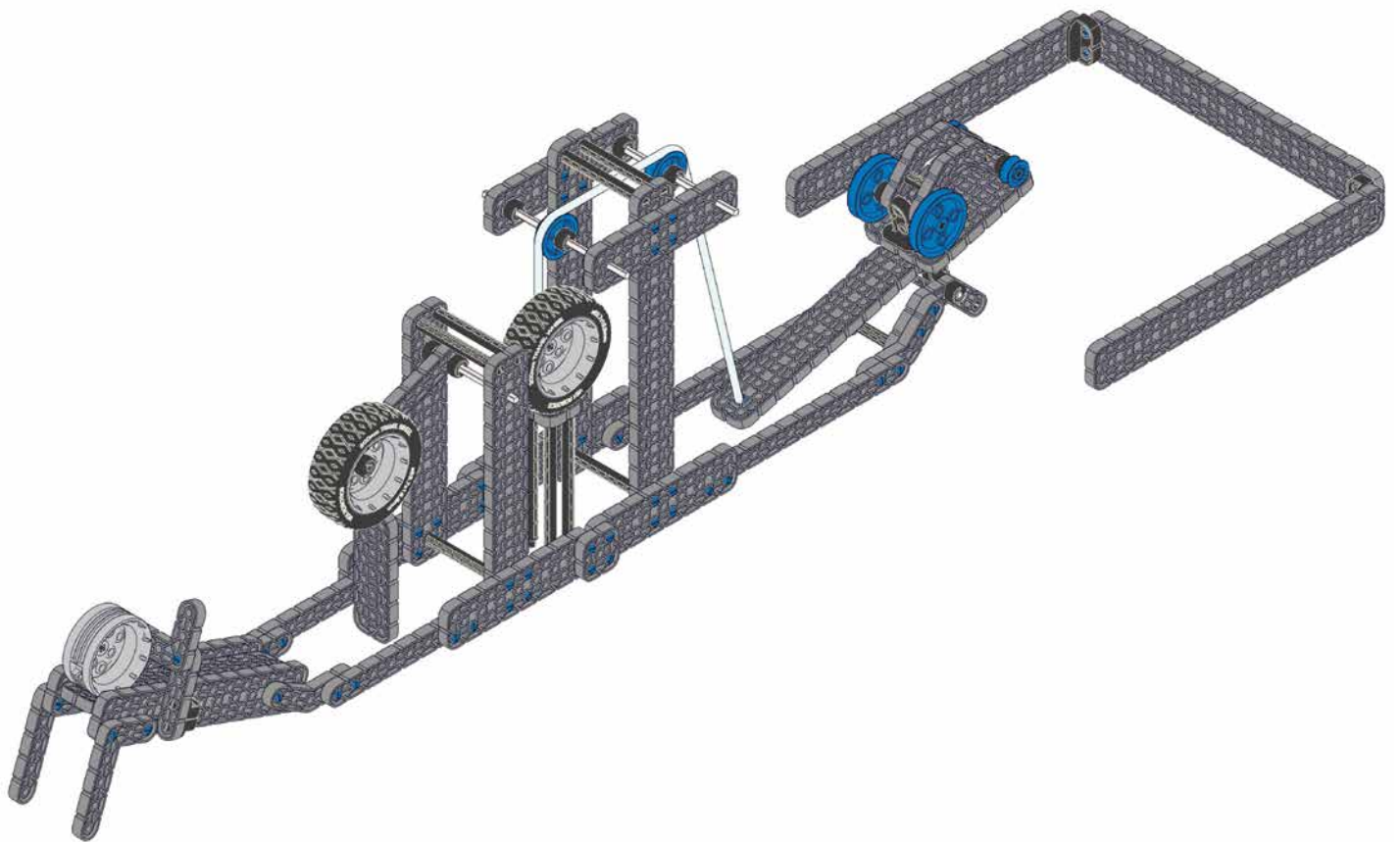




Chain Reaction Challenge

Teacher Unit Materials



E.t1

Unit Purpose, Objectives, Vocabulary, & Materials

Recommended Grade Level:

Grade 2 to Grade 8

Suggested Prior Learning:

- Completion of the **Let's Get Started & Simple Machines & Motion** units are suggested

Unit Purpose:

The purpose of this unit is for students to design and build a Chain Reaction Device to rubric specifications (either unpowered, powered, or both).

Learning Objectives:

- Students will apply knowledge of Simple Machines and Pendulums
- Students will learn key terminology related to Chain Reaction Devices
- Students will follow assembly instructions to build a sample Chain Reaction Device
- Students will utilize design process in building their own Chain Reaction Device(s)
- Students will document design
- Students will be able to troubleshoot and solve problems to improve design

Additional Purpose(s)/Objectives:

If desired, teachers can add additional content-specific purposes and objectives to any open-ended robotics challenge (like this unit provides) to develop corresponding targeted lessons around specific science, technology, and math content.

