TINKERING LABS™

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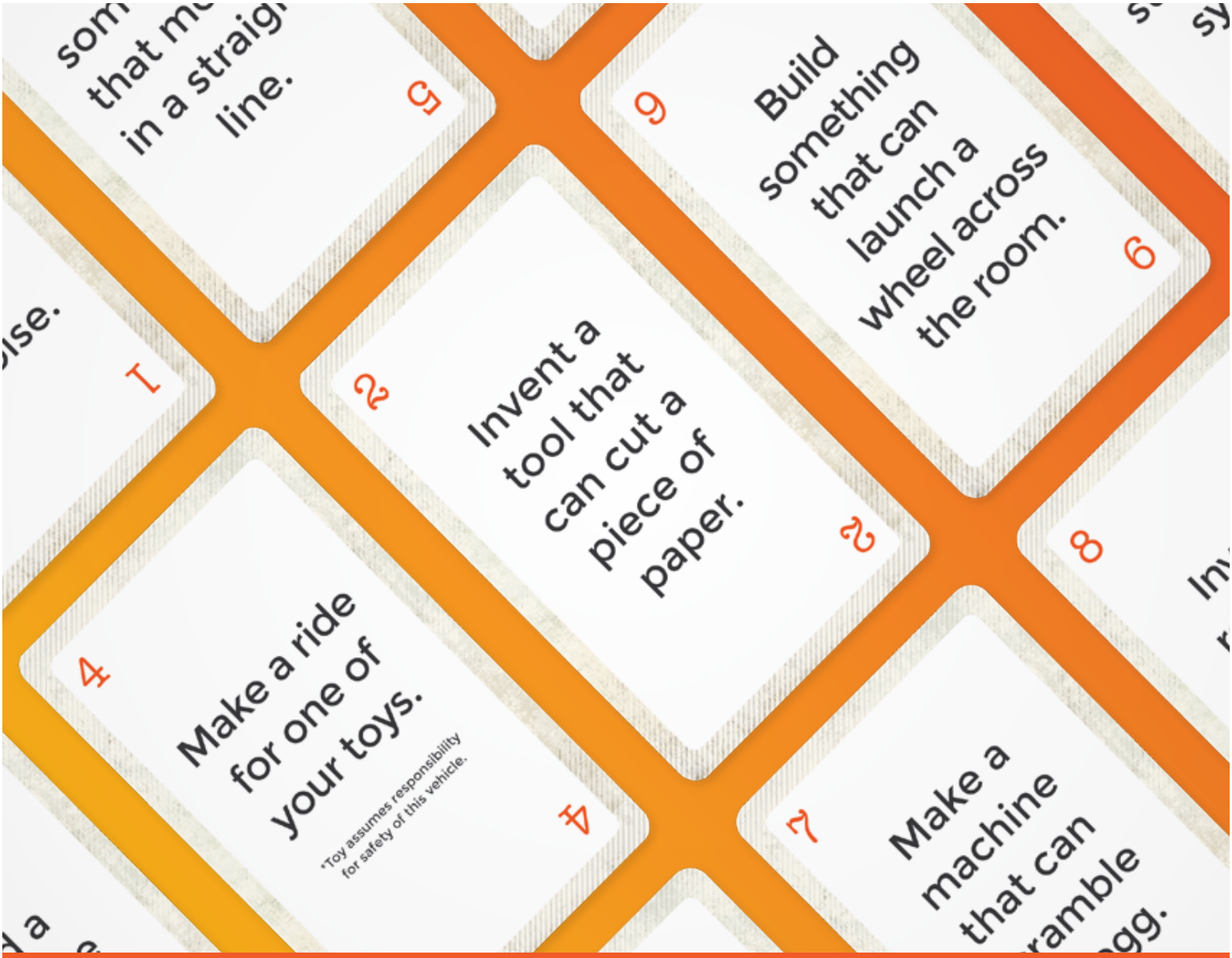


