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ELECTRIC MOTORS CATALYST

Curriculum Guide

By Marisa Miller and Matthew Brocchini

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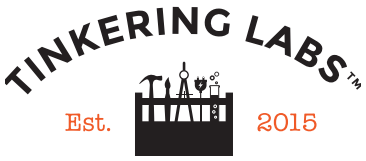

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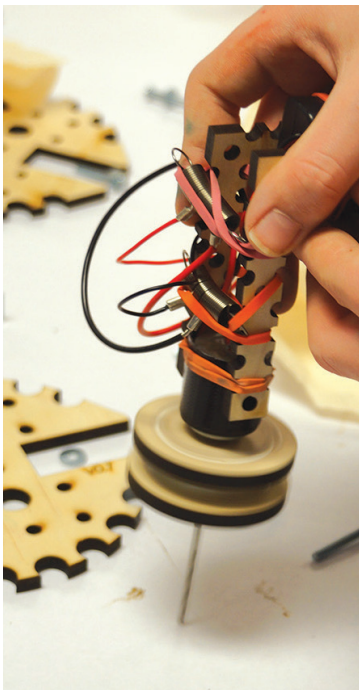

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Tinkering Labs – Electric Motors Catalyst: NGSS Curriculum User Guide

The Electric Motors Catalyst Class Pack can be used in classrooms in many ways, including in-school or after-school clubs and enrichment. It can also be used as a vehicle to teach students in elementary and middle school the Next Generation Science Standards (NGSS). While the kit provides many opportunities to connect student tinkering to energy, motion, and engineering, this curriculum has been developed to explicitly address when and how these connections can be made. The NGSS performance expectations (the official name for the standards) have been bundled with specifically identified Electric Motors Catalyst Challenges into an Electric Motors Catalyst NGSS Unit. Each unit is comprised of a series of lessons that will allow students multiple opportunities to wonder, test, invent (and yes, play!), while learning important physical science and engineering core ideas (content). Each unit also begins with a phenomenon for students to make sense of, embedded formative assessments, and a summative performance assessment.

How does the Electric Motors Catalyst support the NGSS?

The Framework for K-12 Science Education, upon which the Next Generation Science Standards are built, placed an emphasis on the engineering practices.

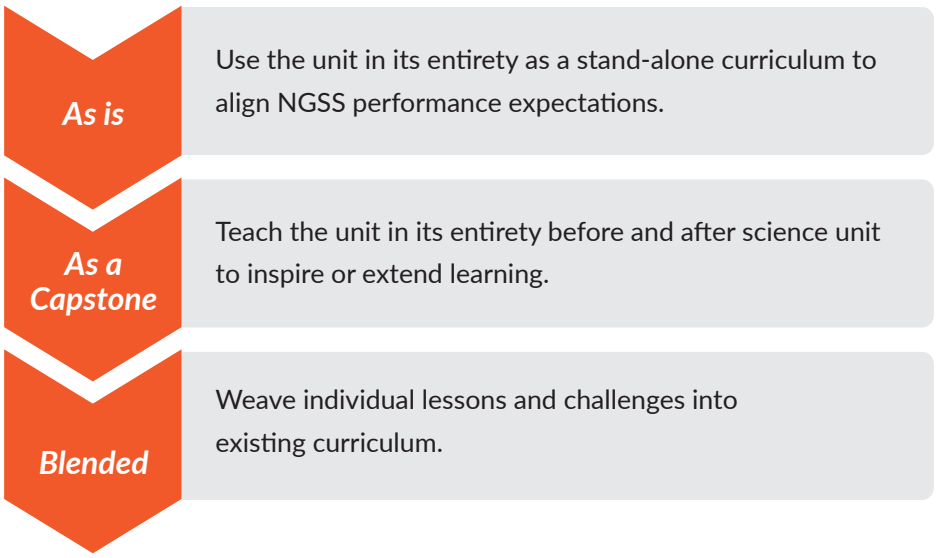
> *"The actual doing of science or engineering can also pique students' curiosity, capture their interest, and motivate their continued study; the insights thus gained help them recognize that the work of scientists and engineers is a creative endeavor [5, 6]—one that has deeply affected the world they live in. Students may then recognize that science and engineering can contribute to meeting many of the major challenges that confront society today, such as generating sufficient energy, preventing and treating disease, maintaining supplies of fresh water and food, and addressing climate change. Any education that focuses predominantly on the detailed products of scientific labor—the facts of science—without developing an understanding of how those facts were established or that ignores the many important applications of science in the world misrepresents science and marginalizes the importance of engineering."*
>
> *– A Framework for K-12 Education*

