About Galileo Learning

Galileo Learning (Galileo) creates and operates Innovation Camps for kids. Their mission is “to develop innovators who envision and create a better world” and this mission comes to life each summer at nearly 60 imagination-sparking locations (40 in the Bay Area, 15 in SoCal locations and 4 in Chicagoland.) They also train and employ more than 2100 educators and aspiring educators as summer staff. Galileo’s programs serve campers from pre-K through 8th grade.

In all of Galileo’s programs, the curricula focuses on helping campers (and staff) develop 21st Century skills and mindsets through understanding and applying the Galileo Innovation Approach (GIA). The GIA is inspired by the Stanford d.school’s design thinking process and mindsets and fine tuned for 5-14 year old campers who are especially open to absorbing new ways to think, explore and create. Click here for more information about Galileo Learning.
The Galileo Innovation Approach

The Galileo Innovation Approach (GIA) is our unique approach to teach and learning. It is designed to develop Galileo Innovators – campers and staff who imagine and create a better world. Galileo Innovators approach their work with an Innovator’s Mindset, do their work with an Innovator’s Process, and seek/leverage Innovator’s Knowledge.

Galileo Innovator’s Mindset
Galileo Innovators have dispositions that support breakthrough thinking and creative work. The Galileo Innovator’s Mindset has five elements:

BE VISIONARY
• I envision a better world.
• I imagine things that don’t yet exist.
• I believe that it is my place to turn ideas into reality.

BE COURAGEOUS
• I freely share my creative thoughts.
• I stretch myself to try new things.
• I embrace challenges.

BE COLLABORATIVE
• I value the unique perspectives of others.
• I build on the ideas of others.
• I use my strengths to support the work of others.

BE DETERMINED
• I persevere until I achieve my goal.
• I recognize setbacks as opportunities to learn.
• I know that innovation and mastery require effort.

BE REFLECTIVE
• I take time to think about what is and isn’t working in my design.
• I think about how my work impacts other people and the world.
• I seek feedback to improve myself and my work.

Galileo Innovator’s Process
Galileo Innovators learn and practice an iterative process to bring the best ideas to fruition. The diagram below shows the Galileo Innovator’s Process:

Galileo Innovator’s Knowledge
Galileo Innovators require subject-specific knowledge to creatively solve problems and make their visions a reality. Galileo Innovator’s Knowledge lies in the following four categories:

CONCEPTS AND FACTS
Galileo Innovators understand the big ideas, principles, and facts relevant to their work.
Examples: Adding more tension to a rubber band creates a higher pitch when it’s plucked

HISTORICAL CONTEXT
Galileo Innovators understand the contributions, objectives, and processes of relevant movements, artists, scientists, designers, and other experts who came before them.
Examples: Kandinsky uses a variety of brushstrokes and line types to represent music visually

SKILLS AND TECHNIQUES
Galileo Innovators understand how to use relevant materials, tools, and technology so they can effectively build, test, and share their ideas.
Examples: Manipulating cardboard by cutting, curling, bending, folding, scoring, tabbing, and fastening; taping techniques; watercolor resist

AUDIENCE AND ENVIRONMENT
Galileo Innovators understand the needs, beliefs, and circumstances of their users and the physical context in which their work will be received.
Examples: Engineers need to design buildings in a specific way when constructing in an earthquake prone area

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**Galileo Innovation Approach and the Curriculum**

Our curriculum is designed to support you in teaching the Galileo Innovation Approach and nurturing Galileo Innovators. Below are some ways in which the curriculum fosters your development as an Innovation Educator.

First, you’ll find that the components of the GIA literally leap off the page.
- The GIA terms are emphasized throughout the curriculum in ALL CAPS to help you easily identify opportunities to integrate the GIA.
- An overview of the **key Innovator’s Knowledge, Process**, and **Mindset** for each lesson appears in the Instructional Priorities & Supporting Innovation section. Think of these as the blueprint of a successful lesson. Starred sections in the curriculum are connected to these priorities and should not be skipped.

Second, the curriculum includes a daily **Innovator’s Mindset Challenge**. The Mindset Challenge helps campers focus on developing a different part of the Innovator’s Mindset each day and shows how practicing this element can help them develop as innovators. The challenge is introduced near the beginning of the lesson, supported with details in the facilitation notes and debriefed as part of the lesson wrap up.

Third, each day concludes with a **Lesson Wrap Up** that provides a forum for you to go deep on innovation themes with campers. Prompts are provided to support project sharing, reviewing key Innovator’s Knowledge and debriefing the day’s Mindset Challenge. Use this time to help campers solidify what they learned, notice how practicing the mindset helped them with their project and recognize the innovator in themselves and in others. Familiarize yourself with the discussion questions before each lesson so you can best guide campers to develop as innovators throughout the rotation.

Additionally, these general practices can help you to bring the GIA to life:
- **Think** about what it means to you to be an Innovation Educator and find ways to realize that vision.
- **Pace** your class to allow time for campers to engage with each project, giving ample time for the TEST, EVALUATE and REDESIGN phase so that campers can thoughtfully evaluate how they can improve their designs, and then implement the modifications.
- **Model** the Mindset in your teaching. When you make a mistake, celebrate it! Tell the campers that your teaching or the project didn’t go as planned, and that you’ll learn from that and try it a different way in the next rotation.
- **Help** campers understand what it means to be a Galileo Innovator and strive to shape their self-images as such.
- **Recognize** campers as they exhibit the Innovator’s Mindset as relevant throughout the day—in addition to this focus during the Wrap Up. *(E.g., I see that you’re BEING REFLECTIVE, thinking about what is and isn’t working with prosthetic hand design. That’s a great way to start developing an innovative solution!)*
- **Refer** to the steps of the Innovator’s Process (and your Galileo Innovator’s Process Poster) as you describe the day’s activities and as campers work.

Finally, the curriculum supports your own innovations for how to integrate the GIA in your classroom. Please apply the Innovator’s Mindset and Process to this end and SHARE your learning with your colleagues!
### Galileo Makers – Star (Grades 1-2)

#### Real-World Inventions

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### Project Overviews

#### Galileo Makers Day 1 – **Grabber, Part 1 of 2**

**Project Description**

Grabbers are useful for many situations in which something is just out of reach. Today campers will build grabber components (hinges and arms) to add to and customize tomorrow.

**Instructional Priorities and Supporting Innovation**

- **Demo & Discussion: Grabber Hinge and Arm**
- **Introduction**: Introduce the CONCEPT of a hinge to create the movable grabber hand.
- **Demonstrate**: Demonstrate the TECHNIQUE of using the awl to punch holes in cardboard on top of a box.
- **Demonstrate**: Demonstrate the building and taping TECHNIQUE of “overlap and wrap.” Throughout the Lesson
- **Support the Innovator’s Mindset Challenge**: BE DETERMINED – Campers take their time building each step of the project and practice using the awl and tape techniques discussed.
Galileo Makers Day 2 – Grabber, Part 2 of 2

Project Description
Campers design and create the tips of their grabbers, then put their creations to the test by attempting to grab various objects from different positions.

Instructional Priorities and Supporting Innovation
- Demo & Discussion: Design the Grabber Tips Intro
- Introduce the CONCEPT of friction and discuss how to add friction using today’s materials.
- Support GENERATING IDEAS about grabber tip designs and about how to REDESIGN to meet each specific challenge.
- Do-With-Me: Add the Rubber Band and String
- Demo the TECHNIQUE for adding the rubber band and string one step at a time.

Throughout the Lesson
- Support the Innovator’s Mindset Challenge: BE DETERMINED – Campers continue to redesign their grabbers to meet the next most challenging goal, until their grabbers can perform all of today’s challenges.

Galileo Makers Day 3 – Vacuum, Part 1 of 3

Project Description
Why buy a vacuum when you can make your own? In this project, campers will design and build a working vacuum cleaner that operates in the same way as the store-bought handheld appliance.

Instructional Priorities and Supporting Innovation
- Demo & Discussion: Circuits and Suction
- Define the CONCEPT of suction and how it applies to a vacuum cleaner.
- Introduce the CONCEPT of a circuit and explain how a circuit functions.
- Demo the SKILLS AND TECHNIQUES needed to make a simple circuit, including twisting and insulating wires.

Throughout the Lesson
- Support the Innovator’s Mindset Challenge: BE DETERMINED – Campers put in the time and effort to do the best job possible of completing each step.
Galileo Makers Day 4 – Vacuum, Part 2 of 3

**Project Description**
Campers add a filter and canister to make their vacuums more functional.

**Instructional Priorities and Supporting Innovation**

*Demo & Discussion: Canister and Filters Intro*

- Introduce the CONCEPTS of filters and canisters, and how they work together to collect debris.
- Demo how to TEST, EVALUATE, and REDESIGN each of the three filter options.

**Throughout the Lesson**

- Support the Innovator’s Mindset Challenge: BE REFLECTIVE – Campers notice how different variables affect their designs and use these discoveries to help them figure out what adjustments they need to make.

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Galileo Makers Day 5 – Vacuum, Part 3 of 3

**Project Description**
Campers complete their vacuums by adding a handle and a vent. Additional build time can be used to decorate and personalize the vacuums.

**Instructional Priorities and Supporting Innovation**

*Demo & Discussion: Handles, Vents and Decorations Intro*

- Introduce the CONCEPTS of handles and vents, and how these components improve the vacuum.
- Demo TESTING and EVALUATING handle and vent designs.
- Help campers GENERATE IDEAS around how to customize the vacuum.

**Throughout the Lesson**

- Support the Innovator’s Mindset Challenge: BE VISIONARY – Campers imagine and design specialized features to turn their vacuums into unique creations.
This Week’s Story
Each week at camp a story will unfold though a series of skits done at opening and closing ceremonies. The story provided to your Camp Director for this theme has been included here so that you can incorporate the story into your classroom this week. We’ve provided some suggestions in the curriculum for how to tie activities into the storyline, and we also encourage you to bring the story to life in your own way!

Galileo Makers Story Overview

Website Teaser

*Galileo Makers: DIY Art and Real-World Inventions*

Flex your maker muscle and put a creative spin on everyday objects. Design a personalized stool, clock or pillowcase for your room. Build useful inventions to take home like a vacuum or a secret lock box with an alarm that really works. Harness your innovative energy and join the marvelous maker movement as you transform intriguing ideas into functional, faire-ready reality.

Characters

- **Storyteller**
  *Our narrator, who reads Monday's story and parts of Wednesday's and Friday’s—this role can be played by anyone who is a clear-spoken, engaging reader of stories*

- **Lucy**, a girl who lives in Land Land
  *A curious, potentially creative human stuck in a world of dull sameness—a situation that has resulted in a state of constant restlessness, as she never quite knows what to do with herself*

- **Finn**, a boy who lives on Cardboard Island
  *A super-enthusiastic kid who’s always up for a challenge and has ideas to spare—an I-have-an-awesome-idea-so-what-are-we-waiting-for kind of guy*

- **Lucy’s parents**
  *Formerly creative folks who have lived in Land Land so long they don’t remember what it’s like to make things themselves*

- **The makers of Cardboard Island**
  *Assorted creative folks—including our Camp G campers—who live and make on Cardboard Island*

Setting

- **Land Land and Cardboard Island**
  - *Land Land: A place where everyone is the same—everyone dresses the same (in dull colors), decorates the same (minimally, also in dull colors), has the same haircut and says all the same things (e.g.: Person 1: "Welcome to Land Land"; Person 2: "Welcome to Land Land")*
  - *Cardboard Island: An alternate world that's covered in cardboard as far as the eye can see—its inhabitants spend their days transforming its vast cardboard reserves into awesome hand-made gizmos, gadgets and pieces of furniture, all wildly colored and wonderfully personalized*

Plot

Restless in her Land Land existence (and dreading an upcoming move to a new house that’s just like her current house), Lucy draws a doorknob on the back wall of her closet, which opens a portal to Cardboard Island, a land covered in cardboard and inhabited entirely by marvelously creative makers. There she meets Finn, who introduces her to the fabulous, fearless creativity of the Cardboard Islanders. They offer to help her make items to personalize her new room. When Lucy gets stuck back in Land Land, she and the Cardboard Islanders work together to reopen the portal and stage a mini-Maker Faire featuring items for Lucy’s new room.

Conflict

Lucy’s dad paints over the "doorknob" in Lucy’s closet, sealing the portal and locking her in Land Land before she can realize her vision for her new room. She and the Cardboard Islanders need to reopen the portal and stage their Faire before Friday’s move and without upsetting Lucy’s parents, who might not approve of such un-Land-like creations.

Resolution

Lucy and the Cardboard Islanders reopen the portal between the lands and put on an awesome Maker Faire on the island. Lucy’s parents follow her through the portal to the Faire, but instead of being upset, as Lucy feared, they’re impressed and inspired by her VISION.

What We Want Campers to Learn

- The Maker Movement is all about making things and getting people together to learn and create.
• Maker Faire is an all-ages gathering of makers who come together to collaborate, get inspired and share what they've made and learned.
• As long as you have an imagination (and a little cardboard) you never have to be bored.
• Innovators are VISIONARY and COLLABORATIVE.

Galileo Makers: Monday

The storyteller reads:
Once upon a time, so long ago that nobody but the storytellers remember, there lived a girl named Lucy. Lucy lived in a place called Land Land where everything was the same. In Land Land, everyone wore the same clothes, ate the same food, drove the same cars and lived in rows of identical houses. And this is how it had been in Land Land for generations. Year after year, it was the same, and that sameness had been the same for Lucy’s parents, her grandparents and her great-great grandparents, all the way back as long as anyone could remember.

