Balloon-Powered Cars

| **Subject:** Physics  **Related Subjects:** Mechanical Engineering, Physics. | **Grade Level(s):** 6-8th  **Length of Lesson:** 55 minutes | **Type:** Project  **Keywords:** Newton’s Laws, friction, gravity. |
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# Lesson Overview

*Students will explore Newton's laws of motion and understand the effect of gravity and friction on moving objects. Additionally, students will design and build their own cars and apply what they learned to their design using the engineering design process.*

# Lesson Focus

# *What are Newton’s laws of motion? How does friction affect moving cars? How does gravity affect moving cars?*

| Lesson Objective(s) | By the end of this lesson, students will…   1. Understand Newton’s Laws of Motion. 2. Explain the friction force and how it impacts moving objects. 3. Understand the gravity effect on moving objects. |
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# Lesson Timing

| 10 minutes | Introduction |
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| 10 minutes | Newton’s Laws of Motion and simple physics lesson. |
| 15 minutes | Design Process and Building Cars |
| 5 minutes | Testing the Cars |
| 10 minutes | Reflection and Discussion |
| 5 minutes | Wrap Up |

| Materials | * Cardboard (count: 1 ). * Straws (count: 3). * Wooden Skewers (count: 2). * Tape (count: 1). * Children “Safety” Scissors (count: 1). * Bottle Caps. (count: 4). * Balloons (count: 1). * Ruler (count: 1). |
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| Teacher Prep | 1. Practice building the balloon-powered car prior to presentation. 2. Set up super glue or cut holes in the bottle caps, as they will serve as the wheels and need to be secured to the wooden skewers 3. Decide whether you want to demo/give the directions to build the cars OR print out the directions below to give to students |
| Related Resources | * Youtube video (1): <https://youtu.be/5gYF5azO6jI>(4 minutes) * Youtube video (2): <https://youtu.be/PFHs-uNVFpw> (~2 minutes) * [Build a Balloon-Powered Car - Scientific American](https://www.scientificamerican.com/article/build-a-balloon-powered-car/) |

# Lesson Plan

## Introduction

1. Get the students engaged by asking some questions related to the lesson. For instance:
   1. Has anyone seen a race car before?
   2. Has anyone seen a car accelerate from 0-60 mph (even in a movie)? How does it accelerate so fast?
2. Show students the examples of different car designs [in the pictures below] and give them time to identify which design they think is the fastest car? Best at off-roading?
   1. Talk about how cars are designed for different purposes.
   2. Different functions call for different features and designs.

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## Lesson on Physics

* Before we start the lesson, let’s keep the conversation going for a little longer.
* Ask the students:
  1. First, can anyone describe what gravity is or what it does? (Take responses before showing an answer).
  2. Now, if you roll a ball (or model car) down a ramp, will it keep moving forever? Why or Why not?
     1. No because of friction. Friction is what happens when two things rub against each other. Friction slows or stops moving things. A rolling ball eventually stops because friction between the ball and the ground brings it to a stop.
  3. Which do you think will cause less friction, smooth surfaces or rough surfaces?
     1. Smooth. Think about this when we build and test our car.
  4. Which do you think moves faster: a regular car or a van? Why?
     1. First, take a couple of responses. Then explain that the van’s shape creates more air resistance which slows it down. Hence, a regular car moves faster than a van.

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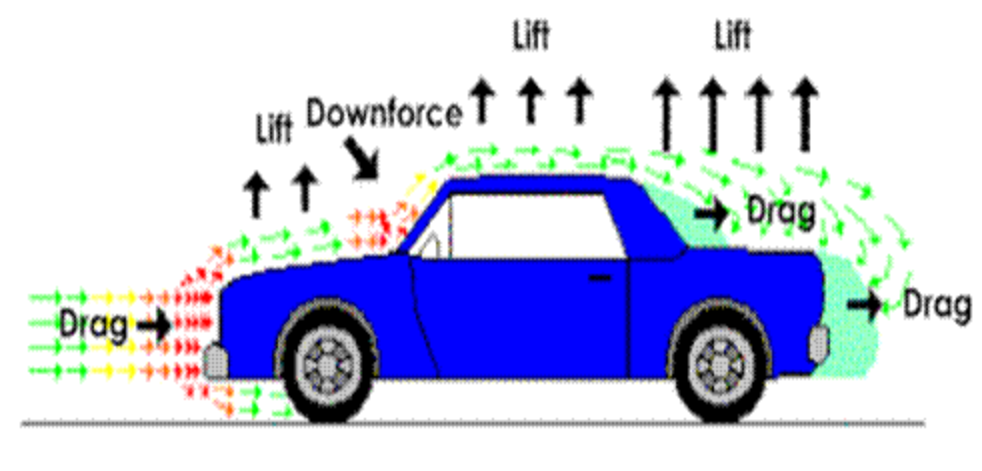
In order to make the concept of air resistance easier to understand, you can use the following example:

* When we ride a bike, we usually feel the wind against our faces; that is the power of air moving against us. This moving air slows us down. It can even stop us completely if it is strong enough. This is called wind resistance, or sometimes, drag.

