Motorized Zipline

Lesson Plan for Grade Level 6-8

Last updated: December 10, 2021

Welcome

Thank you for choosing KitHub. Our programs enable learners to foster a more in-depth understanding of a range of subjects and interest areas and build confidence by asking questions and investigating ideas independently. Hands-on activities teach learners to iterate and revise designs and document their experience to encourage peer learning. The projects are open-ended so that learners can remix them based on themes and interests they enjoy. Most KitHub projects can be completed without a digital device; however, most include extensions for programming, graphic design, and physical computing.

Online Courses For Learners

We have created online courses for learners that complement this lesson plan and the kit instructions. The sessions go in-depth in many subject areas and include wellness breaks, additional project ideas, and troubleshooting guides. The coursework is printable for those learners without access to a web-enabled device. You can find courses and kits at https://kithub.cc/.

Interest Pathways

For an interest-driven approach to learning these subjects, we have created learning pathways focused on themes, including music, games, fashion, and storytelling. You can find thematic programming at https://kithub.cc/.

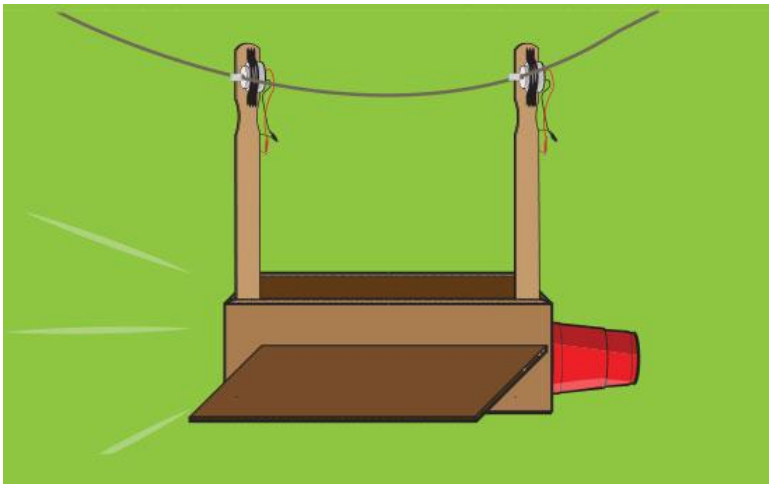
Disclaimer

Neither KitHub nor any other party involved in creating this curriculum can be held responsible for damage, mishap, or injury incurred because of this lesson. We recommend adult supervision at all times.

⚠ **Important!**
Products may include small parts and are not for children under three years old. Products may be a choking hazard. Proceed with caution when dealing with electronic circuits. Adult supervision is required.

What Is A Zipline?

In this lesson, students will work with a partner to design and build a zipline spaceship that uses simple electric circuits using the materials from the KitHub Motorized ArtBot Classroom kit. This lesson focuses on the elements of the engineering design process of design, test, evaluate, and redesign. There are additional opportunities to integrate statistics and data collection.



Preparation

KitHub provides instructions and tutorials online to help facilitators become familiar with the materials. This lesson is a simple introduction to electricity and circuits, but it might be helpful to have a deeper understanding before you begin. Please refer to KitHub's *Vocabulary for Facilitators - Energy and Electricity Basics*.

Prior Knowledge

Learners should have basic listening skills and group work skills. Learners should know the procedures for working with materials alone and in groups and be able to follow appropriate safety routines.

Before Teaching This Lesson

- ❏ Review the KitHub tutorials and instructions online. These can help you better understand the materials, directions, and goals for this activity.
- ❏ Review KitHub's *Vocabulary for Facilitators - Energy and Electricity Basics*
- ❏ Review the step-by-step directions for building a motorized zipline. Follow the directions and make your own sample to learn how the item is assembled and to practice troubleshooting. This will help you be able to answer questions your students may ask.
- ❏ Read this lesson plan in its entirety and gather and/or prepare all materials needed.
- ❏ If your students are new to electronics and circuit building, take time to complete the *Basic Circuit: Light an LED* and *Conductors and Insulators* lessons. Each of these lessons should take 45-60 minutes to complete.
- ❏ If your students have built simple circuits already, your students should have the skills they need to complete this lesson.