ELECTRIC MOTORS CATALYST

# Challenge Guide

By Susan Kunze and Matthew Brocchini

tinkeringlabs.com

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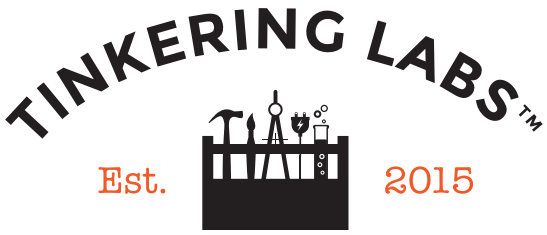


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# Challenge Guide

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Tinkering Labs

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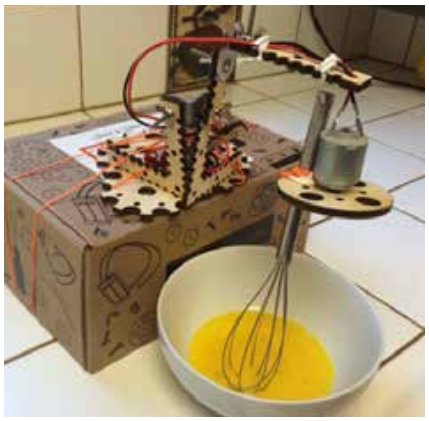

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## Getting Started Intro Lessons:



## Challenges:

Hello Fellow Tinkerer!

Welcome to the Tinkering Labs Electric Motors Catalyst. The following is a set of lessons to help you guide your students into the wonderful world of tinkering!

These lessons are divided into two parts. The first section contains five introductory lessons designed to help your students gain valuable experience in how the equipment found in the Electric Motors Catalyst works, as well as some of the basic principles of electrical circuits. It includes tips for using the equipment safely and building efficiently. These lessons are designed to be done under a teacher's direction with students working in pairs to build each project. At the end of these introductory lessons, your students should have the skills to reach success with the Electric Motors Catalyst Challenges.

The second part consists of lessons tied to the ten Electric Motors Catalyst Challenges. The Challenges are deliberately open-ended, and students are encouraged to invent their own solutions. But to support the teacher and students, these lessons include a set of directions for one way to complete each Challenge. Unlike the introductory lessons, having step-by-step directions for each Challenge does not mean it must be done as a teacher-directed activity. These included directions are meant to support teachers in guiding student discovery and learning. The directions can provide teachers with a quick and easy way to explore and complete a Challenge in preparation for presenting that Challenge to students. They can be used by teachers to make a sample of a successful Challenge project or for use by students needing a bit of guidance as they work on the Challenge. Or, the directions can be used as an introductory, teacher-directed lesson for the Challenge, with the teacher providing follow-up opportunities for students to explore and discover other methods for successfully completing the Challenge.

Each lesson has a goal, a materials list, step-by-step directions for one way to achieve the goal, teacher tips, and discussion starters. In a few cases, simple materials such as index cards are called for, and these are identified along with the Electric Motors Catalyst components that are needed for the activity. The Teacher Tips section provides explanations, notes for successful building, and opportunities for extending the Challenge. The Discussion Starters section has questions that should get students talking about the science and engineering that they have learned while designing and completing the Challenge. These questions are designed to guide students to understandings aligned to the Next Generation Science Standards. The Challenge lessons include a list of those Next Generation Science Standards, including the Disciplinary Core Ideas, addressed by that Challenge.

Take a few minutes and look through the lessons. They are designed with you and your students in mind. Enjoy your Tinkering Labs Catalyst 30-Student Class Pack and the engaging STEM activities your students will love doing!

- Susan & Matt

# Tips for Tinkering Sessions

## Safety Tips

1. All students should wear safety glasses. Wheels and other parts occasionally go flying, and they are not dangerous unless they hit you in the eye.
2. Avoid short circuits. If a student connects both leads from the battery pack to a single bolt, the bolt will heat up after a while, and the batteries will drain quickly. Showing the students how to make safe electrical connections or having one of the students show the others is usually a good idea.