This ties directly to today’s lesson; **Newton’s laws of motion**, Present these laws:

* The first law of motion states that objects at rest will stay at rest and objects in motion will stay in motion unless outside forces acted upon them.
* You see this all the time. The school bus does not move until the bus driver puts the key in the ignition, turns on the car, and starts driving. In our case, the balloon-powered cars we will build today will not move until we blow some air into the balloon, pinch the straw for a second, and then let it go!
* The second law of motion states that the greater the mass of an object, the more force it will take to accelerate the object.
* We also see this all the time in the real world. The school bus is heavier than our parents' personal cars, and therefore, it is most likely slower than our parents’ cars. In our case, the larger (heavier) the cardboard we use for our cars, the slower it is for the car to move. Therefore, one way to build a faster balloon-powered car is to use smaller cardboard than the one described in this lesson.
* The third law of motion states that for every action there is an equal and opposite reaction.
* The easiest way to understand this is to look at the balloon-powered cars that we will build today. In this experiment, we will blow some air in the balloon, pinch the straw, and place it at the back of the car. By doing this, we will notice that the air will flow from one side of the straw and the car is going to move in the opposite direction. The action here is blowing air into the balloon and directing the airflow into one direction. While the reaction is the car moving in the opposite direction of the airflow.

Show the forces that result from a moving car:

Show Video: [What Causes Drag on Cars? Viscous and Pressure Drag Explained - YouTube](https://www.youtube.com/watch?v=xReTQzdocdA)

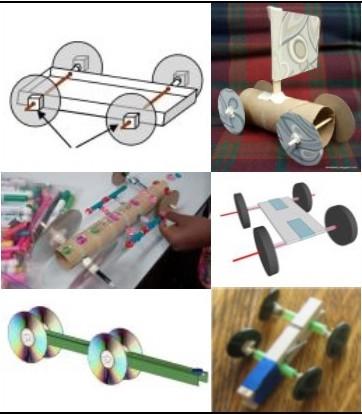
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## Design & Build

Time to design! Our goal is to create the most *aerodynamic* car possible. Your goal is to create a car that will travel the farthest. Thus we are looking to reduce drag.

Here are some examples for you to look at for inspiration.

Highlight that many of these designs are not very aerodynamic while others are. Remind them we are looking to minimize drag to get their car to be the most aerodynamic, so it can travel the farthest.



**Directions to Build**

Emphasize the importance of the axle mechanism (skewer inside straw), as their war won't move unless the wheel/axle can rotate freely!

Let students know it's okay to deviate from these directions, they can get creative!

1. Cut a ~3-inch by ~6-inch rectangle out of cardboard.

* First, use a pen and ruler to draw the rectangle.
* Then, cut the rectangle out with the safety pair of scissors.

1. Cut two 3-inch pieces from a straw.

* Make sure to only use the straight part of the straw, and do not use the flexible section. This is because this part will hold the wheels and axles in place, and it must be straight.

1. Tape the straws to the cardboard.

* Lay the straws across the cardboard widthwise, ½-inch from each narrow end.
* Make sure that the straws are straight and parallel to the ends of the cardboard.

1. Cut two 4-inch pieces from a wooden skewer.

* Cut the pointy ends off of the wooden skewer first. Then, cut the wooden skewer down to 4 inches.
* We will need two pieces to make the axles for the car’s wheels.

1. Slide the skewers into the straws.

* Make sure you have about ½ inch sticking out of each end because the wheels will go onto the end of the skewers next.

1. Make the wheels.

* Use four bottle caps to form the wheels. Use the safety scissors to poke a hole in each bottle cap.
* Make sure the hole is large enough for the skewers to fit.

1. Attach the wheels to the skewers.
2. Tuck a straw into a balloon and tape it in place.

* Slide a straw into a balloon by ~2 inches.
* Wrap some tape in a tight spiral around the end of the balloon.
* Extend the tape over the edge so that it covers part of the straw. Make sure that there are no gaps.

1. Tape the straw to the top of your car.

* Turn the car so that it is standing on its wheels.
* Place the straw and balloon on top, each facing a narrow end.
* Make sure that the straw is straight.

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## Test Run!

1. Blow some air into the balloon through the straw.
2. Pinch the straw shut so that the air does not escape.
3. Place the car on a smooth, flat surface.
4. Let go of the straw and watch the cargo!
5. After practicing, record 3 trials of your car going -- record its distance using either your own feet or a ruler. Also, record how long it went before stopping.

## Discussion

1. Have students briefly present their finished cars.
2. Ask students for a thumbs up if their car worked, and a thumbs down if their car did not work.
3. Many may have thumbs down, let them know that is perfectly okay!

* In fact, this is what always happens in the real world. We build, test, learn from our mistakes, and then, improve our designs. This is what we call the engineering process!

1. Identify whose car went the furthest and discuss why the class thinks it was the most successful car.
2. Now ask the students, what was responsible for slowing their cars to a stop.
   1. Ran out of air -- lost its propulsion, **AND**
   2. Friction from the tires and the ground slowed the car to a stop.
3. Ask students what would happen if they changed the material of the wheels to be smoother or rougher.

## Wrap-up

1. Ask students what design choices could be made to get their car to go faster.

Examples:

* 1. Adding more air to the balloon.
  2. Making their design more aerodynamic/sleek to minimize drag

2. Recap the connection to Physics (Newton’s 3 laws of motion, friction being the reason for the halt of their cars, etc).

## Key Concepts and Vocabulary

* **Drag:** the force of air that pushes back/against something or someone; air resistance.
* **Friction:** the force created when two things rub against each other.