Vocabulary

Additional vocabulary is available in KitHub's *Vocabulary for Learners*.

Battery - a source of power that helps electricity flow.

Circuit - an electric circuit is a path that allows electricity to flow.

Closed Circuit - a circuit in which electric current can flow in an uninterrupted path.

Conductor - material in a circuit that allows electrons to move freely.

Current - the flow of charged particles.

Electricity - a form of energy produced by the movement of tiny charged particles called electrons.

Energy - how things change and move. The Law of Conservation of Energy states that energy is never created or destroyed, it is only changed from one state to another.

Engineer - a person who designs and builds things to solve a problem.

Insulator - material in a circuit that does not easily allow energy to flow.

Light-emitting Diode (LED) - An electronic device that emits light when an electric current passes through it.

Motor - a machine, sometimes powered with electricity, that has moving parts.

Receiver - an object that receives electrical energy and changes it to light, sound, movement, or another kind of energy.

Recycle - the process of changing waste into something you can use again.

Reuse - to use again, especially in a different way.

Switch - A device for making or breaking the connection in a circuit. It can prevent electricity from flowing.

Additional Information

- The battery doesn't store or create electricity; it provides a source of energy to get the electrons flowing. When a battery becomes "dead," it's not because it lost its charge; it's because the chemicals that create the energy have reacted.
- The electrons aren't necessarily moving very quickly. Imagine flicking a marble at the end of a row of marbles— the marbles may only travel to the next one and stop, but the energy from the flick moves quickly.
- An electric current is the flow of charge. The charges do not disappear when the circuit is broken or the "current stops flowing."
- Other types of particles can flow with energy to make electricity, but electrons are what flow in metals.
- Wires aren't empty until they are attached to a source such as a battery. When a battery is connected, electrons move very slowly everywhere at the same time, like a wheel.

Common Solutions

We see troubleshooting as an exciting learning opportunity to figure out more about how things work. Encourage learners to keep asking questions and trying out ideas to find solutions.

The most common problem is making a solid connection between the parts.

- Make sure nothing is in the battery holder impeding the connection between the conductive surfaces.
- Readjust tape over small wires to make sure they're touching the battery.
- Another problem educators come across is learners not understanding the positive and negative sides of electronic parts. This is an introductory activity to help learners understand this concept. The activity ensures that learners become familiar with the kit's components' fundamental aspects to build on that knowledge in subsequent lessons.
- To make the double battery pack, students will need to make sure the negative end of one battery is touching the positive end of the other battery.
- If the spaceship body is having trouble making across the zipline, encourage students to add some weight to the body or the action figure in the spaceship.

Review Safety Procedures

It's essential to be aware and cautious when working with electricity or any hands-on project. Please go over the following with the participants.

Protect Your Eyes

Watch Out For Others

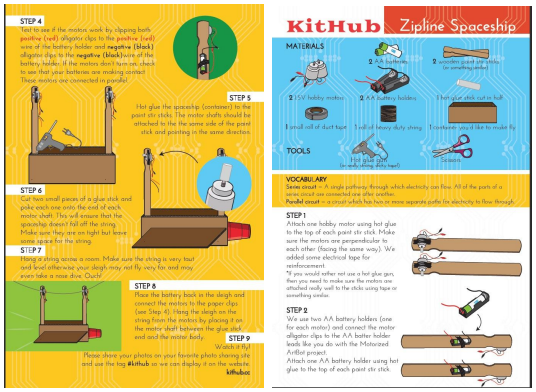
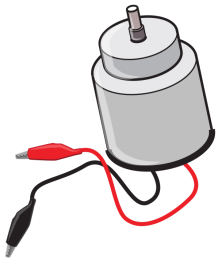
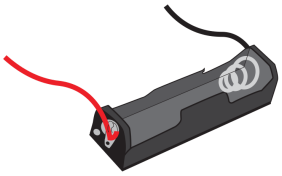
Use Caution With Tools

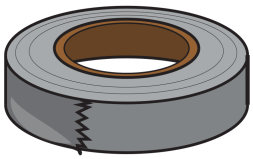
Use Parts As Directed

Materials and Tools

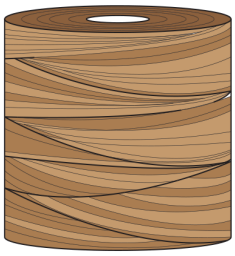
The materials for this lesson are available in the [KitHub Motorized ArtBot Kit] at [shop.kithub.cc].