Unit Vocabulary:

- Chain Reaction Device
- Chain Reaction Stage
- Trigger Mechanism

Unit Materials:

- 📖 Unit Content Materials (E.1, E.2, E.4)
- 🍏 Unit Rubrics (E.5, E.6)
- 🖋️ Unit Written Exercise (E.7)
- ⚙️ Unit Build Instructions (E.3)
- Pencils or pens
- VEX IQ Kit Hardware & Components (as needed for chosen lessons)
- String (for pulley assembly)
- Controller and Robot Brain (as needed for chosen lesson)
- Internet access - optional
- Additional paper - optional

E.t2

Unit Plan and Options

20 Minutes:

Review information, terminology, and definitions related to Chain Reaction Devices from Unit Content Material (E.1, E.2, E.4).

45+ Minutes (optional, for grades 2-8):

Have students use the Sample Chain Reaction Device Assembly Instructions (E.3) to assemble and test a Four-Stage, Unpowered Chain Reaction Device that parks a car. Time needed for this activity will be longer if students have not assembled (or are not using) the **Simple Machines & Motion** Sample Assemblies built from the corresponding previous unit. Students in grades 2-3 can complete this activity INSTEAD of tackling the full challenge. Students in grades 4-8 should complete this activity only if you want students to see and test a Chain Reaction Device that "works" before taking on the open-ended challenge of "Parking the Car."

15 Minutes:

Review the **Chain Reaction Challenge** Rules (E.4) with student teams. The challenge is designed to use the car and garage models from the Sample Chain Reaction Device Assembly Instructions (E.3). You may choose to use a different car and/or garage design, or even have students build these creatively if desired and time allows. Choose the set of rules (Unpowered Device for grades 4-6 (E.5) or Powered Device for grades 4-8 (E.6)) that best fits your classroom needs. There is also the option of having students tackle both the unpowered AND powered versions of the challenge.

1 Hour:

Challenge planning using Idea Book Pages 1 and 2 from this unit. Have students plan and design a Chain Reaction Device that meets challenge and rubric criteria.

3+ Hours:

Student teams design, build, and test Chain Reaction Devices for the given challenge all while using the "THINK-DO-TEST" approach to completing troubleshooting Idea Book pages. Use the corresponding Rubric as a vehicle for improvement during the process and/or to assess final designs.

30+ Minutes:

Have students demonstrate their final/functional Chain Reaction Devices for whole class.

- Celebrate effort and results
- Optionally, create & give awards in addition to providing rubric and Idea Book Page feedback.

Unit Standards Connections: Next Generation Science Standards (NGSS)

Grade	Category	PE Code	Performance Expectation (PE)	Unit Activities
4	Energy	4-PS3-1	Use evidence to construct an explanation relating the speed of an object to the energy of that object.	- Device Build(s) - Idea Book Pages
4	Energy	4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	- Device Build(s) - Idea Book Pages
3-5	Engineering Design	3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	- Device Build(s) - Idea Book Pages - Following Challenge Rules
3-5	Engineering Design	3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	- Device Build(s) - Idea Book Pages - Following Challenge Rules
3-5	Engineering Design	3-5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	- Device Build(s) - Idea Book Pages - Following Challenge Rules
6-8	Energy	MS-PS3-5	Construct, use, and present arguments to support the claim that when the motion energy of an object changes, energy is transferred to or from the object.	- Device Build(s) - Idea Book Pages
6-8	Engineering Design	MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	- Device Build(s) - Idea Book Pages
6-8	Engineering Design	MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	- Device Build(s) - Idea Book Pages
6-8	Engineering Design	MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	- Device Build(s) - Idea Book Pages

Standards for Technological Literacy (STL)

Code	Grade	Standard	Benchmark	Unit Activities
1.D	3-5	Students will develop an understanding of the characteristics and scope of technology.	Tools, materials, and skills are used to make things and carry out tasks.	- Device Build(s) - Idea Book Pages
1.F	6-8	Students will develop an understanding of the characteristics and scope of technology.	New products and systems can be developed to solve problems or to help do things that could not be done without the help of technology.	- Device Build(s) - Idea Book Pages