   The first two "Getting Started" challenges introduce students to short circuits and how to avoid them. For more information, see the video "Safe Electrical Connections" at tinkeringlabs.com/electricmotors.

## Facilitation Tips

1. Plan some time at the end of each session for discussion about what students have discovered. Students gain understanding by sharing their observations, and it provides you an opportunity to address any student misconceptions.
2. Have students work in pairs or individually. Groups of three can also work, but we've found pairs to be better.
3. Consider giving each team a parts container. If each team has a small bowl or plate to hold their components, it makes it easier to distribute parts.
4. If you are working on a challenge that includes the markers, cover the work area with paper. Rolls of butcher paper can be handy for this purpose.
5. Arrange the space to make sharing ideas easy. We've run Tinkering sessions in all kinds of places including classrooms, kitchens, driveways, and city parks. In all cases, we try to organize the kids so that they can easily see what others are doing to encourage sharing of ideas.
6. In a room full of Tinkerers, parts will drift from team to team. If you are using the 30-Student Class Pack, that's fine, let it happen. If you are using individual Electric Motors Catalyst kits and you need to get all the parts from each kit back into its own bag or box at the end, consider using the large sheet of paper that comes with the kit as a work surface, and ask the students to keep their parts on their work surface.
7. Encourage students to incorporate other parts and materials. We use the word "Catalyst" because these materials should be a starting point, not an end. Other hardware, building toys, paper, binder clips, corks, and even electronics such as arduinos can add new possibilities. Just try to avoid anything that will make it hard to take the inventions apart, such as tape or glue.

## Clean Up Tips

1. Leave time for deconstruction. Taking the inventions apart is part of the process and opens up the possibility of new inventions.
2. Get the kids involved in clean-up. We usually assign jobs to kids, organized according to the bins. For example, we will ask one student to find and store all the rubber bands.
3. If you have any magnets around, give them to the kids for clean up of the small hardware parts.

# Make a Ride for One of Your Toys

CHALLENGE #4

## Teacher Section

This vehicle will move a toy or other small object, using two motors to drive two wheels. For a version of a vehicle that uses 1 motor and can transport small objects, try building the vehicle in Challenge #5.

**Goal: Design and build a vehicle that can carry a small object.**

### Disciplinary Core Ideas

- Engineering Design
- Energy
- Motion and Stability: Forces and Interactions

### Next Generation Science Standards

| Grades 3-5 |
|---|
| ETS1-1 |
| ETS1-2 |
| ETS1-3 |

| Grades 3 |
|---|
| PS2-2 |

| Grades 4 |
|---|
| PS3-1 |
| PS3-3 |
| PS3-4 |

| MS |
|---|
| PS2-2 |
| PS2-3 |

# Make a Ride for One of Your Toys

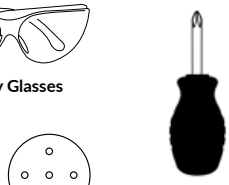
CHALLENGE #4

## Student Section

### MATERIALS FOR EACH PAIR OF STUDENTS



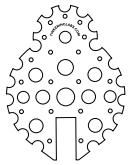
Safety Glasses


Screwdriver


2 Motors

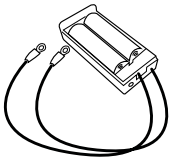

4 Bushings


2 L-Brackets


1 Chassis


4 Wheels (two of one size, one of another)


3-4 Rubber Bands


1 Battery Pack


2 L-shaped Connectors


4 Bolts & 6 Wing Nuts


1 Axle

### ADDITIONAL MATERIALS

A small toy or other small, lightweight object that can fit on the chassis
Or, the students can make their own “riders” out of paper

### HERE’S HOW


Use a bolt and wing nut to attach an L-shaped connector to one side, near the back end of the chassis. Attach the bolt with the wing nut on the top of the chassis.


Use a bolt and wing nut to attach the other L-shaped connector to the other side of the chassis, near the back end of the chassis. Attach the bolt with the wing nut on the top of the chassis.