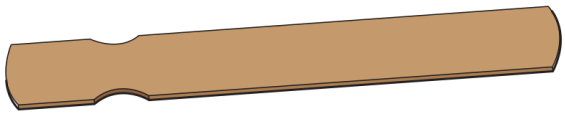
*Note: Before the day of the lesson, have students collect string and a cardboard box or plastic containers from home.

	[Zipline Spaceship Instructions Front] [Zipline Spaceship Instructions Back] [KitHub Education Standards] [KitHub's Vocabulary for Learners] [KitHub's Vocabulary for Facilitators]
	Hobby Motor (1 DC hobby motor with alligator clip leads 1.5V-3V)
	AA Battery Holder

	AA Battery
	Tape - Clear, Duct, Electrical

Additional Materials Needed

	String or cord for the zipline
	Boxes, cardboard tubes, paint sticks, and other recycled materials for the spaceship body
	Scissors

	2 Paint Sticks or similar.
	Craft materials
	Action figure or doll to ride the Zipline.

Learning Outcomes

Science/Robotic Tech/Engineering Design/Art

Learning Outcomes:

- ✔ Demonstrate understanding of open and closed circuits.
- ✔ Apply knowledge about circuits to create a more powerful battery pack.
- ✔ Work as a team to create a vehicle that moves across a zipline.
- ✔ Design, build and test a project.

Standards

Refer to the *KitHub Education Standards for K-8* that cover:

- Common Core State Standards (CCSS)
- International Society for Technology in Education (ISTE)
- National Art Education Association (NAEA)
- Next Generation Science Standards (NGSS)
- New York State Learning Standards (NYSP-12SLS)
- Texas Essential Knowledge and Skills (TEKS)

Lessons

Activities 3 parts, 3-5 hours total

Gather These Materials

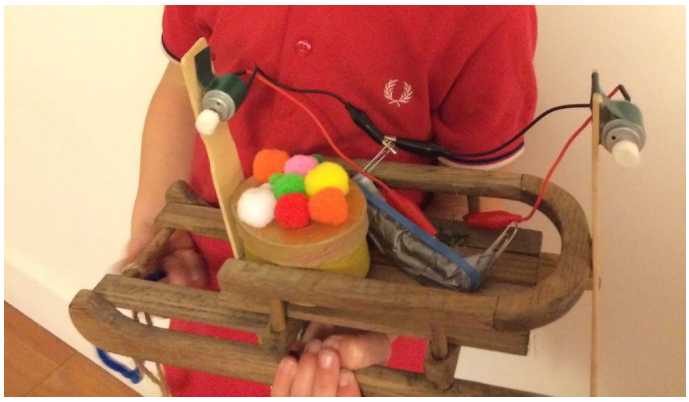
- Hobby motor (1 per student)
- AA battery (1 per student)
- AA battery holder (1 per student)
- Tape

Part One - Build a Battery Pack 1 hour

- Explain to students that they will be using what they know about circuits to build a zipline spaceship.
- Show students a sample of a completed spaceship with a customized battery pack. Show students how the spaceship zooms along the zipline so they understand what they are aiming to create.
- Students should already know how to make a simple circuit with one battery and one hobby motor. In order for their spaceship to have enough power to cross the zipline, they will need to create a custom battery pack that uses two batteries and two motors.
- Show students the materials they will be using to create this custom battery pack. Be sure to review the proper way to work with and handle each item.

