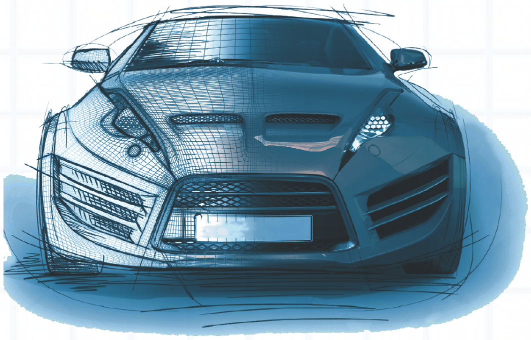
1. Set up the work area with four separate areas: tables with basic tools (pencils, scissors, tape, glue, etc.) and building materials; an additional supply table with scrap paper, cardboard, ribbon/string, recycled materials, etc.; a hot glue station with glue guns and paper to catch any melting glue; and a testing area.
2. It may be helpful to display information for students on the design problem and key things to keep in mind while completing the design challenge. On a whiteboard or poster board, display the design problem and helpful hints or reminders for students to reference during build time. Additionally, you may want to have a few samples handy for any students who need a little extra inspiration to get started. These shouldn't necessarily be pointed out initially, as we are really encouraging students to come up with their own solutions.
3. Set up a separate testing area where students can test their cars. Create a ramp by taking a folding table and setting it with only one side of the table up on it's legs. The other set of legs should remain folded under the table. The side of the table that is laying on the floor should be pushed up against an empty wall. It may be helpful to create bumpers using cardboard and attach them to the sides of the table so cars don't fall off the sides. When students are ready, they will release their cars at the top of the ramp and watch as they roll down and crash into the wall. You may want to protect the wall at the end of the ramp from dents and potential egg mess with cardboard or something else.

PROCEDURE:

Begin with a discussion about vehicle safety. First, ask the students if anyone can share Newton's First Law of motion, and if they can explain how that relates to car accidents. Then, ask the students to think about and share some of the features car designers include when designing automobiles that keep passengers safe. Some answers should include air bags, seat belts, etc. Ask the students if any of them have younger brothers or sisters—what keeps them safe in the car? (Car seats are a great example of how to keep the egg safe!) If need be, remind the students that there are some safety features built into cars that they can't see. Explain some of these features like roll cages and crumple zones, and why they are important (crumple zones are built to absorb some of the force of the crash—meaning passengers inside won't feel the full extent of the force of the crash).

Then, explain the project for the day. Tell the students that they'll be designing and constructing a small-scale car that will keep an egg safe in the event of a crash (rolling their cars down the ramp/8' table into the wall). Remind them that when a car stops, the passengers keep moving… how will their eggs stay safe? Explain that the students will be testing their cars first with a fake Easter egg, and then, only when the students are 99% sure their cars will be successful, with a real raw egg. Tell students to use the materials you've given them, as well as additional materials they find to build their cars.

As the students are working, encourage them to test their cars early and often. They can test whether their cars are successful by putting them down the ramp in the classroom and crashing



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them into the wall. Students should first use the Easter egg as a placeholder for the real egg, and should be sure that the egg can be easily removed and replaced. As you help students test their cars, make some suggestions and ask questions about different aspects of their cars. If the egg pops out, you can ask: “What could you add to make sure the egg stays in the car?” Also, remind students that the Easter egg is a lot lighter than the real egg, and therefore is easier to keep in the cars. If they need to, students can (and probably should) return to the workstations and make any necessary modifications. Once the students are 99% sure that the real egg will survive the crash, the instructor should take a real egg and put it in a small plastic bag before inserting it into the car for the final test! At this point, assuming there’s some time left, have a follow-up discussion with the students. You can ask questions including:

- Why do you think some cars protected their eggs better than others? What did the most successful cars have in common?
- Did anyone have any challenges when designing their cars? What were they and how did you change your design to address them?
- What might you have done differently after seeing the results of the testing?

STANDARDS ADDRESSED:

Next Generation Science Standards (NGSS):

K-PS2-1: Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

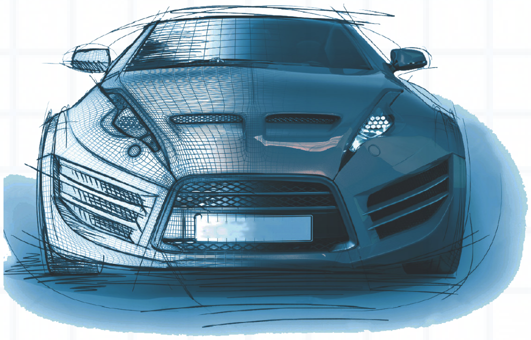
K-PS2-2: Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

2-PS1-1: Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

3-PS2-1: Plan and conduct an experiment to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

3-PS2-2: Make observations/measurements of an object’s motion to provide evidence that a pattern can be used to predict future motion.



Force and Motion

Force and Motion

What is a force?
A force is a push or a pull on an object. A push or a pull can set a still object in motion and likewise, a push or pull against an object in motion can stop it. If you push a toy car to make it move, the push is the force that made the car roll. If you pull the car to you, the pull is the force that made the car roll back to you.

What is motion?
When something is not sitting still, it is in motion. In order to put the car in motion, you must apply a force. If you push the car it begins to move and is in motion. Once in motion, a force must be applied to make it stop. For example, if the car hits a wall, the wall applies a force that stops the car from moving.

What is inertia?
The tendency of something to keep moving or stay at rest, unless a greater force stops or moves it, is called inertia. Imagine riding a skateboard down a hill. If you pushed off and coasted down the hill you would keep going until you hit something that would make you slow down or stop.

What is friction?
Friction is a force that slows things down. An example of friction is the rubbing of car tires against the road as it moves forward. When a road is covered in ice, there isn't as much friction between the tires and the ice. This is why cars can slide out of control when driving on ice. By adding rough sand on top of the ice, a car's tires can hold on to the road better because there is more friction between the tires and sand than there is between the tires and ice.

What is gravity?
Gravity is a force that pulls all things towards the earth. It keeps your feet on the ground unless another force pushes or pulls you off of the ground. Gravity is what helps pull your bike down a hill and it is why you pick up speed as you continue down the hill. It is also what makes it harder for you to ride uphill.