It wasn’t such a bad place to live, but Lucy couldn’t help but feel a little tired of all the sameness. Sure, it made it easy to pick out her clothes in the morning and decide what to eat for lunch, but she couldn’t help but feel like there was something... missing.

On the day our story begins, Lucy was sitting in her room doodling, thinking about her family’s big move to a new house later that week. She wanted to be excited about moving, but she just couldn’t muster up any enthusiasm, because in Land Land, new houses were pretty much just the same as old houses. Which meant that her new room would look pretty much the same as her old room, which, in turn, looked exactly the same as her brother’s room... and her best friend’s room... and her best friend’s brother’s room...

"UGH!" Lucy exclaimed, rising to her feet. She was suddenly so fed up with the dreary, tedious BORINGNESS of it all. "Why does EVERYTHING I own have to look exactly the same as everything everyone else owns?" she wondered out loud, waving her pencil around for emphasis. Throwing open her closet door, she scanned racks and shelves stuffed with identical shirts, shoes, toys, books and sports equipment, all in drab, sensible colors. Pushing them aside, she stood considering the back wall of her closet. "Well," she said, looking at the pencil in her hand, "maybe I there's SOMETHING I can make look a little different."

And with that, she drew a big, round, ornate-looking doorknob on the wall in front of her, right where a doorknob would go if the back of her closet were a door instead of a wall. When she was done, she stood back, pleased with her handiwork. In fact, her doorknob looked so real, she almost felt like she could reach out and grab hold of it... so she did. And to her surprise, the knob turned in her hand and her closet wall swung open in front of her like a big door. Speechless and more than a little curious, she took a deep breath and stepped through it.

Lucy blinked in the bright sunlight. As her eyes started to adjust, she noticed three things about her surroundings:

Number one: She wasn’t inside her closet anymore. The warm, dazzling sun and fresh, salty-smelling air made that part pretty obvious.

Number two: She was surrounded by cardboard as far as the eye could see. But not just cardboard boxes and tubes and scraps—cardboard EVERYTHING. There were cardboard trees and flowers, cardboard benches and streetlights, cardboard houses and bicycles... and they were all so DIFFERENT. Every last flower petal and bicycle spoke was different from the one next to it—brightly painted, adorned with trims and tassels, some even wired with lights and switches. She’d never seen anything so intriguing or beautiful in her whole life... certainly not in Land Land.

And the third thing she noticed was the people—because there were plenty of people in this strange new place, and they had started to notice this new, drably dressed visitor. The people here were a little like the place itself: decked out in a variety of colors and cool embellishments, every one totally, marvelously different from the last. There was even a whole batch of kids about her age, sitting right in front of her, who seemed to be campers of some kind...

One of these utterly unique individuals—a boy about her age, wearing a wildly cool, totally wacky cardboard hat and a backpack covered in buttons and lanyards—walked right up to her and stuck out his hand. "Finn's the name," he announced cheerfully, "it's awesome to meet you!" Lucy took his
hand tentatively. "Hello, hello. I'm Lucy," she said, nodding her head twice, as was traditional in Land Land. And then, before she could stop herself, she blurted out, "Um... I'm sorry, but I... I'm just a little confused. Where am I?" Finn laughed. "Oh, how silly of me," he said, "where are my manners? Lucy, welcome to Cardboard Island!"

Galileo Makers: Wednesday

1. Lucy and Finn learn about each other’s homes
The storyteller reads: "Now, where did we leave off? Ah yes! There Lucy was, on the other side of a mysterious door in the back of her closet, surrounded by bright people and their bright creations, talking to a boy named Finn..."

- Finn tells Lucy about Cardboard Island, a place covered in cardboard and inhabited by makers, including this group (i.e., the campers), who only just arrived Monday.
- Lucy explains how different this place is from her home and tells Finn what led her here: She’s tired of everything being so same-y in Land Land, especially the idea of her not-so-new "new" room in the house she’s moving to.

2. Finn and his Cardboard Island friends offer to help
- Excitedly, Finn says that he and his friends are experts at personalizing special spaces—they can help her make stuff for her room!
- Lucy gets excited too, confessing that she sometimes sketches ideas for inventions.
- The pair makes a plan: On Friday, Lucy, Finn and the Cardboard Islanders (including the campers) will put on a Maker Faire (an event Finn has to explain to Lucy) on the island, full of creations she can use in her new room.
- Lucy is thrilled, but she muses that she probably shouldn’t tell her parents yet, since she’s not sure how they’ll feel about all these unique creations in their Land Land home.

3. Lucy gets stuck back in Land Land
The storyteller reads: "A few days passed, with Lucy traveling back and forth between Land Land and Cardboard Island, sharing her sketches and starting to learn how to bring them to life. But one day, when she came rushing home from school, excited to head to the island with a new batch of ideas, she got an awful shock..."

- Lucy finds her dad in her closet, just having painted over her doorknob (an innocent mistake—he saw something out of order and thought he’d fix it).
- Once her dad leaves, Lucy confirms that the door is, in fact, gone.
- She tries redrawing the doorknob but it’s no use—she bangs on the door helplessly.

4. The Cardboard Island folks reopen communication
- Just then, a note arrives through the closet wall (the Cardboard Island gang heard her banging and fashioned a quick mail slot), which Lucy reads aloud: "Pretty cool mail slot, huh? We think we can figure out a new door, too. We just need a little time..."

5. The Cardboard Island folks convince Lucy to stay the course
- Lucy is skeptical, but then she hears Finn calling faintly through her wall: He tells her that nothing is impossible if they COLLABORATE—they’ll keep planning and making for the Friday Faire (sending plans through the mail slot), plus work on ideas to help them reopen the portal between the two lands.

Galileo Makers: Friday

1. Lucy wraps up the finishing touches on her Maker Faire project
The storyteller reads: "It had been a busy few days since the door in Lucy’s closet—the one between her home in Land Land and Finn’s home on Cardboard Island—had been accidentally sealed shut. Lucy had been spending that time hard at work, communicating with her friends on Cardboard Island, sending plans back and forth as they generated ideas and creating her own project for Friday’s Maker Faire..."

- Lucy finishes her project and holds it up to inspect it, looking proud, then sighs, wondering aloud if she’ll ever be able to go to Cardboard Island again—was this all a big waste of time?

2. Lucy reopens the door to Cardboard Island
- Just then, she hears something coming from her closet and walks over to check it out.
- "Is that you, Finn?" she asks.
- "Yup," he responds, and then: "Draw a new doorknob!"
• She doesn't hear him clearly at first, and once she does, she has to remind him that she already tried redrawing the doorknob with no luck.
• Finn explains that they figured out the secret to unlocking the portal: She can't just draw the same doorknob again: "We're makers—it has to be a totally reimagined thing... something the world has never seen before!"

3. Lucy attends her first Maker Faire
The storyteller reads: "Lucy picked up her pencil and studied the wall for a moment, then began to draw a completely new kind of doorknob, this one square and modern-looking with broad stripes running across it. When she was done, she picked up her project, took a few steadying breaths and reached out to turn her new doorknob. And once again, there she was, standing in the dazzling sun of Cardboard Island. But before she could celebrate her successful arrival, she was stopped in her tracks by what she saw: Everywhere she looked, there was a different maker with a different incredible thing—chairs and beds and beanbags; nightlights and desk lamps and fairy lights; clocks and door hangings and murals. It was all so overwhelmingly, astonishingly amazing that she almost couldn’t take it all in... but she wanted to try..."

• Lucy runs around the Faire delightedly, meeting makers, hearing about their projects and sharing her own.

4. Some unexpected visitors show up
• As Lucy begins to run to another booth, she runs smack into her mom and dad.
• Lucy is at a loss for words, but begins to stammer an excuse for what she’s doing and why she’s there, trying to hide her project behind her back.
• Her parents (a little speechless themselves) slowly explain that they're not mad... they're impressed—in fact, they remember a time, long ago, when they used to make things, too...
• They ask to see Lucy's project and marvel at it—they're inspired by her VISION.
• Overjoyed, Lucy says that she couldn’t have done any of it without the COLLABORATIVE efforts of Finn and her other Cardboard Island friends—the community of makers that welcomed her.

5. The storyteller wraps things up
The storyteller reads: "Lucy, her parents, Finn and the rest of the Cardboard Island makers spent hours together at the Faire that day, showing each other what they made and sharing what they learned making it. The Land Landers started to truly understand the power of creating things the world has never seen before and of working together with interesting, innovative people. And they learned a lesson that Cardboard Islanders, Galileo campers and makers all over the world have known for many years: As long as you have an imagination—and maybe a little cardboard—your life will never be boring.

By the end of the day, Lucy and her parents were so utterly inspired and full of ideas for what else they could make—objects to decorate their new house, to solve everyday problems, to give as gifts—that they couldn’t wait to show everyone back home in Land Land. And that’s exactly what they did. And from that day forward, to their delight, Land Land was never the same again."

Notes and Additional Ideas
• Your other actors can act out the read-out-loud scenes as the storyteller reads them.
• As inhabitants of Cardboard Island, campers can submit their own ideas/plans for a new door between their land and Land Land.
• Lucy and Finn not being able to hear each other through the wall can be played for comedy: They can stand directly next to each other (with either a cardboard or an imaginary wall between them), shouting as loud as they can, but barely able to make each other out.
• Lucy's project for the Faire can be anything—a camper project or something entirely different.
• On Wednesday or Friday, Lucy can meet real makers (played by staffers) that campers have been learning about, who can share their projects with her.
• On Friday, campers can stage the Maker Faire that Lucy discovers on the other side of her door.
• Feel free to turn Friday's Faire into a deeper exploration of campers' work throughout the week—look at each project and call out (or have campers identify) the Mindset elements and Process steps they used in making it.
Preparation for the Week

This section contains preparation of materials such as cutting paper and cardboard. Give this list to Summer Interns (SIs) who have some time to help Lead Instructors (LIs) or to Team Leaders (TLs) who help LIs do prep work after camp. It also helps you get a sense of the prep needed for the week. It does not include tasks such as setting out materials or preparing a place to store projects. Those suggestions are in the prep section of each lesson.

Day 1 – Grabber, Part 1 of 2

Days earlier

 ensl Cut 1.5” x 18” cardboard strips in half (two 9” pieces per camper).
 ensl Draw lines 6” from the end of the 9” pieces (2 per camper) and the 18” pieces (2 per camper). A good method for drawing lines on several at once is below.
 • Line up the 9” and/or 18” cardboard strips
 • Make a mark 6” from the edge at the top and bottom of the stack.
 • Use a yardstick to draw a line 6” from the edge.
 ensl Build a sample grabber.

Day 2 – Grabber, Part 2 of 2

Days earlier

 ensl Cut string into approximately 30” lengths. A quick way to do this is to set two chairs 30” apart, wrap the string around the chairs, and then cut the string along the edge of each chair. If you wrap the string around the chairs thirty times you’ll end up with sixty 30-inch lengths of string.

Advance prep

Start stripping wires and/or cutting slits in tubes for the vacuum project on Day 3 (see details in the Day 3 prep). This is the most prep-intensive day this week, and it is recommended that you start now.

Day 3 – Vacuum, Part 1 of 3

Days earlier

 ensl Cut slits into tubes for mounting the motor inside the motor cover (1 tube per camper).

Note that the slits are offset from being directly across from each other. This is important to prevent the propeller blade from hitting the inside of the tube. Test your first few prepped tubes by slipping the motor mount inside and making sure that the propeller does not hit the tube.
 ensl Strip about 1” of insulation off of the wires for the motor, battery pack, and switch (1 of each per camper).
 ensl Build an example vacuum for the Demo & Discussion (see the pictorials for Days 3-5).
 ensl Remove the screws from the real vacuum cleaner so you can easily take it apart to show campers the components inside during the Demo & Discussion.

Day 4 – Vacuum, Part 2 of 3

Days earlier

 ensl Punch a hole at the bottom of the deli container (1 per camper).
 ensl Use the cutting mat. Lay the cutting mat over a hard surface such as tile or concrete. The punch won’t work if the mat is placed on carpet. Place the arch punch in the center of the deli container. Swiftly strike the punch with a mallet one to three times.
 ensl Use scissors to cut the burlap into quarters (1 piece per camper).
 ensl Use the paper cutter to cut the cardstock into quarters (1 piece per camper).

Day 5 – Vacuum, Part 3 of 3

Days earlier

 ensl Cut craft sticks in half as a handle option (2 halves per camper).
READ ME: IMPORTANT CIRCUIT SAFETY PROTOCOL

What’s a Short Circuit?
A short circuit will occur any time the electric current can flow around a circuit from one terminal of the battery to the other without passing through any other components like a motor or light. Without the current passing through a component there is nothing to provide resistance (consume electricity), resulting in an unsafe flow of excess current.

Both of these pictures show a short circuit. Even though the picture on the right has a motor wired to the batteries, the circuit is still shorted because the battery pack wires are directly touching, creating a path that allows the current to travel back to the battery without passing through the motor.

It is extremely important that you prevent short circuits while working with electronics. Short circuits can damage the battery and other components. They also cause overheating that may result in smoke or fire.

While we do not expect any issues if you follow these protocols, should you experience any overheating, alert your CD so s/he can alert the Curriculum and Field teams immediately.

Prevent Short Circuits and Overheating
• Never connect the wires leading from the battery to each other. This will quickly overheat the battery.
• Do not insert batteries into the battery packs before the lesson. It’s easy for loose battery pack wires to cross. Putting batteries into battery packs before the battery pack wires have been wired to a component increases the chance of accidental short circuits.