- Have students pair up and distribute a double set of materials to each pair. Before they try to connect the parts, they will first draw a diagram of how they think the parts go together.
- After students complete their drawings, they can begin to connect their materials together as shown on their diagrams. Students should note on their paper whether or not their diagram worked. If their plan did not work, encourage students to go back to their diagram to see what they might need to change to get their customized battery pack to work. While students work, circulate and observe student pairs. Ask questions to encourage scientific thinking such as:
    - Why did you decide to do it this way?
    - Why do you think that works/doesn't work?
    - What do you think is happening to make the motor turn? What do you think each part is doing?
    - Can you design it another way that will still work?
    - What does your design have in common with other students' designs that work/ don't work?
- If students are having a hard time figuring out how the parts go together to create the custom battery pack, pause and show how the motor can turn and propel itself forward by pushing off of a string or cord. The batteries need to be connected in series—the positive side of one battery connects to the negative side of the other battery. For more information on how to make the circuit, watch the how-to video https://www.youtube.com/watch?v=LdFKeJCHxs0
- Share results as a whole group. Discuss similarities and differences between designs that worked and did not work. Modify the rest of the activity as needed to accommodate students still struggling with the processes, knowledge, and skills to create the battery pack.
- Using the definitions and what they have learned about circuits so far, have students discuss in their groups what they think is happening in the circuit. They should try to describe the process using concepts like electrical energy, charged particles, and flowing current. Give students about 5–10 minutes to discuss. These questions may be helpful in guiding the conversation:
    - Why does everything in the circuit have to touch for it to work?
    - What's going on?
    - Go back to your definitions, does your explanation make sense based on that description?

- What do you already know about matter and electricity? How can you use that to help you understand?



Gather These Materials

- Small box
- 2 wooden paint stirrers (per pair)
- String for a zipline
- Previously built custom battery pack (1 per pair)
- Assorted recycled materials (egg cartons, cardboard, oatmeal canister, plastic lids, etc)
- Assorted craft materials
- Hot glue gun and glue gun sticks

Part Two - Build the Spaceship **1-2 hours**

- Now that students know how to create the circuit, it is time for pairs to design their spaceships. Show students your example again. Explain how you designed your ship and why you designed it as you did. Tell students after they are finished building their spaceship, pairs will race against each other to see which spaceship is the fastest. They will need to keep this in mind as they design their spaceship.
- Review the elements their spaceship must:
  - Use all recycled/reused materials
  - Be able to seat an action figure or doll
  - Move from one end of the zipline to the other on its own
  - Follow the basic directions for making the spaceship from the KitHib Zipline Spaceship direction card

- Review the step-by-step directions for making the spaceship from the KitHib Zipline Spaceship direction card before teams begin designing and building. Make sure each team has their own set of directions to follow while they design and build.
- Pair students in teams. Allow time for teams to draw and design a model of their spaceship. Their model should indicate the specs for their spaceship, including the materials, sizes, shapes, color/design of their space vehicle.
- After teams have designed their space vehicle, allow teams ample time to build and run tests with their spaceship. Encourage teams to go back and redesign parts that do not function as they planned or intended. As students work, circulate and observe teams at work, asking questions such as:
    - What have you tried? What else might work?
    - Have you tried _____?
    - Which part do you think is the most important in making the spaceship move? How could you adapt your design to make it more effective?

Part 3 - Zipline Trials **1 hour**

- After teams have completed their spaceships, it's time to test each one out.
- Each team can take a few test runs to show how their spaceship runs.
- If there is room in your learning area, set up two ziplines to allow two teams to race at a time. If there is not enough room, run each spaceship at a time and use a timer to determine a winner. You can set up a bracket-style competition to determine which spaceship is the fastest.

Wrap Things Up **30 minutes**

- After the zipline trials, have a whole group discussion in which the class discusses why some spaceships were more successful than others. Ask questions of the whole class:
    - What is effective about this design? What could be better?
    - What is making the spaceship move? What force is acting on it?
    - What else could they add to the battery or motor using supplies in the room to make it more effective?
    - Is there anything else you could have added besides the motor? (Lights, sounds, etc.)

- Tell students to come up with questions, share ideas, or related information during the discussion.
- Summarize and elaborate on any misconceptions to finish the lesson.

