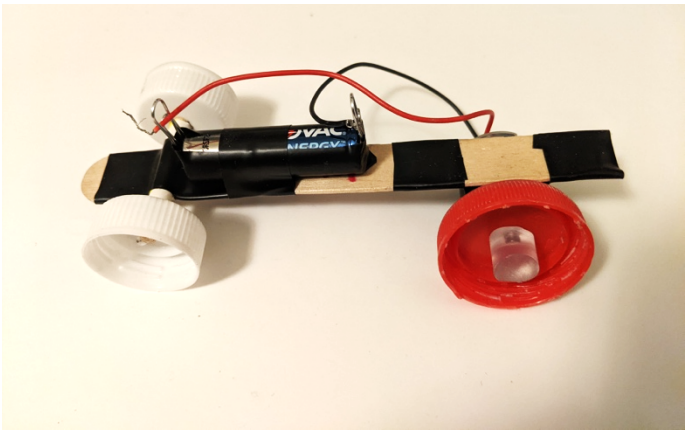
Build a simple motorized car or use the parts to create a vehicle design of your own!

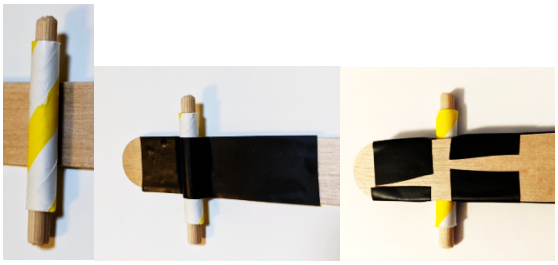
Materials needed:

- Hobby DC motor
- AA battery
- 2 uncoated metal paper clips
- 3 plastic bottle caps with holes drilled in center
- Large popsicle stick
- Straw
- BBQ stick
- Tape
- (optional) extra materials to modify car



YouTube **VIDEO INSTRUCTIONS** at SciWorkshop.org/KITS

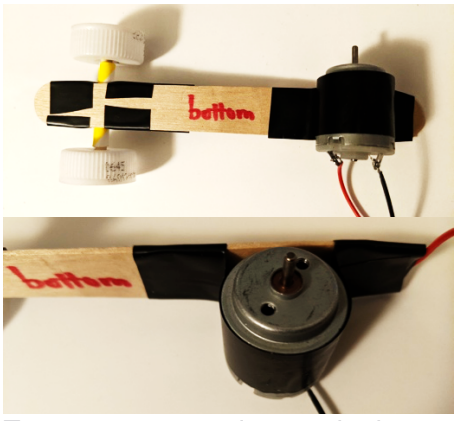
1.



Tape axle (piece of straw with slightly longer piece of BBQ stick inside) on one side of the large popsicle stick. Make sure not to squish the straw so that the axle can rotate freely.

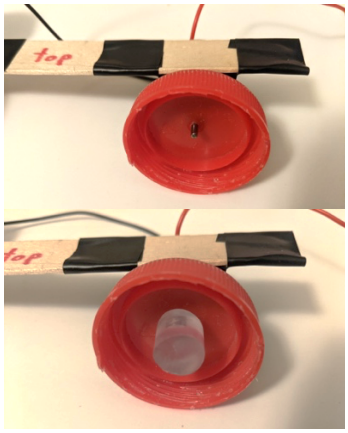
2. Push two bottle caps (with holes drilled) onto the BBQ stick. Holes should be a little smaller than the stick. A tight fit means they won't fall off or wobble! You might have to push hard (ask an adult for help if you need it). Spin them and make sure they are not rubbing against the straw.

3.



Tape motor securely onto the bottom side of the front of the popsicle stick. This takes a surprisingly long piece of tape.

4.

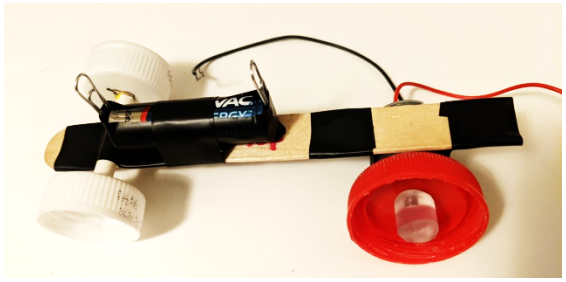


Push a wheel with very small hole drilled into it onto axle of motor. Push glue stick piece on after the wheel to hold it firmly in place.

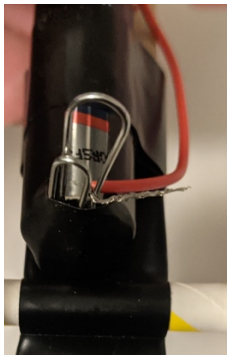
5.

Attach paper clips to both ends of battery to serve as wire connectors. Stretch the tape tight around. The clips need to be held firmly against the battery.

6.