• Clearly review with campers the importance of not creating short circuits and demo all techniques for preventing exposed wires.
• Do not give campers batteries until you have verified that all wire connections have been wrapped in tape with NO exposed wire at all. Exposed wires can accidentally touch and short the circuit.
• Have campers remove batteries at the end of the rotation. This extra precaution will ensure that no electrical issues occur when no one is in the classroom.
• Do not use battery packs that are corroded, damaged, or show signs of other degradation. Battery corrosion looks like a white powder, usually near the battery terminals. Check for corrosion during inventory. While corrosion doesn’t cause short circuits, it can cause overheating.

Signs of a Short Circuit
• Batteries, wires, or battery holders feel uncomfortably hot to the touch. (Note that it is normal for batteries to get slightly warm. This is not a sign of a short circuit.)
• Battery packs are melting.
• The circuit is smoking or catches on fire.
• Motors or lights are not turning on even when the circuit is turned on.

Instruct campers to let you know immediately if they notice their batteries getting hot. Emphasize it is extremely important that they alert an adult as soon as possible if this is happening.

What to Do If You Experience a Short Circuit or Overheating
• Immediately deactivate the circuit by uncrossing wires and carefully removing the batteries.
  ▪ Do not use your hands if the battery is hot.
• Ventilate the room if you smell overheated batteries.
• Check for damaged components such as melted battery holders, melted wires, or overheated electronics.
  ▪ Discard damaged parts. Do not reuse them.
  ▪ Discard the components in a heat-resistant container. Create an electronics-recycling container for your camp. Don’t dispose of electrical components in the trash.
• Determine the cause of the short
  ▪ Check for exposed wires and have the camper wrap any imperfect connections in tape before inserting new batteries (do not reuse the shorted batteries).
  ▪ If the wires are not crossed and the batteries are still overheating, put the project sample aside and alert your CD. Save the project sample for the curriculum team to analyze.
Day 1
Grabber, Part 1 of 2
Building the Hinge and Arm
Grabbers are useful for many situations in which something is just out of reach. Today campers will build grabber components (hinges and arms) to add to and customize tomorrow.

The Big Picture
Lesson Breakdown

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welcome to Science</td>
<td>10 min</td>
</tr>
<tr>
<td>Introduction</td>
<td>5 min</td>
</tr>
<tr>
<td>Demo &amp; Discussion: Grabber Hinge and Arm</td>
<td>15 min</td>
</tr>
<tr>
<td>Camper Work Time: Build the Hinge and Arm</td>
<td>30 min</td>
</tr>
</tbody>
</table>
| Build the hinge. Extend the cardboard arm and reinforce it with craft sticks. (The arm can be finished tomorrow if necessary.) The grabber must have:  
  * A hinge that is able to freely rotate  
  * An arm that is rigid and not wobbly  
| Designable Components: arm length, reinforcements |          |
| Testing: hinge – manually move the hinge back and forth; arm – hold the grabber and sway it from side to side to see if it bends |          |
| Clean Up                                       | 5 min    |
| Wrap Up                                        | 5 min    |

GIA Focus
Innovator’s Knowledge Focus: SKILLS AND TECHNIQUES
Innovator’s Mindset Focus: BE DETERMINED – I persevere until I achieve my goal.

What’s Next: Tomorrow (Day 2) campers will finish their arms if necessary. Then they’ll design different tips for their grabbers and attempt a variety of challenges.
How to Create Today’s Project

Step-by-Step Pictorial

This is intended to help you understand how to create today’s project. It doesn’t include everything campers will do today (like the demonstration of successful taping techniques). It also doesn’t describe how you’ll facilitate this lesson for campers. You’ll need to read the “Play-by-Play” section for this information.

Hinge

Fig. 1

Place the cardboard strips on top of a cardboard box and use an awl to puncture a hole on the line. (You’ll prepare strips of cardboard with lines for campers ahead of time.)

Fig. 2

Use this method to punch a hole in two long pieces and two short pieces.

Fig. 3

Insert a fastener through the four pieces with the two short pieces sandwiched between the two long pieces.
• Tape both ends of the long cardboard strips together.
• Tape one end of the short cardboard strips together as shown.

Arm

Extend the arm with another two cardboard strips. Reinforce it by taping paint stirrers to one side.
Modifications

This shows a paint stirrer reinforcement without additional cardboard extensions. (This is an option for today if campers are short on time.)

Fig. 9

This shows the bottom of the arm wrapped in yarn for added comfort. (This is an option if campers finish early.)

Fig. 10

Get Ready!

Lesson Materials
* (starred) items are choice materials; un-starred items are required for each camper

Pre-Assembly
☐ finished project sample, for Li demo (1 per classroom)
☐ box, corrugated, 8” x 8” x 5”, for awl stations (1 per 3 campers)
☐ yardstick (2 per classroom)

Demo & Discussion: Grabber Hinge and Arm
(You will be building a hinge and arm during the activity.)
☐ cardboard, corrugated, 1.5” x 18” (5 per rotation)
☐ fastener, brass, 1-1/2” x 1/2” (1 per rotation)
☐ paint stirrer, wood, 12” (2 per rotation)
☐ tape, masking, 1” wide (24” per rotation)

Camper Work Time: Build the Hinge and Arm
☐ cardboard, corrugated, 1.5” x 18” (5 per camper)
☐ fastener, brass, 1-1/2” x 1/2” (1 per camper)
☐ paint stirrer, wood, 12” (2 per camper)
☐ tape, masking, 1” wide (24” per camper)
☐ awl, metal (1 per 3 campers)

Extension
☐ yarn, jumbo, asst. colors, 60 ft. bag (60” per camper)
☐ marker, asst. colors, set of 8 (1 per 4 campers)
Preparation

Days earlier

- Cut 1.5" x 18" cardboard strips in half (two 9" pieces per camper) (below).

- Draw lines 6" from the end of the 9" pieces (2 per camper) and the 18" pieces (2 per camper). A good method for drawing lines on several at once is shown below.

- Line up the 9" and/or 18" cardboard strips
- Make a mark 6" from the edge at the top and bottom of the stack.

Day before

- Set up awl stations (1 per 3 campers).

Suggested Materials Management

Hand out cardboard strips and fasteners first to make the hinge, and then allow campers to access the other materials from the materials station at their own pace.

Suggestions for Large Classes

Space out the awl stations to allow campers to safely share the stations.

Check In With Your TL

Make sure your TLs are clear about their role in helping today’s lesson run smoothly. Specific ways TLs can help today are listed in the dotted overview boxes throughout the lesson.
On the Board

Design Goals
The grabber must have:
- A hinge that can move back and forth
- An arm that does not wobble

Write down and/or illustrate the project steps on the board:
1. Awl station
2. Fastener
3. Tape the ends
4. Extend the arm
5. Reinforce the arm

Guiding Questions
BE DETERMINED
- What is the next part to build?
- Where might you reinforce/improve taped connections?
- What else can you do to make sure your grabber is as strong as possible for tomorrow?

Vocabulary
awl – a pointy tool used to poke holes
hinge – a moving connection that allows something to move back and forth
overlap – when something covers part of another thing

Teaching the Lesson: Overview

Instructional Priorities & Supporting Innovation

These are the key lesson elements you’re expected to communicate/support today. Think of this as the blueprint of a successful lesson. When applicable we’ve included details about why an element is important for innovation.

Demo & Discussion: Grabber Hinge and Arm
★ Introduce the CONCEPT of a hinge to create the movable grabber hand.
★ Demonstrate the TECHNIQUE of using the awl to punch holes in cardboard on top of a box.
★ Demonstrate the building and taping TECHNIQUE of “overlap and wrap.”

Throughout the Lesson
★ Support the Innovator’s Mindset Challenge: BE DETERMINED – Campers take their time building each step of the project and practice using the awl and tape techniques discussed.
Why – This part of the project uses some unusual building techniques and it is the foundation for tomorrow’s class. Taking the time to make each part correctly will set campers up for success tomorrow.
Teaching the Lesson: Play-by-Play

Welcome to Science (10 min)

It’s important to set clear expectations for the whole week. Go over daily procedures you’ll want campers to be familiar with (what they do when they first come in, what materials they can and can’t touch, where they put projects, etc.). Have campers come up with agreements about how they can respect you, one another, and the space and materials.

Introduce the idea of being an innovator. Say: We’ll be learning about science all week, but we’ll also be practicing being Galileo innovators. Being an innovator is a really important job. Innovators think of really great ideas and can turn them into something real!

Point out your Innovator’s Process poster. Say: These are the steps that good innovators follow to help them make amazing creations. They come up with a lot of ideas, test them out, and redesign to make them better.

Point out your Innovator’s Mindset poster. Say: This is how good innovators think and act. They try new ideas, they work together, and they don’t give up!

Say: Are you ready to innovate?! Let’s get started!

Introduction (5 min)

Welcome campers and make a quick story connection

Did you learn about Lucy this morning? What happened to her in the story? (She traveled to a place called Cardboard Island that’s covered in cool cardboard creations.) Why don’t we get into the Cardboard Island spirit by making some inventions ourselves! Maybe we can inspire Lucy to build something that no one in Land Land has ever seen before.

Introduce the week’s theme

- Explain that this week’s theme is all about Making, which means creating things oneself.
  - This includes tools, things for games and play, and totally new inventions.

- This week, campers are making things that are useful for every day.
- Explain that people who make things are called makers. The maker community is a space where makers can come together to share ideas.
- Tell campers they’ll be learning about some current-day makers who are creating things similar to the things we’ll be making at camp.
- If this is your second or third rotation you can ask campers to tell you what they know about making and makers since they will have gotten this introduction in art.

Build excitement for today’s project

- Place a sponge out of reach (behind a table, high on a shelf, or simply far away from where you are sitting/standing).
- Tell campers that you really want that sponge, but you can’t reach it!
- Hold up your example grabber and use it to grab the sponge.
- Inform campers that today and tomorrow, they’ll be making their own very useful grabbers!

Introduce the Innovator’s Mindset: BE DETERMINED ★

- Point to this on your Innovator’s Mindset poster.
- Define the Mindset element in the context of today’s lesson. Say: Today’s project has quite a few steps and some building techniques that you probably haven’t tried before. Today, being determined means completing each of these steps and trying hard to master a new building technique, even if you are not sure what to do next or if one of the steps is hard to do.
**Demo & Discussion: Grabber Hinge and Arm (15 min)**

**What You’ll Need to Cover: Overview**
- Introduce the idea of a hinge. ★
- Introduce awls and awl safety. ★
- Show how to create the hinge. ★
- Demo the “overlap and wrap” technique to extend the arm. ★
- Demo the technique to reinforce the arm. ★
- Review the building steps.

**What You’ll Need to Cover: Details**

**Introduce the idea of a hinge ★**
- Show campers the hinge on your grabber.
- Define what a hinge is and have campers say the word “hinge.”
  - As you say “hinge,” pinch your elbow and move your arm back and forth.
  - Have campers do the same. Kinesthetic memory helps reinforce the definition of “hinge.”
- Move the hinge on your example back and forth many times.

**Introduce awls and awl safety ★**
- Explain that the hinge is made by poking a hole through all the cardboard and inserting a metal fastener.
- Show campers an awl. Explain that an awl is a tool that is very pointy and usually reserved for adults only. Fortunately, as Galileo Innovators, they are going to be trusted to use this tool safely.
- Tell campers that the awl is a tool and not a toy. It’s a what? (A tool!)
- Explain that the awls will be used only to poke holes for the hinge. When not in use, the awls need to be stuck inside a cardboard box.
- Tell campers that if anyone is unsafe with an awl, then they won’t be able to use it. Being unsafe means pointing it at other people, poking unnecessary holes in the box, or walking around the room with the awl.

**Show how to create the hinge ★**
- Show the cardboard strips to campers and point out the prepared lines.
- Demonstrate the technique of placing a cardboard strip onto a box and poking a hole in the middle of the line.
- Poke a hole in all four pieces of cardboard.
- Thread the fastener through the four pieces. Make a “cardboard sandwich” by putting the two short pieces in between the two long pieces.
- Demonstrate how to wrap tape around the ends of the short pieces and the ends of the long pieces as shown in the pictorial.
- Point to the steps on the board and recap what you’ve done so far.

**Demo the “overlap and wrap” tape technique to extend the arm ★**
- Announce that you are going to “overlap and wrap” more cardboard strips to extend the grabber length.
- Emphasize that overlapping and wrapping makes a much more secure connection than taping pieces end to end.
- Have campers repeat the words “overlap and wrap” and copy the action of overlapping your arms, then making a wrapping motion.
- Overlap two cardboard strips to extend the length of the grabber arm as shown in the pictorial.
- Tightly wrap tape to secure the overlapping cardboard in place.
  - Be very explicit about how to tape the cardboard on.
  - Verbalize what you’re doing as you do it.

**Demo the technique to reinforce the arm ★**
- Hold up what you’ve built so far and wave it from side to side. Note how wobbly it is!
- Show campers the paint stirrers. Clearly demonstrate how to place a paint stirrer flat on the cardboard and wrap tape tightly around it to make the cardboard more rigid.
- Tape on a second paint stirrer and then wave the arm again. It’s not wobbly anymore!
- Inform campers that their arms should also be rigid and not wobble.