Standards for Technological Literacy (STL) - Continued

Code	Grade	Standard	Benchmark	Unit Activities
1.G	6-8	Students will develop an understanding of the characteristics and scope of technology.	The development of technology is a human activity and is the result of individual and collective needs and the ability to be creative.	- Device Build(s) - Idea Book Pages
2.G	3-5	Students will develop an understanding of the core concepts of technology.	When parts of a system are missing, it may not work as planned.	- Device Build(s) - Idea Book Pages
2.L	3-5	Students will develop an understanding of the core concepts of technology.	Requirements are the limits to designing or making a product or system.	- Device Build(s) - Idea Book Pages
2.Q	6-8	Students will develop an understanding of the core concepts of technology.	Malfunctions of any part of a system may affect the function and quality of the system.	- Device Build(s) - Idea Book Pages
2.R	6-8	Students will develop an understanding of the core concepts of technology.	Requirements are the parameters placed on the development of a product or system.	- Following Challenge Rules
2.U	6-8	Students will develop an understanding of the core concepts of technology.	Maintenance is the process of inspecting and servicing a product or system on a regular basis in order for it to continue functioning properly, to extend its life, or to upgrade its capability.	- Device Build(s) - Idea Book Pages
8.C	3-5	Students will develop an understanding of the attributes of design.	The design process is a purposeful method of planning practical solutions to problems.	- Device Build(s) - Idea Book Pages
8.D	3-5	Students will develop an understanding of the attributes of design.	Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.	- Following Challenge Rules
8.F	6-8	Students will develop an understanding of the attributes of design.	There is no perfect design.	- Device Build(s) - Idea Book Pages - Following Challenge Rules
8.G	6-8	Students will develop an understanding of the attributes of design.	Requirements for a design are made up of criteria and constraints.	- Following Challenge Rules
9.C	3-5	Students will develop an understanding of engineering design.	The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.	- Device Build(s) - Idea Book Pages - Following Challenge Rules

Standards for Technological Literacy (STL) - Continued

Code	Grade	Standard	Benchmark	Unit Activities
9.D	3-5	Students will develop an understanding of engineering design.	When designing an object, it is important to be creative and consider all ideas.	<ul style="list-style-type: none"> - Device Build(s) - Idea Book Pages
9.F	6-8	Students will develop an understanding of engineering design.	Design involves a set of steps, which can be performed in different sequences and repeated as needed.	<ul style="list-style-type: none"> - Device Build(s) - Idea Book Pages
9.G	6-8	Students will develop an understanding of engineering design.	Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.	<ul style="list-style-type: none"> - Device Build(s) - Idea Book Pages
10.C	3-5	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.	Troubleshooting is a way of finding out why something does not work so that it can be fixed.	<ul style="list-style-type: none"> - Device Build(s) - Idea Book Pages
10.D	3-5	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.	The process of experimentation, which is common in science, can also be used to solve technological problems.	<ul style="list-style-type: none"> - Device Build(s) - Idea Book Pages
10.E	3-5	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.	The process of experimentation, which is common in science, can also be used to solve technological problems.	<ul style="list-style-type: none"> - Device Build(s) - Idea Book Pages
10.F	6-8	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.	Troubleshooting is a problem-solving method used to identify the cause of a malfunction in a technological system.	<ul style="list-style-type: none"> - Device Build(s) - Idea Book Pages
10.G	6-8	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.	Invention is a process of turning ideas and imagination into devices and systems. Innovation is the process of modifying an existing product or system to improve it.	<ul style="list-style-type: none"> - Device Build(s) - Idea Book Pages

Standards for Technological Literacy (STL) - Continued

Code	Grade	Standard	Benchmark	Unit Activities
10.H	6-8	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.	Some technological problems are best solved through experimentation.	- Device Build(s) - Idea Book Pages
11.F	3-5	Students will develop abilities to apply the design process.	Test and evaluate the solutions for the design problem.	- Device Build(s) - Idea Book Pages
11.G	3-5	Students will develop abilities to apply the design process.	Improve the design solutions.	- Device Build(s) - Idea Book Pages
11.H	6-8	Students will develop abilities to apply the design process.	Apply a design process to solve problems in and beyond the laboratory-classroom.	- Device Build(s) - Idea Book Pages
11.K	6-8	Students will develop abilities to apply the design process.	Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints, and refine as needed.	- Device Build(s) - Idea Book Pages

Common Core Standards for Mathematics (CCSM)

Domain #	Grade	Cluster	Standard	Unit Activities
4.OA	4	Operations and Algebraic Thinking	Use the four operations with whole numbers to solve problems.	- Idea Book Pages
4.MD	4	Measurement and Data	Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.	- Idea Book Pages
4.MD	4	Measurement and Data	Represent and interpret data.	- Idea Book Pages
6.EE	6	Expressions and Equations	Represent and analyze quantitative relationships between dependent and independent variables.	- Idea Book Pages
7.RP	7	Ratios and Proportional Relationships	Analyze proportional relationships and use them to solve real-world and mathematical problems.	- Idea Book Pages



NOTES: Given the nature of an open-ended challenge like the one in this unit of study, it's not feasible to list all possible standards connections. The standards listed above are only samples and a fraction of what can be accomplished with this unit. We encourage educators to delve deeper into the areas of STEM most meaningful and useful to their students, tailoring Idea Book entries and/or adding their own lessons where they'd like.

Areas to find/develop additional standards connections for this unit:

NGSS: Structure and Properties of Matter, Energy, Engineering Design, Forces and Interactions

STL: The Nature of Technology, Design, Abilities for a Technological World, The Designed World

CCSM: Operations and Algebraic Thinking, Number and Operations – Fractions, Measurement and Data, Geometry, Ratios and Proportional Relationships, Expressions and Equations, Statistics and Probability.

E.t4

Unit Notes

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