Continued Next Page

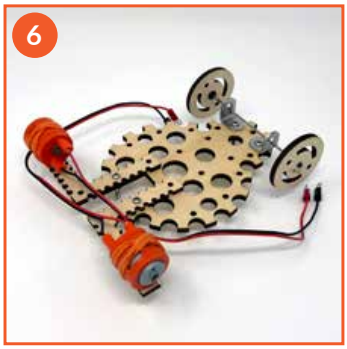
## Challenge #4 - Make a Ride for One of Your Toys


Turn the chassis over and attach an L-bracket to it on each side of the front end (near label). Attach the bolts with the wing nuts on the top of the chassis.

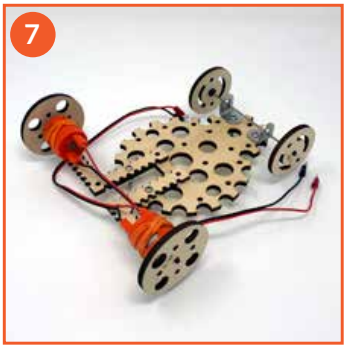

Place the axle through the holes on the L-brackets and then attach bushings to each end.

Attach wheels to the axle.

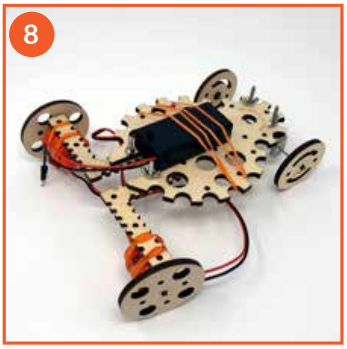

Attach a rubber band in an X on each of the L-shaped connectors.



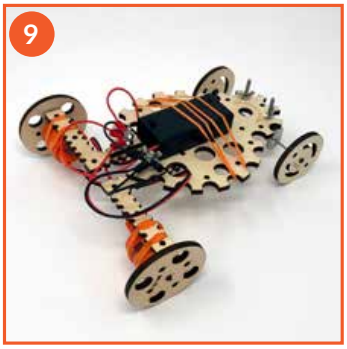

Attach a motor to the bottom sides of each of the L-shaped connectors with the tips facing outwards.



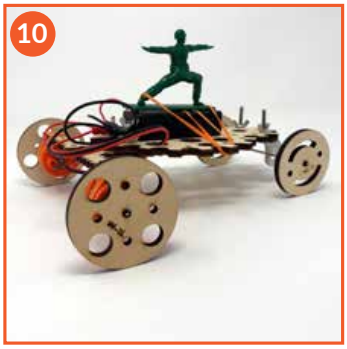

Place bushings on the tips of the motors then attach a wheel to each motor.




Turn the vehicle over and use a rubber band to attach the battery pack to the top of the chassis.




Slide all the red wires over one bolt and all the black ones over another. Secure them with an additional wing nut on each bolt (it does not have to be tight).




Place a toy on your vehicle.

Turn on battery pack and watch your toy take a ride on your vehicle.

# Challenge #4 - Make a Ride for One of Your Toys

## Teacher Tips

- Use a rubber band, if necessary, to keep the wires away from the wheels, axle, and motors.
- If the vehicle moves in a circle, it means that the motors are turning in opposite directions. The easiest way to get the motors turning in the same direction is to carefully remove and reinsert the two wire tabs into the opposite slots at the back of one of the motors. This will require unscrewing the orange motor casing to access the wires. See tinkeringlabs.com/wires for more information.
- For directions for a simpler vehicle to move small objects, see Challenge #5. Both of these sample vehicles consistently move in a forward direction.

## Discussion Starters

- What did you discover about using two motors for this vehicle?
- How do the two motors produce a stable system for your vehicle to move forward?
- Why does using only one battery pack work to power this vehicle?
- Can you show your partner/your teacher the circuit in this vehicle?
- Is there anything you would change if you tried this challenge again? Is there anything you would do again?