**Review the building steps**
- Refer to the board and review the building steps with the group.
- Use the kinesthetic reminders when you mention “hinge” and “overlap and wrap.”
- Tell campers that they will begin by taking two short pieces and two long pieces to the awl stations to poke their holes.
Camper Work Time: Build the Hinge and Arm (30 min)

<table>
<thead>
<tr>
<th>During Work Time Campers Will...</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE &amp; TEST (hinge) ★</td>
</tr>
<tr>
<td>1. Use an awl to create a hole in each of the four pieces of cardboard.</td>
</tr>
<tr>
<td>2. Insert a fastener through the four pieces of cardboard</td>
</tr>
<tr>
<td>3. Tape the outer two (long) pieces together on both ends. Tape the inner two (short) pieces together on one end.</td>
</tr>
<tr>
<td>4. Move the hinge back and forth to make sure it can freely rotate.</td>
</tr>
<tr>
<td>CREATE &amp; TEST (arm) ★</td>
</tr>
<tr>
<td>5. Extend the arm.</td>
</tr>
<tr>
<td>6. Reinforce the arm.</td>
</tr>
<tr>
<td>7. Wave the grabber back and forth to test the arm’s stability.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrap the arm in yarn to make it more comfortable to hold.</td>
</tr>
</tbody>
</table>

How Your TL Can Help

- Monitor the awl stations and enforce awl safety.
- Redirect campers to the steps on the board when they are unsure of what to do next.
- Support good taping technique.

Facilitate the Project Steps

<table>
<thead>
<tr>
<th>CREATE &amp; TEST (hinge) (Steps 1-4) ★</th>
</tr>
</thead>
<tbody>
<tr>
<td>• There are quite a few steps that campers must remember to create a successful project foundation. During work time, you’ll likely be focused on helping campers remember what to complete next and supporting good taping technique.</td>
</tr>
<tr>
<td>• Make sure campers are using the awls safely and storing them back in the boxes at the awl stations.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CREATE &amp; TEST (arm) (Steps 5-7) ★</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Campers may give the grabber a preliminary test by manually operating the hinge to grip a sponge.</td>
</tr>
</tbody>
</table>

Extension

- Give campers who finish early yarn to wrap around the handle.
- The easiest way to do this is to tape one end of the yarn to the handle, then wrap the entire length around where the grabber will be held. When finished, tape the other end of the yarn in place.

Support BEING DETERMINED ★

Suggest strategies that help and encourage campers to be determined

Some specific strategies for today:

- Giving you or a neighbor a high-five whenever they complete a step.
- Tracking their progress by mentally checking off the steps on the board. This allows them to visualize what they’ve done and how close they are to finishing.
- Asking for help when feeling stuck or frustrated.

Recognize determined campers

This encourages the camper and helps others see how they can be determined as well. Recognition can be just verbal or include some kind of physical award. Be sure to be specific about how you see campers being determined. Some ways you might see determination today:

- Using any of the strategies mentioned above
- Taking their time to complete each step well

Ask the Guiding Questions that support being determined

Clean Up (5 min)

Be sure campers write their names on their grabbers.
Lesson Wrap Up (5 min)

Recognition and Reflection (BE DETERMINED)
Help campers see how they or others embraced the Innovator’s Mindset, and why this is important for innovation.

Suggested recognition and reflection activity
- Have campers raise their hands if they practiced being determined by:
  - Completing every step carefully
  - Taking their time to practice and use good taping techniques
  - Noticing something wasn’t quite right (like a hinge that didn’t move or a wobbly arm) and redesigning to solve the problem
- Invite campers to recognize someone they noticed being especially determined or who helped them stay determined.
- Reiterate that campers’ effort to construct the base of the grabber today will really pay off tomorrow when they’ll be using their grabbers to pick up all kinds of things!
Day 2
Grabber, Part 2 of 2
Campers design and create the tips of their grabbers, then put their creations to the test by attempting to grab various objects from different positions.

The Big Picture

Lesson Breakdown

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>5 min</td>
</tr>
<tr>
<td>Demo &amp; Discussion: Design the Grabber Tips</td>
<td>10 min</td>
</tr>
<tr>
<td>Demo &amp; Discussion: Design the Grabber Tips</td>
<td>10 min</td>
</tr>
<tr>
<td>Do-With-Me: Add the Rubber Band and String</td>
<td></td>
</tr>
<tr>
<td>Camper Work Time: Design the Grabber Tips</td>
<td>35 min</td>
</tr>
<tr>
<td>Designable Components: grabber tip</td>
<td></td>
</tr>
<tr>
<td>Testing: operate the grabber and attempt to</td>
<td></td>
</tr>
<tr>
<td>pick up the sponge, then the cup, then the</td>
<td></td>
</tr>
<tr>
<td>tube; pick up each object from a tabletop,</td>
<td></td>
</tr>
<tr>
<td>behind a table, a high shelf</td>
<td></td>
</tr>
<tr>
<td>Clean Up</td>
<td>5 min</td>
</tr>
<tr>
<td>Wrap Up</td>
<td>5 min</td>
</tr>
</tbody>
</table>

GIA Focus
Innovator’s Process Focus: GENERATE IDEAS and REDESIGN
Innovator’s Mindset Focus: BE DETERMINED – I persevere until I achieve my goal.
How to Create Today’s Project

Step-by-Step Pictorial

This is intended to help you understand how to create today’s project. It doesn’t include everything campers will do today (like the group brainstorm). It also doesn’t describe how you’ll facilitate this lesson for campers. You’ll need to read the “Play-by-Play” section for this information.

Adding Rubber Bands and String

Fig. 1
Loop a rubber band around the moving part of the hinge.

Fig. 2
Tape the rubber band to the hinge. Then place a piece of tape inside the rubber band.
Fig. 3
Tape the other end of the rubber band to the grabber arm.

Fig. 4
Wrap the end of the string around the short end of the hinge one time and tape it in place. Firmly press on the tape.
Grabber Tips

Fig. 5
These are the materials that campers will be using to modify the tips of the grabber hinge.

Fig. 6
One simple idea is to wrap foam strips around the grabber tips.
Another simple idea is to make pincers by taping craft sticks as shown.

Building on the previous two ideas: Tape pieces of foam to the tips of the craft sticks for better grip.
Fig. 9
This shows an example that uses all four craft sticks.

Fig. 10
When this example is operated it forms an enclosed area.
Fig. 11
Wikki Stix wrapped around the craft stick tips provide better grip.

Fig. 12
Plastic corner braces can be taped to the tip of the grabber. This allows for building perpendicular to the grabber frame.
Fig. 13
A craft stick with a piece of foam is taped to the plastic corner brace in this example.

Fig. 14
Here’s an example of two corner braces being utilized.
Fig. 15
If the grabber hinge is getting stuck, insert some foam in between the cardboard.

Fig. 16
First pick up a sponge from a tabletop.
Fig. 17
Then pick up the sponge on the floor behind an object such as a table, chair, sheet of cardboard, or other obstacle.

Fig. 18
Then pick up the sponge from someplace up high.
Repeat the three steps with the more slippery cup.

Finally, repeat the three steps with the skinny cardboard tube.
Get Ready!

Lesson Materials
* (starred) items are choice materials; un-starred items are required for each camper

Demo & Discussion: Design the Grabber Tips Intro
☐ finished project sample (1 per classroom)
☐ same materials used during Camper Work Time (1 set per Li)

Do-With-Me: Add the Rubber Band and String
☐ rubber band, 3.5" x 1/8" (1 per camper)
☐ string, cotton (30" per camper)
☐ tape, masking, 1" wide (6" per camper)

Camper Work Time: Design the Grabber Tips
☐ *foam strip, asst. colors, 2" x 24" (1 per 3 campers)
☐ *craft sticks, mini, asst. colors, 3" (2 per camper)
☐ *craft stick, regular, 3/8" x 4.5" (2 per camper)
☐ *Wikki Stix, asst. colors, 8" (2 per camper)
☐ *plastic corner brace (2 per camper)
☐ tape, masking, 1" wide (12" per camper)

testing
☐ sponge, cellulose, 3.5" x 6" x 1.5" (10 per classroom)
☐ cup, plastic, heavy duty, red, 16 oz. (8 per classroom)
☐ tube, cardboard, 0.75" x 12" (8 per classroom)

Extension
☐ yarn left over from yesterday, for wrapping around handle
☐ *foam, alphabet piece, sticky back (10 per camper)
☐ *foam, geometric shape, asst. colors, sticky back (10 per camper)
☐ marker, washable, asst. colors (1 per 8 campers)

Preparation

Days earlier
☐ Cut string into approximately 30" lengths. A quick way to do this is to set two chairs 30" apart, wrap the string around the chairs, and then cut the string along the edge of each chair. If you wrap the string around the chairs thirty times you’ll end up with sixty 30-inch lengths of string.

Day before
☐ Set up three testing stations:
  • A table
  • On the floor behind an object like a chair or table
  • A high place like a shelf
At each station, place a sponge, cup, and dowel.
Lay out campers’ projects and the Do-With-Me materials on the tables:
  • rubber band, 3.5" x 1/8" (1 per camper)
  • string, cotton (30" per camper)
  • tape, masking, 1" wide (6" per camper)

Morning of
☐ Gather some of each kind of material for the Demo & Discussion so you can demo building ideas that campers suggest. You should also have your grabber base from yesterday.

Advance prep
Start stripping wires and/or cutting slits in tubes for the vacuum project on Day 3 (see details in the Day 3 prep). This is the most prep-intensive day this week, and it is recommended that you start now.

Suggestions for Large Classes
Place multiple objects at each testing station.

Check In With Your TL
Make sure your Tls are clear about their role in helping today’s lesson run smoothly. Specific ways Tls can help today are listed in the dotted overview boxes throughout the lesson.
On the Board

Design Goals
The grabber must pick up each of the following from three different locations:
- a sponge
- a slippery cup
- a skinny tube

Guiding Questions
BE DETERMINED and REDESIGN
- How might you add more friction/make your tips more rigid?
- What can you add/change/remove on your grabber to improve it?
- Where might you strengthen the taped connections on your grabber?

Vocabulary
friction – a force that stops something from sliding smoothly

Teaching the Lesson: Overview

Instructional Priorities & Supporting Innovation

These are the key lesson elements you’re expected to communicate/support today. Think of this as the blueprint of a successful lesson. When applicable we’ve included details about why an element is important for innovation.

Demo & Discussion: Design the Grabber Tips Intro
★ Introduce the CONCEPT of friction and discuss how to add friction using today’s materials.
★ Support GENERATING IDEAS about grabber tip designs and about how to REDESIGN to meet each specific challenge.

Do-With-Me: Add the Rubber Band and String
★ Demo the TECHNIQUE for adding the rubber band and string one step at a time.

Throughout the Lesson
★ Support the Innovator’s Mindset Challenge: BE DETERMINED – Campers continue to redesign their grabbers to meet the next most challenging goal, until their grabbers can perform all of today’s challenges.
Why – It’s easy for campers to settle for a less than ideal design, especially if it works okay. Challenging them to keep working towards the highest possible bar helps campers push their designs and ideas further.
Teaching the Lesson: Play-by-Play

Introduction (5 min)

Build excitement for today’s project
• Show campers the sponge, cup, and tube. Let them know that these are the things they’ll be trying to pick up with their grabbers today.
• Show them your example grabber and point out that the tips of the grabber are missing!
• Try picking up the cup. It should be difficult or impossible.
• Ask campers if they are ready to help you generate a bunch of great ideas to improve the tip of the grabber. (Yeah!)

Introduce the Innovator’s Mindset: BE DETERMINED ★
• Point to this on your Innovator’s Mindset poster.
• Define the Mindset element in the context of today’s lesson. Say: Today, we’re going to be determined by redesigning our grabbers until they can complete all of today’s challenges. They won’t perform all the functions we want them to right away, but with some hard work and perseverance we can reach our goals!

Demo & Discussion: Design the Grabber Tips Intro (10 min)

What You’ll Need to Cover: Overview
• Discuss adding strong, rigid tips. ★
• Discuss adding friction. ★
• Brainstorm tip designs as a group and quickly demo building a few camper suggestions. ★
• Demo using the plastic brace.
• Demo testing and discuss evaluating and redesigning. ★
• Discuss designing for each new, more challenging goal. ★
• Transition to the Do-With-Me.

How Your TL Can Help
• Gather the camper projects and lay them out on the building tables.
• Place a rubber band, string, and tape at each camper project.

What You’ll Need to Cover: Details
Discuss adding strong, rigid tips ★
• Ask: Do you think my grabber tips will be able to grab any of the materials if they’re floppy or break off easily? (No! They have to be rigid and strong.)
• Show campers the materials for today.
• Ask: What materials look strong and rigid? (Both types of craft stick and the plastic braces are all good candidates.)

Discuss adding friction ★
• Have campers guess what the other materials (foam strips and Wikki Stix) might be good for.
• Explain that these are not rigid, but they are good for adding friction.
• Define friction.
  ▪ Rub your hands together and explain that friction is created when two surfaces rub past each other.
  ▪ The more friction there is, the harder it is for two surfaces to slide past each other.
  ▪ Point out that sticky, rubbery, or rough surfaces create more friction. It would be harder for you to rub your hands together if you were wearing rubber gloves or your hands were covered in sticky glue!
• Explain that creating friction is very useful today. Having a grabber with more friction will ensure things don’t slip out from the grabber’s grasp!

Brainstorm tip designs as a group and quickly demo building a few camper suggestions ★
• Explain that to help everyone get ideas of possible designs they’ll brainstorm as a group now.
• Ask campers how they might use the rigid materials to create strong grabber tips.
• Hold the materials against the grabber in the ways campers are suggesting so they get an idea of many different possibilities.
• Take a few ideas and combine them to actually build something in front of campers. Don’t build something that will work well. You will need to demo the testing, evaluating, and redesign process in a moment.
• As you build, remind campers about the good taping techniques from yesterday (tightly wrapping tape and pressing it down well).
• Next, ask campers how they can add more friction to the grabber, and demo their suggestions in the same way.
Demo using the plastic brace
• Show campers how they can use a plastic brace to allow them to easily tape elements that extend off the sides of the grabber.
• Demonstrate how to attach the brace.
• Do another round of rapid building from the brace based on campers’ suggestions.

