

SCIENCE FAIR CENTRAL

MAKE. CREATE. EXPLORE.



Rocket Car Grand Prix: Family Edition

Create a water rocket race car powered on water and air!

Background

If you were challenged to build a model race car that had no motor, do you think it could win a race? If you constructed it correctly, it just might!

In this family activity, your family will work together to build your own race cars. Your car base will be an empty plastic bottle, which you will fill partway with water and then pump with compressed air. When this combination of compressed air and water is trapped within the bottle, it contains potential (or stored) energy. The compressed air wants to escape, but it can't when the bottle is closed! When an opening is made in the bottle, pressure is released and the air inside the bottle is finally able to leave. As the air escapes, water is forced out of the bottle too. Newton's Third Law of Motion states that for every action, there is an equal and opposite reaction. So as the water and air spurts backwards out of the bottle, it propels the car forward. During this process, the bottle's potential energy transforms into kinetic energy or energy in motion.

Plan

In this activity, your family will follow the instructions below to create a variety of rocket race cars that operate using water power! You will work together to help each other build cars that have a similar base. Then once the base of your cars is built, it's competition time! You'll work individually or in teams to make your car as aerodynamic as possible as you brainstorm how to minimize air resistance and help your car win the *Rocket Car Grand Prix: Family Edition!*



Design

Car Construction Materials: The materials below will create one car. To make additional cars, multiply the materials marked with a star by the number of cars you plan to design!

Create!

Before you begin the instructions below, decide how many cars your family will create. Will you each ultimately want to race your own car or would you like to race in teams? Either way, you will help each other build your car bases before you work more extensively on your own cars. No matter what you decide, try to create at least two different cars so you can have a race!

Step 1: Car Body Basics

The directions below explain how to make one car, so follow these directions together as you create the body of each car:

1. Lay your plastic bottle on top of the piece of wood. Position the bottom of the bottle so it is flush with one end of the wood. (The bottle and the wood should be about the same length!) Then wrap the tape entirely around the wood and the bottle. Do this twice: Once near the bottom of the bottle and once near the top. Try to keep the tape as tight as possible.
2. Next, work together to add the wheels! Decide with your team where you think the wheels will work best. You may want to use the measuring tape so the wheels are the same distance apart on both sides. Then begin with one wheel and hold it in its position. The axle should be placed through the wheel and an adult can use the hammer to nail the axle into the wood. Your car base is complete once you have done this for all four wheels!
3. Now you need to give your race car some energy! First, you'll need to build a nozzle so you can fill your car with air and water. To do this, grab the valve. If there is a cap on it, take it off. An adult should then use the pliers to reach into the valve, grab the inside of it, and twist it until the inside unscrews and can be removed. You now have your nozzle!

Materials

- 2-Liter plastic bottle *
- [Strip-board lumber](#) (at least ½ inch thick) cut by Home Depot into 15 inch by 4 inch rectangles *
- [Wheels and axles](#), 4 *
- [Tire valve stem](#), 1 *
- [Electrical tape](#)
- [Bicycle pump](#)
- [Scissors](#)
- [Needle nose pliers](#)
- Drill and drill bit set
- [Hammer](#)
- [Stop watch](#)
- [Measuring tape](#)

Car Optimization Materials:

The materials listed below are suggestions of what you could use to make your car more aerodynamic. You will likely not need all of the listed materials; nor should your materials be limited only to this list. Use these as a starting point and go from there!

- Additional [cardboard](#)
- [Scissors](#)
- Additional [electrical tape](#)
- [Pine shims](#)
- [Door wedge](#)
- Wheel [Lubricant](#)



4. Now it's time for your family to use your drill and drill bits to make a hole in the bottle's cap so the valve can be inserted. Work together to examine the size of the valve and select a drill bit that looks just a little too small. (It's easier to correct a hole that is too small than one that is too large!)
5. Take the bottle cap off the bottle, so an adult can use the selected drill bit to drill a hole into the cap. Once a hole has been made, see if the nozzle will fit through it. (You should have to push it... it shouldn't just fall through!) If it can't be pushed through the cap, gradually use bigger drill bits to make the hole bigger and bigger until it can be pushed in.
6. Once you have pushed the valve into cap, pull it through until the end is flush against the inside of the top. (In other words, once you screw the bottle cap back onto the bottle, the valve should be sticking out.) It should be a tight fit, so use your strength! Then screw the cap back onto the bottle.