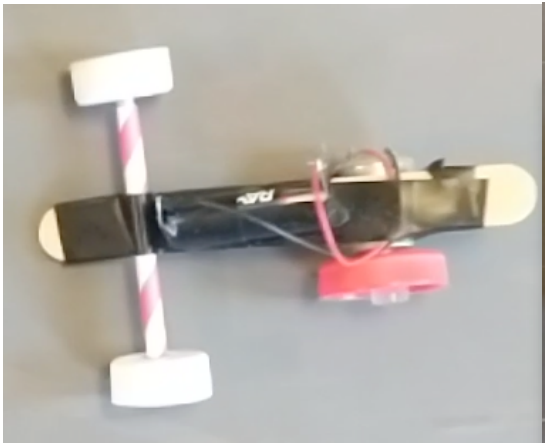


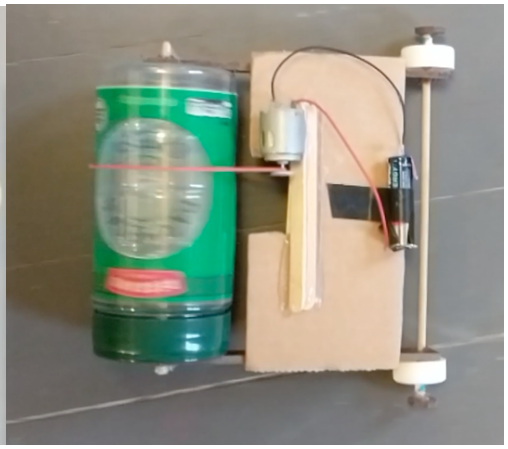
Tape the battery on the back of the car. Battery should be located over the back axle.



Connect motor wires to the paper clips. Twist one side on tightly and leave the other loose, tucking it in between the paper clip loops where it can be easily removed to turn off.

Give your car a test-drive!
Trouble shoot any problems and experiment with variations on the design (see examples below)
How can you improve it?





Which of these cars would win a race? See the video at sciworkshop.org/KITS !

We'd love to see what you made! Share pictures or video of your project
sciworkshop.org/contact

Tips and Tricks:

Want the motor to turn the other direction? Switch which motor wire connects to the negative and positive end of the battery

Be gentle with motor – if the wires get pulled off they are hard to re-attach

To think and to try

How could you change the design so the car drives straight ahead?

Would bigger wheels slow the car down or speed it up?

If you add more weight to the car, will it move slower or faster?

What would make the car "drift" (move sideways) more around a turn?

If you add a second battery in series with the first, what do you think will happen?

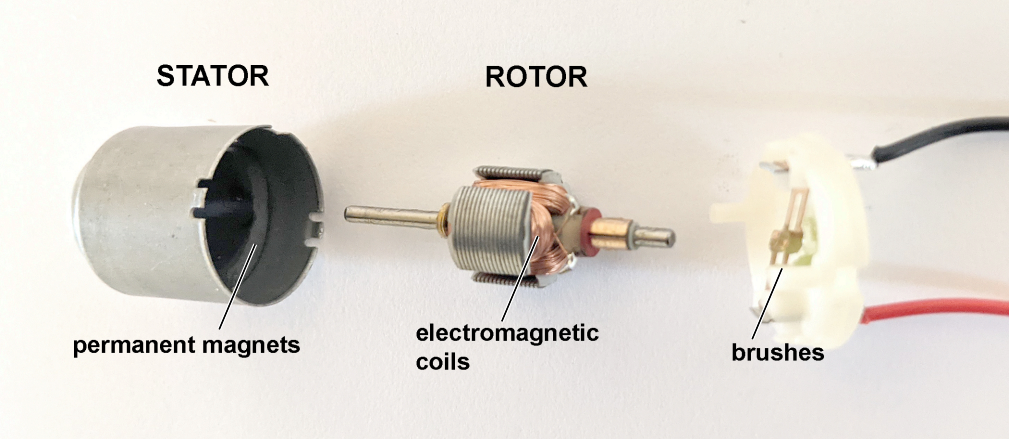
A bit about friction and motors

Friction, which occurs in areas when two surfaces make contact, is both the friend and enemy of your race car design. Make sure that your wheels can spin freely and easily without rubbing, and no part of your car's frame ("chassis", pronounced chas-eey) or wiring is dragging on the ground and slowing your car down.

On the other hand, when it comes to your wheels getting traction (gripping the ground), friction is a good thing! Newton's third law of motion states that for every action there is an equal and opposite reaction. When your car tires push backward against the floor, the floor pushes the car forward equally. If the car wheels do not grip the floor to push backwards, the floor will not push the car forwards. How can you improve traction? You can use a grippy surface like rubber on your wheels, design the car so that the wheels don't spin too quickly, and add enough weight over the axles so that the wheels have good contact with the floor. The amount of contact area matters too – wider wheels generally have more surface area touching the ground.

You can learn many important physics concepts simply by tinkering and trying out different designs. Which is better – big wheels or small? A narrow or wide chassis? Direct drive (wheel directly on motor shaft) or belt-driven (rubber band connecting the motor shaft to the wheel axle or roller)? Heavy or light? More or less voltage? You will quickly find that there are trade-offs to each design choice. Watch closely when you test out a change to your vehicle - you can learn a lot through trial and error!

Curious how the motor works? Let's take a look inside!



The electric motor in your little race car uses magnetic force to produce a turning motion. Try holding a paperclip or similar metal object up to the side of the motor – do you feel the magnetic pull? The motor's walls have permanent magnets on the inside that produce magnetic fields. This part of the motor does not move, and is called the stator. The part in the middle that spins is called the rotor and has coils of thin copper wire. Tiny metal brushes under the lid transfer electric power from outside the motor to the rotor inside. When an electric current flows through the electromagnetic coils a magnetic field is generated. A part called a commutator turns on and off the current flowing to the coils in sequence. This creates rotating magnetic fields that interact with the magnetic field in the stator to spin the rotor.

To learn more about many different types of motors visit: https://learn.sparkfun.com/tutorials/motors-and-selecting-the-right-one/all

Deep Dive

Want a bigger challenge? Keep inventing! There are an infinite number of motorized designs you could prototype with the parts in this kit, plus some cardboard and glue. Here is some inspiration from our friends at Watsonville Community Science Workshop!