Demo testing and discuss evaluating and redesigning ★
• Explain that when they’re ready campers will first test with the sponge, which is easiest to pick up. Point out the three different locations they’ll need to pick up the sponge from.
• Test your creation by trying to pick up the sponge. If it works, try the cup and then the dowel. It shouldn’t work for all the objects.
• Review the Mindset Challenge ★ – Remind campers that it’s no big deal if their grabbers don’t work right away, and they can stay determined to keep redesigning until they do!
• Have campers help you evaluate the design by verbalizing what they notice about why the grabber isn’t able to pick up the object.
• Have campers give a few suggestions of how you might redesign. (You don’t need to actually redesign your grabber at this time.)

Discuss redesigning for each new, more challenging goal ★
• Let campers know that once the grabber can pick up a sponge from all three locations they’ll try the next hardest challenge – the cup.
• Ask: What might make the cup harder to pick up? (It’s more slippery than the sponge.)
• Have campers popcorn-share out some ideas they have about how they might design a grabber to pick up more slippery things.
• Introduce the final challenge of the cardboard tube.
• Ask: What might make the tube harder to pick up? (It’s very skinny and also a little more slippery.)
• Have campers popcorn-share out some ideas they have about how they might design a grabber to pick up small things.
• Review the Mindset Challenge ★ – Let campers know that it’s likely the grabber design won’t work for the cup or tube, even though it worked for the sponge. Remind them to stay determined to redesign until they achieve all three of today’s goals!

Transition to the Do-With-Me
• Tell campers that before they start designing their grabber tips, they’re going to add the rubber band and string to their grabbers. This will allow them to open and close their grabbers.
• Emphasize that everyone will follow along step by step for this part and you’ll wait for everyone to finish each step before moving on.
• Tell campers that as soon as they’re finished, they can go to the materials table and begin designing the tips of their grabbers.
• Excuse campers to the tables and have them find their grabbers.

Do-With-Me: Add the Rubber Band and String (10 min)

What You’ll Need to Cover: Overview
• Guide campers through taping the rubber band to the hinge and arm.
• Guide campers through taping the string to the hinge.
• Transition to Camper Work Time.

How Your TL Can Help
Help ensure that campers properly tape the rubber band and string.

Guiding Campers
Guide campers through taping the rubber band to the hinge and arm
• Have campers look at your example so they can see how the rubber band and string work to open and close the grabber.
• Have campers position their grabbers so that the long arm is lying across the desk and the shorter hinge is open so it’s pointed at them. The longer side of the hinge should be closest to them.

• Point to the part of the hinge where you’ll tape the first side of the rubber band and have campers do the same. Check to see that campers are pointing to the right place.
• Demo looping and taping the rubber band to the longer part of the hinge as shown in the pictorial.
• Have campers do the same and facilitate as necessary.
• Then demo taping the other end of the rubber band to the arm. Emphasize that the hinge should stay close to where it is (pointing towards them) as they tape.

Guide campers through taping the string to the hinge
• Have campers point to the other end of the hinge (the shorter end) and tell them this is where they’ll add the string.
• Show campers how to wrap and tape the string onto the other end of the hinge as shown in the pictorial.
• Have campers do the same and facilitate as necessary.

Transition to Camper Work Time
• Have campers test their grabbers by pulling on the string.
• If their grabbers are working well, invite them to gather materials for their grabber tips.
• If they’re having a hard time closing their grabbers, help them un-tape the rubber band from the arm and reposition it so the band isn’t stretched so tightly between the hinge and arm.

Camper Work Time: Design the Grabber Tips (35 min)

<table>
<thead>
<tr>
<th>During Work Time Campers Will...</th>
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<tbody>
<tr>
<td><strong>DESIGN AND CREATE ★</strong></td>
</tr>
<tr>
<td><strong>TEST, EVALUATE AND REDESIGN ★</strong></td>
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Extension
• Wrap yarn around the grabber handle.
• Decorate with markers and foam shapes.

How Your TL Can Help
• Help reset the challenge in which campers grab things from a high place.
• Remind campers of good taping techniques.

Facilitate the Project Steps
**DESIGN AND CREATE (Step 1) ★**
• During the start of the Camper Work Time, watch campers as they begin building and look out for poor taping techniques. Remind campers how to tightly wrap tape and press it in place.

**TEST, EVALUATE, AND REDESIGN (Steps 2-4) ★**
• Help facilitate at the testing stations.
• If stations get crowded, encourage waiting campers to watch other campers test. They can get as many good ideas from watching others test as they can from testing themselves.

Support BEING DETERMINED ★
Suggest strategies that help and encourage campers to be determined
Some specific strategies for today:
• Celebrating each incremental improvement, even if they haven’t achieved the final challenge yet
• Going back to a challenge they can do for a moment to build confidence if they’re getting frustrated with the current challenge they’re taking on
• Asking for suggestions or help if they’re stuck instead of giving up (getting help from others is a great way to keep pushing ahead)
• Remembering ideas by thinking about some they were especially excited about and/or had ideas for improving on
• Sharing good discoveries and ideas with the group

Recognize determined campers
This encourages the camper and helps others see how they can be determined as well. Recognition can be just verbal or include some kind of physical award. Be sure to be specific about how you see campers being determined. Some ways you might see determination today:
• Using any of the strategies mentioned above
• Staying positive even if they’re having difficulties
• Continuing to find ways to make a working grabber work even better

Ask the Guiding Questions that support being determined
Clean Up (5 min)

Lesson Wrap Up (5 min)

Recognition and Reflection (BE DETERMINED)
Help campers see how they or others embraced the Innovator’s Mindset, and why this is important for innovation.

Suggested recognition and reflection activity
- Have campers raise their hands if they had a design that wasn’t successful at picking something up and redesigned until they were able to pick the object up.
- Recognize campers for being determined!
- Have a few campers share what challenges they faced and how they redesigned to meet their goals.
- Campers can give snaps if they faced and persevered through a similar challenge.
- Give campers a chance to share if they were determined in another way or to recognize a fellow camper for being especially determined today.
Day 3
Vacuum, Part 1 of 3
Wiring the Fan
Why buy a vacuum when you can make your own? In this project, campers will design and build a working vacuum cleaner that operates in the same way as the store-bought handheld appliance.

The Big Picture
Lesson Breakdown

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>10 min</td>
</tr>
<tr>
<td>Demo &amp; Discussion: Circuits and Suction</td>
<td>10 min</td>
</tr>
<tr>
<td>Do-With-Me: Human Circuit Game</td>
<td>15 min</td>
</tr>
<tr>
<td>Do-With-Me: Create the Circuit</td>
<td>20 min</td>
</tr>
<tr>
<td>Install the motor into a cardboard tube. Tape the switch and battery to the outside of the tube. Testing: hold the motor housing over a piece of paper and turn on the fan (see pictorial)</td>
<td></td>
</tr>
<tr>
<td>Clean Up</td>
<td>5 min</td>
</tr>
<tr>
<td>Wrap Up</td>
<td>10 min</td>
</tr>
</tbody>
</table>

GIA Focus
Innovator’s Knowledge Focus: SKILLS AND TECHNIQUES
Innovator’s Mindset Focus: BE DETERMINED – I know innovation and mastery require effort.

What’s Next: Tomorrow (Day 4) campers will design and create a filter and canister. On Day 5 campers will design and create a nozzle, as well as add a handle and embellishments.
How to Create Today’s Project

Step-by-Step Pictorial
This is intended to help you understand how to create today’s project. It doesn’t describe how you’ll facilitate this lesson for campers. You’ll need to read the “Play-by-Play” section for this information.

Vacuum Fan Circuit

Fig. 1
Twist the black wire from the motor to the red wire of the battery pack. Then twist the remaining wires to the button.

Fig. 2

Fig. 3
Insulate the connections by making a “tape sandwich” as shown.
Fig. 4
All of the connections are wrapped in tape.

Mounting the Motor

Fig. 5

Fig. 6
Place a square of mounting tape in the middle of a large craft stick.

Fig. 7
Fig. 8
Place the motor onto the mounting square, and then place a piece of tape over it.

Fig. 9
Push-fit a plastic propeller onto the motor shaft.

Fig. 10
Slip the motor mount into the motor housing. (You will cut slits into the tubes for campers ahead of time.)
• Tape the button and batteries to the motor housing.
• Install the batteries as the very last step.

Fig. 12
Test the direction of the airflow by sucking up a piece of paper.
**Get Ready!**

**Lesson Materials**
* (starred) items are choice materials; un-starred items are required for each camper

**Pre-Assembly**
(You need to strip wires on each component for campers.)
- wire strippers (1 per LI)
- motor, w/ 125mm wires, 1.5V-3.0V (1 per camper)
- momentary pushbutton switch, with leads (1 per camper)
- holder, battery, 2 AA, w/ leads (1 per camper)

**Intro Materials**
- finished project sample (1 per LI)
- copy, color, Sid's Vacuum (1 per 4 campers)

**Demo & Discussion: Circuits and Suction**
- real handheld vacuum, *to be taken apart during the demo* (1 per classroom)
- screwdriver, Phillips (1 per classroom)

**Do-With-Me: Human Circuit Game**
- ball, foam, uncoated, 4" (15 per classroom)

**Do-With-Me: Create the Circuit**
- motor, w/ 125mm wires, 1.5V-3.0V (1 per camper)
- momentary pushbutton switch, with leads (1 per camper)
- holder, battery, 2 AA, w/ leads (1 per camper)
- battery, AA (2 per camper)
- craft stick, large, 3/4" x 6" (1 per camper)
- tape, mounting, 1" square (1 per camper)
- tape, masking, 1" wide (12" per camper)
- propeller, 2 blade, plastic, 3.5", high speed (1 per camper)
- tube, cardboard, 4" x 7" (1 per camper)
- pipe cleaners of different colors, *for demo on how to twist wires* (2 per classroom)

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**Preparation**

Days earlier

- Cut slits into tubes (below), for mounting the motor inside the motor cover (1 tube per camper).

![Image of a tube with slits]

Note that the slits are offset from being directly across from each other. This is important to prevent the propeller blade from hitting the inside of the tube. Test your first few prepped tubes by slipping the motor mount inside and making sure that the propeller does not hit the tube.

- Strip about 1" of insulation off of the wires for the motor, battery pack, and switch (following photo) (1 of each per camper).
### Build an example vacuum for the Demo & Discussion (see the pictorials for Days 3-5).
- Remove the screws from the real vacuum cleaner so you can easily take it apart to show campers the components inside during the Demo & Discussion.

### Day before
- Set out all the Do-With-Me materials except the batteries at each camper work area (below). Campers should not have access to batteries until their wires have been insulated and checked by you.

### Suggested Materials Management
See the notes on battery and circuitry safety at the beginning of this curriculum unit under Battery Safety.

### Suggestions for Large Classes
Have your TL also make a sample circuit so campers in the back can see each step.

### Check In With Your TL
Make sure your TLs are clear about their role in helping today’s lesson run smoothly. Specific ways TLs can help today are listed in the dotted overview boxes throughout the lesson.

### Notes
- Be sure to hand out batteries as the very last step and only after you have checked campers’ tape sandwiches to confirm that no wires are exposed. This will ensure there is no chance of accidental short circuits.
- Only have campers test by sucking a piece of paper against the motor housing. Sucking up small debris can cause a lot of noise, may damage the propeller, and may pose a danger to the user.

### On the Board
**Guiding Questions**

**BE DETERMINED**
- What can you fix/improve/reinforce?
- Have you double-checked each connection?

**Vocabulary**

- suction – the removal of air from an area, causing the surrounding air to rush in and fill the empty space
- circuit – a path for electricity to follow
Teaching the Lesson: Overview

Instructional Priorities & Supporting Innovation

These are the key lesson elements you’re expected to communicate/support today. Think of this as the blueprint of a successful lesson. When applicable we’ve included details about why an element is important for innovation.

Demo & Discussion: Circuits and Suction
★ Define the CONCEPT of suction and how it applies to a vacuum cleaner.
★ Introduce the CONCEPT of a circuit and explain how a circuit functions.
★ Demo the SKILLS AND TECHNIQUES needed to make a simple circuit, including twisting and insulating wires.

Throughout the Lesson
★ Support the Innovator’s Mindset Challenge: BE DETERMINED – Campers put in the time and effort to do the best job possible of completing each step.
   Why – Challenging campers to be patient and to put in sustained effort emphasizes that innovation is a process and can make campers more likely to stay the course.

Teaching the Lesson: Play-by-Play

Introduction (5 min)

Welcome campers and make a quick story connection
What’s going on with Lucy? (She’s been working on inventions for Friday’s Maker Faire, but she got locked out of Cardboard Island.) We can’t let her give up now. Let’s keep creating awesome inventions so we can showcase them at the Faire – maybe we’ll even come up with an idea to get Lucy back to Cardboard Island as we work!

Build excitement for today’s project
• Hold a container with about 10 pom-poms in it. Pretend to clumsily spill the contents on the floor. Oh no!
• Ask campers what useful gadget might help you clean up this mess.
• Show campers the Sid’s Vacuum color copy (below).

• Tell campers that this is a maker named Sid. Sid made something that would be very useful for cleaning up a mess like this – a vacuum!
• Tell campers that Sid’s vacuum is made out of a cup, cardboard, glue, and a motor that he found.
• Take out your own sample vacuum and vacuum up all the pom-poms.
• When finished, open the canister and show campers the contents. Voila!
• Tell campers that just like Sid, they are going to be makers and make their own vacuums over the next three days.
Introduce the Innovator’s Mindset: BE DETERMINED ★

- Point to this on your Innovator’s Mindset poster.
- Define the Mindset element in the context of today’s lesson. Say: Like we did on Monday, we’re going to create something the same way that will help set us up for success over the next two days. Today, we’re going to practice being determined by carefully completing each step of the project to make sure that our vacuums are working awesomely for tomorrow.

