Instructions

It's Lightning Fast
POWERED BY BAKING SODA & VINEGAR

⚠️ WARNING:
High powered projectile. Stinging hazard. Adult supervision required.

⚠️ WARNING:
CHOKING HAZARD - Small parts. Not for children under 3 years.

Adult Supervision Required
Rocket Car Assembly Instructions

A Unique Science Adventure
The Rocket Car is a new addition to our fleet of original high performance rockets. Powered by baking soda and vinegar, this remarkable racer will streak over 200 feet. It's easy to assemble, endless fun, sturdy enough for days of excitement, and you'll learn lots about rocket science.

Building the Rocket Car

All the parts are included
Nose cone • Foam tape for nose cone • Two aluminum axles • Tubing for wheel stops • Wheels • Axle support • One liter fuselage bottles • Balsa wood for stabilizer fin • High pressure fueling modules • Silver foil with adhesive backing to cover fin and to attach parts

Construction supplies
To assemble the Rocket Car you will need scissors and a ruler. Plastic cement is a good adhesive to attach the fin but we also include directions for attaching it with adhesive backed silver foil. Scotch tape and a sharp hobby knife are useful but not essential.

Fuel
The Rocket Car is powered by carbon dioxide gas that forms from the chemical reaction of baking soda and vinegar. A one pound box of baking soda and a quart of vinegar from the grocery store will provide enough fuel for an afternoon of unforgettable fun.

This kit includes a large sheet of adhesive backed silver foil. The pattern below shows how the sheet can be cut to provide foil for taping parts together, covering parts, and making the lightning bolts for the fuselage.

<table>
<thead>
<tr>
<th>Cover Both Sides of Fin 11&quot; × 4.5&quot;</th>
<th>Fin Support 5&quot; × 1.25&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tape to Attach Front Axle Support and Axel 6&quot; × 2.5&quot;</td>
</tr>
<tr>
<td></td>
<td>Tape Rear Axle to Bottle 3.5&quot; × 2.5&quot;</td>
</tr>
<tr>
<td>Cover Axle Support 13&quot; × 3.5&quot;</td>
<td>Lighting Bolt Design 10&quot; × 3.5&quot;</td>
</tr>
<tr>
<td>Tape Fuselage Seam 7&quot; × 1.25&quot;</td>
<td>Tape Fuselage Seam 7&quot; × 1.25&quot;</td>
</tr>
<tr>
<td></td>
<td>Fin Support 5&quot; × 1.25&quot;</td>
</tr>
</tbody>
</table>
Front Axle Assembly

**Step A**

**Cover Axle Support with Silver Foil**

1. Cut a piece of silver foil 3.5” x 13” as shown on the foil layout. Cut this piece in half lengthwise to make two strips 1 3/4” x 13”

2. Poke out the axle holes in the axle support. Then remove the protective backing from the foil and cover both sides of the axle support.

3. Poke out the axle holes through the foil with a pin, nail, or something else sharp.

**Step B**

**Attach Axle Support and Brass Axle to Bottle**

Follow steps 1 through 4 to attach the axle support and the axle to one of the plastic bottles, which will become the front fuselage bottle.

Taping Tip: There is approx. 2.5” x 6” on the foil layout for tape to attach the axle support. Cut strips from this section to attach the axle support firmly to the bottle.

1. Tape axle support on center seam of bottle. Make sure the score line on the axle support lines up with the bottle seam. This is important to keep the wheels straight.

2. Cut two 1/8” long pieces from the rubber tubing for wheel stops.

3. Mark the center of the axle rod then slide it through the holes as shown. Push the wheel stops over the ends to keep the axle from slipping out.

4. Tape center of axle rod to middle of axle support. This will make the axle support curve as shown.
Vertical Stabilizer Assembly

Step A
Make Stabilizer Fin
1. Cover both sides of the balsa wood with silver foil. Then cut out the fin template from the template page and tape it to the foil covered balsa. Use a hobby knife or sharp scissors to cut the fin from the balsa.

2. If you prefer, the fin shape can be cut from the balsa before covering.

Step B
Attach Fin to Rear Fuselage Bottle
If you are using plastic cement, follow steps 1 through 3 to attach the stabilizer fin to the rear fuselage bottle.

1. Glue fin along one of the long seams on the bottle
   Position front edge of fin at second seam around the circumference of the bottle

2. Cut two 1.25” x 5” fin supports from the silver foil. Fold each lengthwise down the center.

3. Remove the protective backing from the foil and attach the supports to each side of the fin.

Rear Axle Assembly
Bend the aluminum rod (1/8” dia. x 12” long) into an axle for the rear wheel. The shape shown is a suggestion only. All you need to do is bend the rod so that the rear wheel points the same way as the front wheels. It’s helpful to make a U or L shape at the end that attaches to the bottle. This will keep the axle correctly aligned when you tape it to the bottle.
**Join Fuselage Bottles**

Follow steps 1 through 4 to complete the fuselage assembly.