Step 2: Optimization

Now it's time to get competitive and brainstorm what else you can do to help your car win the Rocket Car Grand Prix. Once you have worked together to create each of the car bases, split into your teams and follow the directions below to give each car important finishing touches!

1. As your car soars down the race track, you'll want it to be as aerodynamic as possible. To accomplish this, you'll need to reduce its **drag**.
For instance: Think about the difference between throwing a piece of paper through the air versus throwing a paper airplane through the air. No matter what, both will experience drag—which is the wind and air that slows them down by pushing them in the opposite direction of their motion. However, the paper airplane will fly much farther because it has been designed in a way that reduces drag and makes it fly through the air more easily. The same effect happens with cars!
2. Confer with your teammates and brainstorm what you may be able to do to optimize your car and help it travel as quickly as possible. Ideas to explore include:
 - a. Shape: Could you change the shape of the front of your car so it's more aerodynamic and air can flow over it more easily?
 - b. Weight: Will extra weight make your car move more quickly or more slowly?
 - c. Wheels: What could you change (or add) to help the wheels glide on the ground as smoothly as possible?
3. Once you have brainstormed a few ideas, use the materials available (or other materials in your home that you think may be helpful) and get to work!

Tip: Before you make any permanent changes, test out your ideas! First give your car a push to see how it moves without any alterations. Then make small, non-permanent changes to see if your ideas are on the right track. If your car seems to move more easily, you'll know your optimization idea works and you can make the full change!



Step 3: Race Time!

1. Before you can race, you need find a race track! Go for a walk or drive as a family and search outside for an area with pavement where you can race your cars. Try to find a long, safe driveway or an empty paved area. Do not try this on the sidewalk, because your car may turn onto the street if it can't go straight.
2. Once you have scouted out a good location, gather your racing supplies! First, you'll need to prepare your cars by filling each bottle about 2/3 of the way full with water. When you lay the bottle sideways, water should entirely cover the bottle hole. Your family will also need to bring tape, a stopwatch, and a bike pump to the race.
3. Then travel back to your Rocket Car Grand Prix location. Use the tape to mark a starting line and finish line on the pavement. The lines should be at least 20 feet apart, but decide together if you'd like to make your race more or less challenging.

Alternatively, you could decide to have *just* a starting line and then race to see which car travels the farthest—not the fastest. How your race works is up to your family!

4. When your family has decided on the ground rules, it's time to race! If you have two bike pumps, your cars may race at the same time. If you only have one, you will race them one at a time, but you can use the stopwatch to record how long it takes for each one to cross the finish line or use tape to mark on the pavement how far each car was able to travel.
5. Decide which car will go first, and attach the bike pump to the car's nozzle. Then use the pump to put a little pressure into the bottle...Two pumps should do the trick!
6. Keep the bike pump attached to the race car, and carefully position the car on the starting line. Make sure it is facing the right direction!
7. Decide who is going to be in charge of timing each car. Then, as a family, count down from 3 and release the pump. The car should (hopefully!) propel towards the finish line.
8. Record how long it took for the car to cross the finish line and/or use tape to mark how far it traveled. Then complete the steps above with each new car to see which family member or team will walk away with the Rocket Car Grand Prix First Prize!

Next Steps

- Use a smartphone to record the race, and then share the results with others—either on social media or in person!
- Think about how each of the cars performed and consider what you learned. Then try to construct another car, this time making slight modifications to make your car even better. See if you can beat your original time!
- Students can bring their rocket race car to school and share how it works. They could even try to inspire their peers to build their own so Rocket Car Grand Prix: School Edition can be held!