**Demo & Discussion: Circuits and Suction (10 min)**

**What You’ll Need to Cover: Overview**
- Introduce the idea of suction. ★
- Take apart a real vacuum and go over the main components. ★
- Discuss and demo creating a simple circuit to power a motor. ★

**What You’ll Need to Cover: Details**

**Introduce the idea of suction ★**
- Have campers wave their hands in front of them to feel the air.
- Explain that vacuums use a motorized fan to suck air away from wherever the nozzle is pointed.
- When air is sucked out of that area, the surrounding air rushes in to fill up that space. This process is called suction.
- The air that just filled up that space then gets sucked into the vacuum. This keeps happening until the vacuum is turned off.
- Have campers make a small “O” shape with their mouths and sharply inhale. That air rushing inside their mouths is just like how a vacuum works!
- In fact, the word “vacuum” also means a space in which there is nothing, including air.

**Take apart a real vacuum and go over the main components ★**
- Identify the parts of the vacuum and have campers guess the purpose of each part.
  - Motor and fan – Pulls air through the vacuum and creates suction
  - Filter – Prevents the vacuumed stuff from hitting the fan but still lets air through
  - Canister – Holds the vacuumed stuff
  - Nozzle – Focuses the vacuum’s suction

Discuss and demo creating a simple circuit to power a motor ★

- Ask: What do you think powers the motor so it can turn the fan? (Electricity!)
- Tell campers that their vacuum cleaners will be getting electricity from batteries. Hold up the batteries and battery pack campers will be using.
- Ask: How does the electricity get from the battery to the motor? (The electricity travels through wires that connect the battery pack to the motor.)
- Twist together the wires from one side of the battery pack and the motor.
- Ask campers to raise their hands if they think the motor will turn on when you put the batteries in.
- Try it. Campers will see that it doesn’t turn on.
- Ask: Why do you think it didn’t work even though the battery is connected to the motor? (Electricity won’t move unless it can travel in a complete loop to get back to where it started, in this case the battery. Another word for this kind of loop is a circuit.)
- Take the batteries out and twist the second wire from the battery pack to the second wire of the motor.
- Put the batteries back in to show that it will now turn on, since you’ve created a complete circuit.

**Do-With-Me: Human Circuit Game (15 min)**

**What You’ll Need to Cover: Overview**
- Introduce the Human Circuit game.
- Make a human circuit.
- Reinforce the concept of complete and broken circuits. ★
- Introduce the switch component. ★
- Make a human circuit with a switch.
- Review the main components of the circuits campers will be making.

**How Your TL Can Help**
- Help facilitate the Human Circuit game.
**Guiding Campers**

**Introduce the Human Circuit game**
- Announce that the campers will now play a game called Human Circuit.
- Have the campers sit in a tight circle with their knees touching.
- Designate one camper to be the fan and have your TL be the battery. These two people should be on opposite sides of the circle.
- The rest of the campers are the wires.
- Hold up the foam balls and announce these will be the electricity.
- Explain that the electricity can only be passed by placing it in the hand of the person next to them. It cannot be tossed. Balls will also only be passed in one direction.
- Instruct the fan to make a whirring noise or blow air each time a ball is handed to him/her before passing the ball on to the next person.

**Make a human circuit**
- Have your TL “battery” start to pass the electricity in one direction by handing the balls one by one to the camper next to him/her. Keep it at a pretty quick pace.
- There should be a continuous flow of balls making its way around the circle and the fan should be whirring away!
- Continue until the balls have made their way around the circle at least twice.

**Reinforce the concept of complete and broken circuits ★**
- Call out a few campers’ names and have them step out of the circle.
- Ask: *Is our circuit complete anymore?*
  (No, the circuit is broken since parts of the wire aren’t connected anymore.)
- Ask: *What happens to the electricity now?*
  (It stops moving. The electricity can’t flow if it doesn’t have a continuous path to travel through.)
- Have campers stop passing balls if they haven’t already.
- Tell them that for the second round you’ll call out a few names again, like you just did. Those campers will have to find a new place in the circle.
- Everyone else will have to pay attention. They’ll need to stop passing electricity when the campers are out of the circle and start only when the circuit is complete again.
- If you want, choose a new person to be the fan.

- Have the campers you called out find a new place in the circle and get the fan going again.
- Play a few rounds, calling out different campers each time.
- Stop and have everyone pass their balls to the TL again to get ready for the final round.

**Introduce the switch component ★**
- Announce that for the last round there is going to be new component.
- Point out that right now there’s no way to stop the fan except by disconnecting and reconnecting the wires. This is not very efficient.
- Explain that an easier way to turn something on and off is to have a switch.
- Hold up the button switches that campers will be using.
- Explain that this switch is also part of the circuit.
  - When the button is up that part of the circuit is disconnected, so the electricity doesn’t flow.
  - When the button is down that part of the circuit is reconnected and the electricity starts to flow.

**Make a human circuit with a switch**
- Assign a camper to be the button. Have that camper stand so s/he is no longer touching anyone in the circle.
- Explain that when the button is ready he or she will sit to complete the circle/circuit and say, “On!” Everyone will then start to pass the balls.
- At any time the button can stand up and say, “Off!” and everyone must stop passing balls.
- Play a few rounds, choosing a new button each time. You can also choose a new fan each time.

**Review the main components of the circuits campers will be making**
- After the final round, hold up the real example of each component in the human circuit and review how they’ll all be connected.
  - The battery, which will be connected to the motor
  - The motor, which will be connected to the switch
  - The switch, which will be connected back to the battery
- Quickly add the switch into the sample circuit you started earlier.
- Show how pressing the button turns on the motor, just like in the human circuit game.
- Tell campers that they will each make their own circuits as a group now.
Do-With-Me: Create the Circuit (20 min)

What You’ll Need to Cover: Overview
- Set expectations for the circuitry Do-With-Me.
- Introduce circuitry safety.
- Have campers twist the black motor wire to the red battery wire. ★
- Have campers connect the switch. ★
- Have campers wrap their wire connections in tape. ★
- Have campers mount the motor to a craft stick, attach the propeller, and insert the motor into the cardboard tube. ★
- Demo the final test and mounting the motor. ★
- Have campers test and mount the motor. ★

How Your TL Can Help
Monitor campers to ensure they are creating the circuits correctly.

Guiding Campers
Set expectations for the circuitry Do-With-Me
- Be sure to do this before you have campers move to worktables where they’ll be distracted by all the materials.
- Explain that everyone will do each step together, which means campers should wait until everyone is ready and not move ahead.
- Let campers know what attention-getter you’ll use to let them know you’re about to give the next set of directions. Practice it now and make sure campers know that this also means they need to turn off their vacuum cleaners if they’re on.
- Have campers move to the worktables or spread out on the floor.

Introduce circuitry safety
- Explain that there’s something called a “short circuit.” A short circuit can occur when the wires from the battery pack are touching with no motor in between.
- Explain that a short circuit can make the batteries, wires, or battery holder very hot!
- For this reason, you are going to withhold the batteries until the very end and only hand them out after you have checked everyone’s circuits for safety.

Have campers twist the black motor wire to the red battery wire ★
- Emphasize the importance of connecting the correct colors of wire together. If the colors are incorrect, then campers will create a leaf blower instead of a vacuum.
- Instruct campers to watch you closely before making the connection themselves.
- Demo how to twist the wires by using two pipe cleaners (below).

- Then have campers hold the black motor wire in one hand and the red battery wire in the other.
- Have campers twist them together.
- Review the Mindset Challenge ★ – Remind campers not to rush through these steps and to make sure their wires are twisted together really well. Loose connections will lead to circuits that don’t work.

Have campers connect the switch ★
- Use the same wire-twisting technique to connect the switch to the motor and back to the battery.
- The switch wires do not have to be connected in a specific way.
**Have campers wrap their wire connections in tape ★**
- Use your attention-getter for a very important announcement.
- Tell campers that the wires must be covered or insulated to prevent them from touching and creating a short circuit. If wires that aren’t supposed to be touching touch for a long time, it can cause a fire.
- Explain that you need to cover the metal wires in something that electricity can’t travel through, and masking tape is perfect for this.
- Show campers how to make a tape sandwich as shown in the pictorial. Emphasize making sure that no wire is peeking through.
- Review the Mindset Challenge ★ – Before campers start, ask them if they think they should rush through this part. (Definitely not!) Reiterate that taking time to make sure everything is wrapped neatly in tape is not only important for a working circuit, but for a safe one!
- Have campers start wrapping their connections.

**Have campers mount the motor to a craft stick, attach the propeller, and insert the motor into the cardboard tube ★**
- Show campers how to use a mounting square and tape to attach the motor to a stick as shown in the pictorial.
- Emphasize mounting the motor as close to the center of the craft stick as possible.
- Show how to shake the stick back and forth to test that the motor is attached securely.
- Support BEING DETERMINED ★ – Have campers tell you why it’s important that they take the time to make sure the motor is in the center and taped securely. (If the motor isn’t in the center, it will hit the sides of the tube. If the motor isn’t taped well, it won’t stay on the stick when it’s turned on.)
- Show campers how to put a propeller on the motor and insert the motor into the cardboard tube.
- Explain that the propeller can hurt if it accidentally touches you while it’s on, so campers should not turn it on until it’s inside the cardboard tube.
- Have campers complete these steps.
- Remind campers to test that the motor is secure.

**Demo the final test and mounting the motor ★**
- Use your attention-getter for the final step.

**Support BEING DETERMINED ★** – Tell campers that if they think they’re done they should do one more double-check to make sure they’ve done the best job possible with the following:
- Wrapping their wire connections in tape
- Taping the motor securely
- Mounting the fan so it is not hitting the edges of the tube
- Once they think they’re ready, they can raise their hands for batteries.
- Show campers how to test the suction of the vacuum by turning it on and holding it over a whole piece of paper. The paper should get sucked up against the tube.
- Finally, if everything is working, campers can tape the batteries and switch to the tube.
  - Demo taping the wires instead of the actual battery pack and switch.
  - Also, let campers know they don’t have to use a ton of tape for this, especially because they might decide to move the switch when they add a handle to the vacuum on Friday.

**Have campers test and mount the motor ★**
- As campers raise their hands, double-check their wire connections. Pass out two batteries to each camper only after you’re sure there are no exposed wires.
- As you hand out batteries, insert one into the pack to demo how it’s done and have the camper insert the other.
- Use your fingers to rotate the batteries back and forth. This will help remove the possible layer of oxidation on the battery pack terminals.
- If the fan is blowing the wrong direction, help campers flip the battery orientation to flip the direction of the current.
- Help campers troubleshoot as necessary. Check for loose wire connections or battery orientation if it doesn’t work.
- Campers who finish can continue to test their motors or help a friend.

**Clean Up (5 min)**
- Make sure campers have their names on their vacuums.
- Have each camper remove one battery and return it to you. This ensures that tomorrow campers only have their vacuums on at the testing stations.
Lesson Wrap Up (10 min)

Recognition and Reflection (BE DETERMINED)
Help campers see how they or others embraced the Innovator’s Mindset, and why this is important for innovation.

Suggested recognition and reflection activity
- Have a few campers share how they put in effort and took their time today. Recognize them for their determination.
- The rest of the group can give snaps if they also put in effort in the same way.
- Ask: Why was it important to take our time on each step today? How would our projects be different if we rushed through all the steps or if we didn’t take the time to fix things we noticed weren’t right?
- Reiterate that campers’ hard work today means they have a solid base to work from as they continue to design their vacuums tomorrow.

Application
Leave campers with a challenge or prompt to help them apply today’s learning outside your classroom.

Suggested prompts
- Have campers go home and turn on any vacuum that may be in the house and see if they can identify where the motor, switch and battery (if it has one) are located.
Day 4  
**Vacuum, Part 2 of 3**  
Campers add a filter and canister to make their vacuums more functional.

Example of a vacuum and a variety of filter designs

One happy camper with a hole punch-based filter

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**The Big Picture**

**Lesson Breakdown**

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<td>15 min</td>
</tr>
<tr>
<td>Camper Work Time: Canister and Filters</td>
<td>35 min</td>
</tr>
<tr>
<td>Create and attach the canister. Choose a filter material and design a filter. The filter must:</td>
<td></td>
</tr>
<tr>
<td>• Allow enough suction to vacuum pom-poms, corks, and sequins</td>
<td></td>
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<tr>
<td>• Not let pom-poms, corks, and sequins get past the filter and hit the fan</td>
<td></td>
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<tr>
<td>• Be redesigned at least three times</td>
<td></td>
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<tr>
<td>Designable Components: filter material, filter pore design</td>
<td></td>
</tr>
<tr>
<td>Testing: affix the canister over the filter and attempt to vacuum up each of the materials</td>
<td></td>
</tr>
<tr>
<td>Clean Up</td>
<td>5 min</td>
</tr>
<tr>
<td>Wrap Up</td>
<td>10 min</td>
</tr>
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</table>

**GIA Focus**

Innovator's Process Focus: TEST, EVALUATE & REDESIGN

Innovator's Mindset Focus: BE REFLECTIVE – I take time to think about what is and isn’t working in my design.

**What’s Next:** Tomorrow (Day 5) campers will create a handle and vent, as well as embellishments and decorations.
How to Create Today’s Project

Step-by-Step Pictorial
This is intended to help you understand how to create today’s project. It doesn’t describe how you’ll facilitate this lesson for campers. You’ll need to read the “Play-by-Play” section for this information.