1. The red plastic sheet rolls into a tube to join the front and rear fuselage bottles together. The sheet is 10” x 12.5”. You can use the tube as it is or lighten it slightly by cutting 1.5” off the long side to trim it to 10” x 11”.

2. Peel the protective backing from the foam tape and wrap the tape around the inside edge of the nose cone.

3. Roll the red plastic into a tube 10” long. Then slide the front and rear bottles into the tube until it touches the front of the fin and the rear of the axle supports. Adjust the tube to fit snugly around the bottles and tape the seam.

4. Push the nose cone on to the end of the bottle. It should come almost to the front edge of the axle support. The foam tape will usually hold the nose cone in place, but you may need to attach it with small pieces of silver foil or tape.

**Attach Wheels**

**To Attach Front Wheels**

A. Cut two 1/8” long pieces of tubing for wheel stops.

B. Slide wheel over axle.

C. Push wheel stop over axle.

D. Adjust so that wheel turns freely.

**To Attach Rear Wheel**

A. Cut two 1/8” long pieces of tubing for wheel stops.

B. Slide wheel stop over axle.

C. Slide wheel over axle.

D. Push wheel stop over axle end.

E. Adjust so that wheel turns freely.

*Note:* After putting the rear wheel on the axle, you may need to bend the axle rod to make the wheel run straight and keep it from touching the bottle.
Apply Lightning Bolts

Cut the lightning bolts from the template page and tape them to the silver foil. Cut out the shapes with scissors, peel off the protective backing, and apply the bolts to the sides of the red fuselage tube.

Attention!

For Your Safety
The Rocket Car should NEVER be operated without adult supervision.

WARNING: Like all rockets, your Rocket Car will take off with a powerful launching thrust. You should always observe the following rules for every launch and only those 8 and older should operate the Rocket Car. Adult supervision is required. This is not a toy for young children!

Operating Safety Rules:
1. Please read all instructions and the science section of this booklet before you begin assembling your Rocket Car.

2. Do not use any fuel in the Rocket Car other than that specified in this booklet.

3. Never stand in front of the Rocket Car. Serious injury could result if the Rocket Car were to launch.


5. Never point the Rocket Car at people, animals, houses, cars, etc. Always launch the Rocket Car from level ground.

6. After every launch, check to make sure that all of the parts are securely fastened and reconnect them if necessary.

7. For maximum safety, use safety glasses or goggles (not included) during each launch. Keep all observers at least 60 feet from the launching area. Do not try to catch the Rocket Car.

8. It can take anywhere from a few seconds to a couple of minutes for the Rocket Car’s fuel (baking soda and vinegar) to mix and generate enough gas for launching. Do not approach the Rocket Car if it fails to take off. Ask an adult to examine the car. When examining or refueling the Rocket Car always hold the Rocket Car away from the body. Do not point toward yourself, any other person, animal or thing.

Safety Between Launches:
Clean out the Rocket Car with soap and water between uses. This should be done every time, because vinegar is acidic and will damage the plastic if it is allowed to dry in place, which will cut down on the effective life of your car.
Special Safety Precautions with High Pressure Fueling Module

The fueling module controls the gas pressure inside the rocket. When the gas reaches a high pressure level it blows the entire fueling module out the back of the rocket with great force. (It can go 200 feet or more.) Because of this, take special care to make sure no one is behind the Rocket Car at any time. You can tie a length of kite line or other strong string (approximately 20’ long) to the fueling module to limit how far it goes.

The high pressure fueling module comes preassembled. If you take it apart, put it back together as shown above. **Never use the Rocket Car without both stoppers. The back stopper is a safety feature that must always be in place.** The tube is attached at launch time.

**Fueling the Rocket Car**

Maximum performance of the Rocket Car requires approximately 1 cup of vinegar and slightly less than 3 tablespoons of baking soda. A one pound box of baking soda and a quart of vinegar will give you a good number of runs.

**A. Pour Vinegar into Rocket Car**

Turn the Rocket Car upside down and pour in vinegar. For the best performance, we suggest 3/4 to 1 cup of vinegar. If you don’t have a measuring cup, the back edge of the red fuselage tube is a good reference point. It will take about one cup of vinegar to fill it to that level. If you want to start with less power, try 1/2 to 3/4 cup of vinegar.

**B. Adjust rubber stopper on fueling module**

The red rubber stopper should be tightened slightly but not enough to compress the black rubber stopper.
C. Slip tube on fueling module and fill with baking soda

Slip the tube loosely over the end of the stopper on the fueling module. Do not force it on tightly. Then fill the tube with baking soda (1/2 to almost full, depending on how far you want the Rocket Car to go.)

D. Insert fueling module into rocket

Hold the Rocket Car horizontally (to keep the vinegar and baking soda from mixing) and insert the fueling module into the bottle mouth. Push it in as tightly as you can. Twist the stopper as you insert it for a tighter fit.