The Electric Motors Catalyst Class Pack is a teacher-friendly way of piquing student curiosity, engaging in creative science work, and confronting challenges. The Class Pack includes 10 engineering design challenges and materials to solve each challenge in a variety of ways. What is not included? A pre-defined procedure to create each device. Instead, students use their creativity and autonomy to build, create, and tinker! As students work through different engineering design challenges, teachers can highlight different aspects of the engineering process that students are utilizing. After the students have created their devices, the teacher can leverage their interest in their designs to discuss disciplinary core ideas in science such as force, motion, electricity, or energy.

How should I use an Electric Motors Catalyst NGSS Unit?

The units are designed to align to specific NGSS performance expectations for a grade band. By completing a unit in its entirety, students will be able to demonstrate an understanding of the **Science and Engineering Practices**, **Disciplinary Core Ideas**, and **Crosscutting Concepts** for the performance expectations identified. However, the units can be modified and adapted to blend with your current curriculum.

Ways to Use The Electric Motors Catalyst NGSS Units



The units include integrated engineering and physical science units, as well as stand-alone units to target engineering practices.

How do the Electric Motors Catalyst NGSS Units align to the NGSS?

The units are crafted so that students are figuring out specific elements of the **Disciplinary Core Ideas** and **Crosscutting Concepts** while engaging in the **Science and Engineering Practices**. Directions and support are provided to teachers to use the Electric Motors Catalyst challenges to drive student learning as students ask questions, define problems, and design solutions.

Is the Electric Motors Catalyst Class Pack right for my students?

The Electric Motors Catalyst Class Pack works in any classroom. Engineering design challenges provide all students, even those who struggle with traditional assessments, with an opportunity to shine and show their learning in non-traditional ways. Regardless of background, location, or previous science exposure, hands-on, inquiry learning provides a common experience with which all students can make sense of and communicate about.

Curriculum Unit Map:
An overview of the units & lessons in this guide

Unit #1: Grades K-2 Engineering: How do new things get invented?

Lesson #1.1: Introduce the phenomenon - How to make a device that makes a loud noise

Lesson #1.2: EMC Getting Started - Make a wheel spin

Lesson #1.3: EMC Challenge #2 - How to make a device that cuts paper

Lesson #1.4: EMC Challenge #3 - How to build a device that draws curvy lines

Lesson #1.5: EMC Challenge #4 - How to build a ride for a toy

Lesson #1.6: EMC Challenge #1 - How to make a device that makes a loud noise

Unit #2: Grades 3 - 5 Engineering: How do engineers make inventions better?

Lesson #2.1: Introduce the phenomenon - How to create a machine to scramble an egg

Lesson #2.2: EMC Challenge #3 - How to build a device that draws curvy lines

Lesson #2.3: EMC Challenge #4 - How to build a ride for a toy

Lesson #2.4: EMC Challenge #5 - How to build something that moves in a straight line

Lesson #2.5: EMC Challenge #6 - How to build a creature with spinning arms

Lesson #2.6: EMC Challenge #7 - How to create a machine to scramble an egg

Unit #3: Grades 3 - 5 Science - Force, Motion, and Engineering

Lesson #3.1: Introduce the phenomenon - How to build a robot that can push or pull another toy

Lesson #3.2: Why do objects move?

Lesson #3.3: EMC Challenge #4 - How to build a ride for a toy

Lesson #3.4: How to stop my invention without turning the motor off

Lesson #3.5: EMC Challenge #8 - How to build a moving robot with no wheels

Lesson #3.6: How to predict where an object will go

Lesson #3.7: EMC Challenge #3 - Why do objects move in curved lines?

Lesson #3.8: EMC Challenge #5 - Why do objects move in straight lines?