Canister and Nozzle Assembly

Fig. 1
Cut a slit into either a long or a short cardboard tube. A short tube is chosen here.

Fig. 2
Fit the tube into the plastic deli container. (You’ll punch holes in deli containers for campers ahead of time.)
These are the materials that can be used for the filter: strawberry basket, burlap, and paper.

Cut holes into the filter material to allow air to pass through. One construction technique for the filter is to fold paper in half and cut slits.

A hole punch can also be used to modify a paper filter.

Another similar idea involves folding the paper in half and cutting out shapes.
Fig. 7
Slits and holes in burlap can be created in the same way.

Fig. 8
If holes are made too large, place tape on both sides of the hole to repair it.
Fig. 9
Place the filter over the vacuum opening, and then fit the deli container over the motor housing to secure it in place.

Testing

Test the filter by vacuuming pom-poms, sequins, and small corks in separate bins.

Fig. 10
Fig. 11
After the items have been vacuumed, point the nozzle upward and observe if any items fall out of the back. In this case, the filter was not fine enough to filter out the smallest sequins.

Fig. 12
After redesigning and determining the best filter, tape the final filter on.
Get Ready!

Lesson Materials
* (starred) items are choice materials; un-starred items are required for each camper

Pre-Assembly
(You’ll punch holes in one deli container canister per camper.)
- container, plastic, deli, 16 oz., for canister (1 per camper)
- mallet, rubber (1 per classroom)
- punch, arch, 1.5" (1 per classroom)
- cutting mat, 18" x 24" (1 per classroom)

Demo & Discussion: Canister and Filters Intro
- same materials as Camper Work Time (1 set per LI)

Camper Work Time: Canister and Filters Intro
- *tube, cardboard, 1.5" x 4", toilet paper, for nozzle option (1 per 2 campers)
- *tube, cardboard, 1.5" x 8", for nozzle option (1 per 2 campers)
- pre-punched container, plastic, deli, 16 oz., for canister (1 per camper)

filter materials
- *fabric, burlap, asst. colors, 9" x 12" (1 per 4 campers)
- *paper, copy, Brights, asst. colors, 8.5" x 11" (1 per 3 campers)
- *basket, strawberry (1 per 2 campers)
- tape, masking, asst. colors, 3/8" x 25 ft., set of 11 (12" per camper)
- tape, masking, 1" wide (12" per camper)

testing materials
- pom-poms, asst. colors and sizes (50 per classroom)
- sequins, asst. colors and sizes (50 per classroom)
- corks, tapered size 2 (50 per classroom)
- tub, plastic, w/ lid, 72 oz., for organizing testing materials (3 per classroom)

Preparation
Days earlier
- Punch a hole at the bottom of the deli container (1 per camper).
  Use the cutting mat. Lay the cutting mat over a hard surface such as tile or concrete. The punch won’t work if the mat is placed on carpet. Place the arch punch in the center of the deli container. Swiftly strike the punch with a mallet one to three times (below). The following photo shows the deli container with a hole punched through the bottom.
Suggestions for Large Classes
None

Check In With Your TL
Make sure your TLs are clear about their role in helping today’s lesson run smoothly. Specific ways TLs can help today are listed in the dotted overview boxes throughout the lesson.

On the Board
Design Goals
The filter must:
- Allow enough suction to vacuum pom-poms, corks, and sequins
- Not let pom-poms, corks, and sequins get past the filter and hit the fan
- Be redesigned at least three times

Guiding Questions
TEST, EVALUATE & REDESIGN and BE REFLECTIVE
- What happened when you tested? Why do you think that happened?
- What if you made a small change to your design? What if you tried something totally different?
- What do you notice about the holes in your design?

Vocabulary
filter – something that blocks unwanted things from passing through
canister – a container for storing things (in this case, vacuumed garbage)

Day before
- Use scissors to cut the burlap into quarters (1 piece per camper).
- Use the paper cutter to cut the cardstock into quarters (1 piece per camper).

Separate the three testing materials into the 72 oz. plastic bins. Have a container with a few batteries available as replacements.

The photo below shows a sample of the testing materials.
Teaching the Lesson: Overview

Instructional Priorities & Supporting Innovation

These are the key lesson elements you’re expected to communicate/support today. Think of this as the blueprint of a successful lesson. When applicable we’ve included details about why an element is important for innovation.

Demo & Discussion: Canister and Filters Intro
★ Introduce the CONCEPTS of filters and canisters, and how they work together to collect debris.
★ Demo how to TEST, EVALUATE, and REDESIGN each of the three filter options.

Throughout the Lesson
★ Support the Innovator’s Mindset Challenge: BE REFLECTIVE – Campers notice how different variables affect their designs and use these discoveries to help them figure out what adjustments they need to make.
Why – Challenging campers to pay very close attention to the design variables will help them understand what changes are effective in striking that balance between suction and filtering.

Teaching the Lesson: Play-by-Play

Introduction (5 min)

Build excitement for today’s project
• Remind campers of what they’re making and what they completed yesterday.
• Announce that today, they will design and build the parts of their vacuums that will allow them to actually vacuum up some materials!

Introduce the Innovator’s Mindset: BE REFLECTIVE ★
• Point to this on your Innovator’s Mindset poster.
• Define the Mindset element in the context of today’s lesson. Say: Today, we’re going to be focusing on a very important part of the vacuum: the filter. The way you design your filter will make a big difference in how much stuff your vacuum can suck up. We’re going to practice being reflective by taking the time to look closely at the filter design to figure out what will work best.

Demo & Discussion: Canister and Filters Intro (15 min)

What You’ll Need to Cover: Overview
• Discuss what a filter is and outline the design goals. ★
• Demo creating, testing, and evaluating a paper filter. ★
• Demo redesigning and retesting the paper filter. ★
• Demo creating, testing, evaluating, and redesigning a burlap filter. ★
• Demo creating, testing, evaluating, and redesigning a strawberry basket filter. ★
• Introduce the idea of combining filters.
• Outline the testing and redesign procedure.
• Show campers how to create the canister and nozzle.

What You’ll Need to Cover: Details
Discuss what a filter is and outline the design goals ★
• Tell campers that the first thing they will be adding is a filter.
• Define a filter as something that blocks unwanted things from passing through.
• Ask: Why is it important to include a filter?  
(To prevent garbage from flying out the back of the vacuum or getting caught up in the fan!)
• Take the filter out of your sample vacuum and show campers what happens when you try to vacuum pom-poms without it.
• Explain that creating a good filter can be a tricky challenge. It has to keep objects out, but it must still allow air to flow through, as otherwise the vacuum won’t be able to create any suction.
• Tell campers that today will be all about creating, testing, and redesigning to come up with a filter that can do both these things.
• Show campers the materials that they must both suck up and filter today.

Demo creating, testing, and evaluating a paper filter ★
• Hold up a sheet of paper and note that right now air can’t flow through it at all.
• Ask: What could I do to allow air to flow through it?  
(Cut a slit or hole in it.)
• Demo how to fold the paper in half and cut into the fold, as shown in the pictorial, to make a small slit.
• Show campers how to hold the paper over the main tube and then place the example canister over it.
• Try to vacuum the pom-poms. It shouldn’t work.
• Review the Mindset Challenge ★ – Tell campers that this is a perfect time to stop and reflect. Have campers help you do this and remind them to stop and reflect after each of their own tests.
• Ask: What do you think the problem is?  
(There isn’t enough suction.)
• Ask: How can we redesign the filter to allow more suction?  
(Make more openings.)

Demo redesigning and retesting the paper filter ★
• As you redesign your paper filter, show campers the following techniques that were depicted in the pictorial:
  ▪ Fold the paper and cut slits
  ▪ Fold the paper and cut out small shapes
  ▪ Fold the paper and use the hole punch
• Design a filter that will work with pom-poms, but not the other two materials. Here is an example (below) that won’t work with corks or sequins because there is not enough suction for the corks, and the existing holes are too big for the sequins.
• Test your filter with the pom-poms. After sucking a few up, demo how to hold your vacuum straight up and shake it to verify that the materials won’t fall through the filter after being vacuumed.
• Demo how to carefully remove your canister and neatly empty the pom-poms back in the testing bin before moving on to the other bins. Emphasizing this now will ensure testing stations stay neat and organized.
• Test the filter on the corks. It shouldn’t have enough suction.
• Test the filter with sequins. Point out that it successfully vacuumed the sequins, but when you held the vacuum straight up the sequins fell out.
• Hold up your filter and ask for suggestions for how to redesign it.
• Show campers the technique for placing tape over a hole that is too big, as shown in the pictorial.

Demo creating, testing, evaluating, and redesigning a burlap filter ★
• Hold up a ¼-piece of burlap. Note that it already can move some air through it, but not enough.
• Attach the piece of burlap to your vacuum and show how it can’t vacuum up the corks.
• Note that the materials must be vacuumed into the canister for the test to be successful. If materials get stuck in the nozzle, it doesn’t count.
• Hold up the burlap and ask: What can we do to create more suction?  
(Make holes or slits.)
- Cut out a large hole in the center of the burlap and test it again.
- The cork should get sucked up, but when you tilt the vacuum and shake it, the cork will fall through the filter.
- Announce that it looks like your hole is too big, and that’s okay! You can scrap that design and start all over again or use the tape method to make it smaller.

**Demo creating, testing, evaluating, and redesigning a strawberry basket filter**

- Hold up a strawberry basket. Note that it already has lots of very big openings.
- Show campers how to cut out the bottom of the basket to use as the filter.
- Place the basket over your example vacuum.
- Ask campers to reflect upon what they’ve seen so far and to guess which materials the filter will work with.
- Test the filter on each of the materials. Note that it has a lot of suction, but the sequins fall right through!
- Point out that this filter needs smaller openings, and therefore we need to add something to it.
- Show campers how to add the thin, colorful masking tape to both sides of the basket to make some of the holes smaller, but do not create a successful filter.

**Introduce the idea of combining filter materials**

- Give campers the idea that they can layer filters on top of each other.
- Take your paper filter with the too-large holes and tape it to the strawberry basket.
- Note that the basket helps cover some of the big holes, but it also doesn’t block the small holes.
- Give campers the idea that layering filters is helpful if they have two designs that both have holes that are too big.

**Outline the testing and redesign procedure**

- Remind campers again about neatly emptying their canisters into the bins after each test.
- Instruct campers to leave one battery at the testing station before returning to redesign their filters.
- Announce that part of today’s challenge is to redesign at least three times. This can include trying three different materials or trying three different things with the same material.
- Let campers know that at the end of the class, when they’ve redesigned at least three times and determined the best filter, they’ll tape the final filter to the canister. Quickly demo how to do this.

**Show campers how to create the canister and nozzle**

- Finally, point out that campers will need their own canisters and nozzles to conduct the filter tests.
- Instruct campers to choose either a long or short tube. Note that shorter tubes will be easier but longer tubes can reach farther.
- Show how to cut a small slit in the tube as shown in the pictorial.
- Then show campers how to insert a cardboard tube into the canister.
- Instruct campers to do this as the first step. Then they can get the first filter material and start designing the first filter.
Camper Work Time: Canister and Filters (35 min)

During Work Time Campers Will...

**DESIGN AND CREATE**
1. Insert the tube (nozzle) into the canister and tape it.
2. Choose a filter material and modify it.

**TEST, EVALUATE AND REDesign ★**
3. Place the filter over the vacuum and attach the canister.
4. Attempt to vacuum each of the testing materials.
5. Observe which materials were successfully vacuumed and/or filtered.
6. Evaluate whether the vacuum needs more suction or a finer filter.
7. Change the filter according to the evaluation.
8. Continue testing and redesigning until the design goals are met.
9. Tape the final filter on.

Step It Up
Challenge campers to design separate filters that are specialized to complete certain tasks.
* Create a filter that can vacuum the largest corks, but is not required to filter smaller materials
* Create a filter that can filter small dust or debris from the floor, but is not required to vacuum heavier materials
* Attach the separate specialized filters to the vacuum in a way that makes them easily accessible so they can be switched out with the main filter when necessary.

Facilitate the Project Steps

**DESIGN AND CREATE (Steps 1-2)**
- Help campers assemble nozzles and canisters as necessary. This is not meant to be a main building component today. Campers should spend most of their time designing filters.

**TEST, EVALUATE AND REDesign (Steps 3-9) ★**
- Make sure campers are redesigning at least three times. Encourage campers to try a totally different idea just to see even if they think the first design works okay.
- Remind campers to test by vacuuming one material at a time.
- Remind campers to undo their canisters over the bins to reduce mess.
- Remind campers to leave one battery at the testing station.
- Help campers tape their final filters on near the end of the rotation.
- Ask Guiding Questions to support evaluating and redesigning.

Extension
- If campers want to do a vacuum race, designate a 5 foot section of the room. Set out 15-20 small pom-poms in a line. Do a countdown and have campers race to pick up all the pom-poms with their vacuums.
- Add fun and flair by taking on the persona of a car race organizer (“Campers! Start your vacuum motors! Vroom vroom!”).
- Switch it up by vacuuming different objects, or placing the objects in a wavy line.
- If facilitating the activity yourself is not possible, have the campers form a line to race. Have the last participants reset the course for the next pair. You may also assign one camper to organize the races.

Support BEING REFLECTIVE ★

Suggest strategies that help and encourage campers to be reflective
Some specific strategies for today:
- Verbalizing what’s happening during testing
- Making small changes and retesting to see the results before making another change
- Watching others test to notice what does and doesn’t work for others

How Your TL Can Help
Have your TL run the testing stations.
Recognize reflective campers
This encourages the camper and helps others see how they can be reflective as well. Recognition can be just verbal or include some kind of physical award. Be sure to be specific about how you see campers being reflective.
Some ways you might see reflection today:
• Using any of the strategies mentioned above
• Making a change based upon something that was observed

Ask the Guiding Questions that support being reflective

Clean Up (5 min)
• Make sure all campers only have one battery in their vacuums.
• Leave the testing stations set up for tomorrow.