E. Tighten red stopper

Tighten the red stopper 8 or 9 turns. Turning the stopper expands it and increases the gas pressure needed to blow it out. We recommend you only tighten the stopper 7 or 8 turns the first few runs. As you gain experience, the stopper can be tightened more for additional power.

Important Note:
Do not overtighten the red stopper. If it is too tight, the gas inside the rocket may not be able to force the fueling module out. This will prevent the Rocket Car from launching.

F. Turn Rocket Car upside down to empty baking soda into the vinegar

Important Safety Note: The Rocket Car will begin to pressurize when the baking soda and vinegar mix. Do not stand over either end of the Rocket Car or point either end at people or animals.
To start chemical reaction, turn the Rocket Car upside down. The baking soda will pour out of the tube into the vinegar and carbon dioxide bubbles will begin to form.

*Helpful Hint:* You can shake the Rocket Car gently to get the baking soda out of the tube, but don’t let the vinegar slosh into the tube. This will clog the tube and keep the baking soda from coming out.

*Another Helpful Hint:* Be sure to clean and dry the tube between launches.

**The Launch**

A. Turn Rocket Car over and place it on the ground

Give the Rocket Car one good shake and place the Rocket Car on the ground.

B. Stand back for blast off

Stand back about 10-15 feet to watch the Rocket Car blast off. The time to launch will depend on the amount of fuel and the tightness of the fueling module. Normally, the Rocket Car will launch in 8-30 seconds.

**Where to Launch**

A large playground at a school or park makes a good course for the Rocket Car. It will perform best on surfaces like asphalt or concrete, but you can also enjoy it in fields with dirt or grass if the ground is smooth.

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**Important Safety Note**

If the Rocket Car does not launch within two minutes, the stopper is probably too tight. If this happens, an adult should pick the Rocket Car up, hold it firmly, and push the stopper out (like removing a champagne cork). Do not stand over the Rocket Car at any time or allow the nose or tail end to point at people or animals. The gas inside the Rocket Car can send the fueling module 30 feet or more.
Rocket Science

Why Rockets Go
As you watch the Rocket Car blast off, you might ask yourself what makes it go. That's probably something the first Chinese rocketeers explored when they invented rockets almost a thousand years ago. And it's a question people continued to think about for centuries as rockets spread across the world.

The secret to rocket power can be found in the work of Sir Isaac Newton, a great scientist who lived in England during the 17th century. His famous laws of motion explained that every action produces an equal and opposite reaction. You can see this with a balloon when you blow it up and let go. What happens? It flies across the room as the air inside flows out the opening, pushing the balloon in the opposite direction.

The same thing happens with rockets. The earliest ones were small tubes packed with black powder. As the powder burned, it created gases that streamed out the exhaust tube, pushing the rocket in the opposite direction. The giant rockets we have today burn thousands of gallons of liquid fuel to create the flow of gas needed to hurl them into space.

Rocket fuel from food
The Rocket Car streaks off for the same reasons. Mixing baking soda and vinegar causes a chemical reaction that makes carbon dioxide gas. As the gas fills the rocket bottle, it creates more and more pressure against the stopper until the fueling module pops out. The pressure blows the vinegar, baking soda, and gas out of the bottle, pushing the rocket with an equal force in the opposite direction. The chemical reaction takes place because baking soda is a base and vinegar is an acid.

High pressure for long distance
The high pressure fueling module is the secret to the Rocket Car's great power. Tightening the red stopper expands it and lets more gas from inside the bottle before the fueling module is forced out. The higher pressure pushes the gas, baking soda, and vinegar out with more force and results in a longer run.

Science Experiments
Racing the Rocket Car is a great way to explore chemical reactions, matter, energy, aerodynamics, and a host of other interesting topics. Here are a few experiments that young rocketeers will enjoy.

Is gourmet vinegar better?
Does stronger vinegar make better fuel? Check the label on the vinegar in your kitchen and you'll probably find that it contains 5% acid and 95% water. Balsamic vinegar is usually one percent stronger (6% acid), and some specialty vinegar concentrates have an acid content of 15%. Fuel the Rocket Car with different strength vinegars and compare the performance to see which ones produce the most power.

How much is too much?
The directions suggest filling the Rocket Car with up to one cup of vinegar and 3 tablespoons of baking soda. What will happen if you add more? Will the rocket go twice as far if you double the fuel amounts? What happens if you use less fuel?

What does the water contribute?
Vinegar from the grocery store is mostly water. Try mixing water and baking soda together to see whether it will produce a chemical reaction. If the water isn't needed to react with the baking soda, does it have any other useful purposes? Try a smaller amount of high strength vinegar concentrate to see what happens when there's less water to push out the rocket.

*The optimum amount of gas is produced when mixing 1200 grams of 5% vinegar and 83.9 grams of baking soda. This allows the ingredients to completely react.
Rocket Car Template

Patterns for: Vertical stabilizer fin and two lightning bolts.

Cut these patterns out to use as templates for making the Rocket Car vertical stabilizer fin and two lightning bolts for the sides of the fuselage.