Extensions

- During the zipline trials, have the class keep track of times or other data. Evaluate the data to find the mean, mode, and median of the data.
- Compare the weights and lengths of the spaceships to see if that affects how long it takes each to cross the zipline.
- Incorporate additional simple circuits to add LEDs to the design of each spaceship.
- Relate the motion of the spaceship across the zipline to Newton's Laws of Motion.

Literature Connections

We recommend incorporating these books into this activity to enhance student learning. Find more on the KitHub Goodreads account.

Charged Up: The Story of Electricity by Jacqui Bailey

Girls Who Build: Inspiring Curiosity and Confidence to Make Anything Happen by Katie Hughes

Energy: 25 Projects by Kathleen M. Reilly

Who Was Nikola Tesla? by Jim Gigliotti

Electricity and Magnetism by Dana Meachen Rau

Whoosh! Lonnie Johnson's Super-Soaking Stream of Inventions by Chris Barton

Junkyard by Mike Austin

The Boy Who Harnessed the Wind by William Kamkwamba

Evaluate Understanding

We believe the best assessment approach is process-oriented, focusing on creating opportunities for learners to talk about their creations (and peers) and creative practices. We view assessment as something done with learners to support their understanding of what they know and what they still want to know. Use the attached printable self-assessment to have students self-evaluate learning objectives.

Zipline Spaceship Rubric

	Unsatisfactory (1 point)	Developing (2 points)	Satisfactory (3 points)	Outstanding (4 points)
Teamwork	Did not complete any assigned tasks and relied on others to do all the work.	Did some tasks that may not have been agreed upon. Worked in isolation or did not listen to the group.	Did most assigned tasks and collaborated. Listened to the group, but may have talked too much or too little.	Performed all assigned tasks without having to be managed. Listened to and encouraged the group.
Engineering Design Process	Ignored the design process.	Followed a few parts of the design process and did not reflect on the initial design.	Followed the design process.	Followed the design process and used resources, note-taking, and collaboration to reflect on each part.
Participation	Did not participate.	Participated minimally. Group may have complained about you or your participation was generally unhelpful.	Participated in all group work and discussions during the lesson. Generally respectful of classmates.	Was a valuable and respectful member of the team and contributed insightful comments and questions in whole-class discussions.
Zipline Trials	The spaceship did not work.	Spaceship made it across the zipline but struggled to get there.	Spaceship worked.	Spaceship worked and was one of the fastest of all.

Name: _____ Date:_____

Write a reflection about your team's experience using the engineering design process to create your spaceship. Explain how designing, testing, evaluating, and redesigning was an important part of getting your spaceship and the battery pack to work.

About

KitHub

KitHub was founded in 2014 in Los Angeles, California, by two women with expertise in hardware and software development, education, and running makerspaces. The company offers hands-on science, technology, and environmental projects that engage and delight the curious mind. Engineers and scientists design our activities, and certified educators write the lessons. Contributors have experience teaching hands-on projects in the classroom, makerspaces, and through distance learning. We provide materials, lesson plans, and assessments so that you're ready to facilitate when you receive your KitHub kit.

Pedagogy

KitHub utilizes project-based learning techniques that include open-ended investigation intended to foster deep inquiry and critical thinking. At the same time, learners work toward producing possible resolutions to authentic challenges. Our lesson plans incorporate the BSCS 5E Instructional Model: Engage, Explore, Explain, Elaborate, Evaluate, and the Connected Learning framework that connects personal interests to meaningful relationships and real-world opportunities. Incorporate the projects into a curriculum, unit, lesson of the day, or extracurricular activity.

When a learner follows their interests, has support from mentors and peers, and have tangible connections to real-world opportunities, it manifests into a thriving space to learn at home and school. Their attention increases, learning deepens, resilience strengthens, and 21st-century competencies expand. Our activities provide repeated exposure to project-based learning processes, so understanding happens through making, not memorizing. Learners will be able to practice the skills and thinking needed for future science, technology, engineering, and math opportunities, utilizing creative and critical thinking skills.

Support

For support, use the chat feature on our homepage or email us. We also have live support sessions that you can find on our calendar.