Lesson #3.9: Open challenge - How to build a robot that can push or pull another toy

Unit #4: Grades 3 - 5 Science - Energy and Engineering

Lesson #4.1: Introduce the phenomenon - How to create a machine to scramble an egg

Lesson #4.2: How can a windmill generate energy?

Lesson #4.3: EMC Getting Started - How can I make a wheel move with a motor?

Lesson #4.4: How does an electric motor work?

Lesson #4.5: EMC Challenge #1 - How to create a device that makes a loud noise

Lesson #4.6: What can electricity do?

Lesson #4.7: EMC Challenge #2 - How to create a device that can cut a piece of paper

Lesson #4.8: EMC Challenge #7 - How to create a device that can scramble an egg

How can I create a device to scramble an egg?

LESSON 2.6

Lesson Overview

Time	Performance Expectations	What students will figure out (Disciplinary Core Ideas)	How students will learn it (Science and Engineering Practices)	How it connects (Crosscutting Concepts)
2 sessions	3-5-ETS1-1 3-5-ETS1-2 3-5-ETS1-3	Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.	Design a solution to create a device that can scramble an egg.	Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.

Objective:

SWBAT design a device that can scramble an egg.

Materials:

Electric Motors Catalyst Class Pack

1 bowl and 1 egg for each team

Lesson Flow:

Context: Introduce Challenge #7 - Make a Machine That Can Scramble an Egg (10 minutes)

- **Build Excitement:** Tell students today is the day! They will be using all of the knowledge and skills they have learned to build a device that can scramble an egg.
- **Revisit Problem:** Remind students of what was learned on Day 1 of the unit: Imagine you wanted to make scrambled eggs but were unable to use your hands to whisk an egg. Our challenge for this unit is to create a device that can scramble an egg. To help us create this device we will be using an electric motor and other parts from the Electric Motors Catalyst kit.
- **Revisit the Engineering Design Process:** Review the Engineering Design Process: Ask – Imagine – Plan – Create – Improve. Remember, engineers often go back and forth between these steps as they try to make the best product they can. We already have our question: How can I use these materials to create a device to scramble an egg? Ask students: What else do we need to know about our problem? Review the criteria and constraints of the problem.
    - *Teacher's Note: The exact criteria and constraints are up to you and your classroom. Criteria may include that the device will need to break the yolk of an egg or that it does not splash egg out of the bowl. Constraints may include the exact materials, time, size, etc.*

Lesson 2.6 - How can I create a device to scramble an egg?

Activity: Challenge #7 – Imagine and Plan (30 minutes)

- **Imagine:** Provide teams (2-3 students) with some materials to start tinkering. Remind students the purpose of this time is to play and test in order to create a plan. Set a time limit for this (approximately 15 minutes). With five minutes left, collect materials and transition students to making a plan by jotting down three things they learned or discovered that will help them inform their plan.
- **Make a Plan:** Tell students to work as a team to create a plan for their invention (see Teacher Resources for template). Tell students their plan should include a sketch of their invention and what materials will be used.

Possible Breakpoint – End of Day 1

Activity: Challenge #7 – Create and Improve (30 minutes)

- **Distribute Materials:** As each group completes their sketch, tell one person from each team to get a bin with the provided materials.
- **Facilitate and Support:** Circulate as students are working. Answer questions – but don't give them a solution! Assess students and teams perseverance and teamwork using the Rubric for Engineering Design Challenge (see Teacher Resources).
- **End the Challenge:** Shout out students/groups that completed the challenge, persevered, or worked well together. Provide direction for returning materials to proper space.

Analysis: (15 minutes)

- **Performance Assessment:** Have students reflect on their designs and what they have learned by answering the Performance Assessment questions (see Lesson Resources).

Lesson Assessment:

Ask students to reflect on the challenge by filling out the rubric for Engineering Design Challenge (see Teacher Resources) and Performance Assessment (see Lesson Resources).

Lesson Resources:

Performance Assessment Questions

1. Create a sketch of your final product. Make sure to include labels.
2. Describe how your device meets the criteria and constraints of the challenge.
3. Explain how your final device is similar to and different from your plan. Why did you make the changes that you did?