Lesson Wrap Up (10 min)

Review (CONCEPTS AND FACTS)
Give campers a chance to review what concepts and facts they learned and used to make their awesome creations today.

Suggested review activity
• Have campers bring their filters that didn’t work and/or collect some discarded filter designs.
• Use blue tape to attach a filter to the board.
• Ask campers to use what they learned about what makes an effective filter to suggest how it might be improved.
• Write those suggestions down around the filter (following photo).

• Repeat with one more filter if you have time.

Recognition and Reflection (BE REFLECTIVE)
Help campers see how they or others embraced the Innovator’s Mindset, and why this is important for innovation.

Suggested recognition and reflection activity
• Have campers give a thumbs-up if they practiced being reflective in the following ways:
  ▪ Carefully noticing what happened as they tested
  ▪ Thinking about why something happened before deciding what to do next
  ▪ Deciding what was working and what needed to be changed
• Recognize campers for being reflective and reiterate that being reflective allowed them to make discoveries about how to make the best filters.

Application
Leave campers with a challenge or prompt to help them apply today’s learning outside your classroom.

Suggested challenge
• Have campers be on the search for other things with filters besides vacuums. Maybe they have a water filter at home that lets water through but not other particles. Or they might notice someone wearing a mask with a filter that lets air through but not harmful chemicals.
Day 5

Vacuum, Part 3 of 3

Campers complete their vacuums by adding a handle and a vent. Additional build time can be used to decorate and personalize the vacuums.

The Big Picture

Lesson Breakdown

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- Design a handle and customize the button placement. Add a vent and customize the design. The vacuum must:
  - Be operable with just one hand
  - Include a vent that prevents a marker from getting past and touching the fan
  - Look unique!

- Designable Components: handle design and placement, vent design, button placement, customization/decoration
- Testing: use the vacuum with just one hand

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GIA Focus

Innovator’s Process Focus: GENERATE IDEAS and TEST AND EVALUATE
Innovator’s Mindset Focus: BE VISIONARY – I imagine things that don’t exist yet.
How to Create Today’s Project

Step-by-Step Pictorial
This is intended to help you understand how to create today’s project. It doesn’t describe how you’ll facilitate this lesson for campers. You’ll need to read the “Play-by-Play” section for this information.

Attach a Vent

Fig. 1
Design a vent that prevents someone’s fingers from accidentally entering the motor housing, but doesn’t restrict too much airflow.

Fig. 2
Test the vent’s security by attempting to insert a marker through it. A successful design will not allow a marker to enter the motor housing.

Attach a Handle

Fig. 3
Design a handle. One way to do this is to tape half a craft stick to each end of a tube.
- Use lots of tape to secure the handle to the vacuum.
- Reposition the button so that the user’s thumb can easily turn the vacuum on.

Fig. 4

This is an example of a handle that doesn’t require large craft sticks.

Fig. 5

This example uses a long tube and long pieces of tape. The tube hangs off of the back of the motor housing, allowing the user to fully grip it.

Fig. 6
Pipe cleaners can also be added in a loop shape to give the user a better grip.

Here foil has been wrapped around the tube and colored tape and pipe cleaners have been added.
**Get Ready!**

**Lesson Materials**
* (starred) items are choice materials; un-starred items are required for each camper

- set of materials from Camper Work Time (1 per Li)

**Demo & Discussion: Handles, Vents and Decorations Intro**
- tape, masking, 1” wide (30” per camper)

**Camper Work Time: Handles, Vents and Decorations**
- handle materials
  - *tube, cardboard, 1.5” x 4”, toilet paper (1 per 2 campers)
  - *tube, cardboard, 1.5” x 8” (1 per 2 campers)
  - *craft stick, large, 3/4” x 6” (1 per camper)
  - *pipe cleaner, asst. colors, 12” (3 per camper)

- vent materials
  - *paper, cardstock, brights, asst. colors, 8.5” x 11” (1/4 per camper)
  - *leftover strawberry basket scraps

- decoration materials
  - *tape, masking, asst. colors, 3/8” x 25 ft., set of 11 (1 per theme)
  - *foil, sheet, aluminum, 12” x 10.75” (1 per camper)
  - *foam, alphabet piece, sticky back (10 per camper)
  - *foam, geometric shape, asst. colors, sticky back (10 per camper)
  - *marker, washable, metallic, asst. colors, set of 6 (2 sets per classroom)
  - *leftover cardstock

**Preparation**

- Days earlier
  - Cut craft sticks in half as a handle option (2 halves per camper).

**Suggested Materials Management**

Today is a great day for campers to use materials from the scrap bin! Make these available so campers can access them.

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**Suggestions for Large Classes**

None

**Check In With Your TL**

Make sure your TLs are clear about their role in helping today’s lesson run smoothly. Specific ways TLs can help today are listed in the dotted overview boxes throughout the lesson.

**On the Board**

**Design Goals**

The vacuum must:
- Be operable with just one hand
- Include a vent that prevents a marker from getting past and touching the fan
- Look unique!

**Guiding Questions**

BE VISIONARY
- How can you put your own twist on the handle design of your vacuum?
- How could you make your vacuum more fun/useful/special?
- Tell me about the kind of vacuum you’re imagining.

**Vocabulary**

vent — an opening that allows air to move from one place to another
Teaching the Lesson: Overview

Instructional Priorities & Supporting Innovation

These are the key lesson elements you’re expected to communicate/support today. Think of this as the blueprint of a successful lesson. When applicable we’ve included details about why an element is important for innovation.

Demo & Discussion: Handles, Vents and Decorations Intro
★ Introduce the CONCEPTS of handles and vents, and how these components improve the vacuum.
★ Demo TESTING and EVALUATING handle and vent designs.
★ Help campers GENERATE IDEAS around how to customize the vacuum.

Throughout the Lesson
★ Support the Innovator’s Mindset Challenge: BE VISIONARY – Campers imagine and design specialized features to turn their vacuums into unique creations.
Why – Giving campers a chance to customize/personalize a project highlights the infinite possibilities inherent in any design and helps campers see that they each have a unique perspective and vision.

Teaching the Lesson: Play-by-Play

Introduction (5 min)

Welcome campers and make a quick story connection
Let’s wrap up the week’s inventions and get them ready to show off at today's Maker Faire. I’m sure Lucy is going to be super inspired by all of your innovative projects and get lots of ideas for how to make her new house unique.

Build excitement for today’s project
• Announce that today is the day that campers will finalize their vacuums. This means adding a handle to make it easier to use and adding a vent on the back to improve the vacuum’s safety.
• Explain that these components will make the vacuum more effective and easier to use, and also make it look more realistic.
• Once campers finish adding those components, they will have the option to decorate their vacuums, give their vacuums names, and more!

Introduce the Innovator’s Mindset: BE VISIONARY ★
• Point to this on your Innovator’s Mindset poster.
• Define the Mindset element in the context of today’s lesson. Say: Up until now, your vacuums look very alike. Today is all about finishing the vacuum in ways that make your creation unique. When you create in a way that hasn’t been done before, we call this being visionary.
Demo & Discussion: Handles, Vents and Decorations

Intro (15 min)

What You’ll Need to Cover: Overview
• Discuss the purpose of a handle.
• Show the handle material options and demo the building techniques. ★
• Discuss the purpose of a vent and show the material options. ★
• Show the decorative material options and explore possible uses. ★

What You’ll Need to Cover: Details
Discuss the purpose of a handle
• Show campers your example and identify the handle.
• Explain that the handle makes it much easier to hold and use.
• Explain that the design goal today is make the vacuum easy to use with just one hand.
• Note that you’ve also placed your button on the handle, which makes it very easy to activate with your thumb.

Show the handle material options and demo the building techniques ★
• Show campers the materials they can use for the handle.
• Hold up an empty motor housing tube and model various placements for the handle without attaching any.
• Ask campers for feedback on how easy they think the vacuum will be to use based upon where the handle is (for example, a handle placed at an awkward angle will probably not be easy to use).
• Choose one position and demo how to securely tape the handle on. Use several long pieces of tape and lay them across the tube.
  ▪ Emphasize making sure that the tape starts on the motor housing tube, goes over the handle tube, and ends back on the motor housing tube on the other side.
  ▪ Press the tape down and tuck it into the creases between the two tubes so it is flush against both tubes where the tubes meet.
• Show campers they can also elevate the handle with craft sticks. Demo this building technique, as shown in the pictorial.
• Finally, show campers the idea of taping an 8” tube to the housing and having it extend behind the motor housing.

• Review the Mindset Challenge ★ – Tell campers that this is one part of today’s project in which they can practice being visionary. They can choose where the handle is, how many handles they want, how the handle is attached, and where the button is placed.

Discuss the purpose of a vent and show the material options ★
• Tell campers that the next thing they’ll add is a vent to close of the back of the vacuum.
• Explain that this makes the vacuum much safer. Without a vent, it’s easy to accidentally put fingers or other things in the back of the vacuum.
• A vent is kind of like a filter. It must also allow air through, but not your fingers!
• For today’s test the vent must not allow a marker to pass through it.
• Let campers know that they will create a vent using paper or leftover strawberry baskets in the same way they created filters yesterday.
• Show campers how to attach an example vent onto the back of the vacuum.
• Demo testing the vent by making sure a marker can’t pass through the holes and going to a testing station to test that the vacuum can still suck up all the materials from yesterday.

Show the decorative material options and explore possible uses ★
• Let campers know that, upon finishing the handle and vent, they may decorate their vacuums.
• Show the decoration materials.
• Review the Mindset Challenge ★ – Let campers know how they decorate their vacuums is another great chance to practice being visionary. No two vacuum cleaners will look the same by the end of today!
• Discuss some possible themes campers might envision for their vacuums. For each, have campers suggest how they might use the materials to create that look and feel. Some ideas:
  ▪ Space vacuum – Wrap in foil, draw metallic stars on it
  ▪ Rainbow vacuum – Cover the nozzle with stripes of colored tape
  ▪ Personalized vacuum – Spell their names out with foam letters; wrap the nozzle and handle in their favorite colors of paper
• Invite campers to suggest their own possible themes.
• Give campers a moment to close their eyes and imagine how they might want their unique vacuums to look by the end of today.
Camper Work Time: Handles, Vents and Decorations (35 min)

During Work Time Campers Will...
CREATE, TEST, EVALUATE & REDESIGN (handle)
1. Add a handle to the motor housing.
2. Redesign the button placement.
3. Hold the vacuum by the handle to determine if it is securely attached.
4. Attempt to operate the vacuum with one hand at the testing station.

CREATE, TEST, EVALUATE & REDESIGN (vent)
5. Create and attach a vent.
6. Make sure a marker can’t fit through the vent holes.
7. Test the vacuum at the testing station to evaluate whether the vent positively or negatively affects the suction.

CREATE (decorations)
8. Customize the vacuum.

Extension
• Create a vacuum sales pitch.
• Have more pom-pom races.

How Your TL Can Help
Help facilitate the testing stations.

Facilitate the Project Steps
CREATE, TEST, EVALUATE & REDESIGN (handle) (Steps 1-4)
• Remind campers to redesign the placement of the button once the handle is installed.
• If you do not see campers using their handles after attaching them, find out why and explore ways to redesign the handles to make them more usable.
• Just like yesterday, make sure campers are only testing at the testing stations and taking one battery out before returning to building.

CREATE, TEST, EVALUATE & REDESIGN (vent) (Steps 5-7)
• If campers’ vacuums perform noticeably worse after installing the vents, help campers figure out how they can increase air flow. Remind campers that the vent doesn’t have to keep out anything small like sequins, so the holes can be bigger.

CREATE (decorations) (Step 8)
• Make sure campers have finalized the positions of all components before taping or covering them with decorations (for example, don’t tape over the button wires unless the button is in its final position).

Extension
• Challenge campers to develop a short pitch that sells the vacuum. Give them prompts such as, “What does your vacuum do/have that others don’t?” or “What’s special about your vacuum?” (It comes from the future! It’s the cheapest vacuum around!)
• Pom-pom races described yesterday can also be done today.

Support BEING VISIONARY ★
Suggest strategies that help and encourage campers to be visionary
Some specific strategies for today:
• Taking an idea they saw the LI demo or someone else try and putting a different spin on it. (For example: creating two handles instead of one, or creating zigzags with tape instead of stripes.)
• Taking time to remember the vacuums they imagined before starting.

Recognize visionary campers
This encourages the camper and helps others see how they can be visionary as well. Recognition can be just verbal or include some kind of physical award. Be sure to be specific about how you see campers being visionary.
Some ways you might see vision today:
• Using any of the strategies mentioned above
• Trying something that no one else has tried yet

Ask the Guiding Questions that support being visionary

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Clean Up (5 min)

- After campers pick up/put away the larger things, challenge them to clean up scraps using their vacuums!
- Have campers return to the circle with their vacuums so they can share.

Lesson Wrap Up (10 min)

Recognition and Reflection (BE VISIONARY)
Help campers see how they or others embraced the Innovator’s Mindset, and why this is important for innovation.

Suggested recognition and reflection activity
- Have campers do a gallery walk of all the vacuums to see how they all turned out!
- Call out visionary ideas you see and have campers share ideas they see that are especially creative and unique.
- Invite visionary ideas you see and have campers share ideas they see that are especially creative and unique.
- Have campers share other ways they might continue to customize and innovate on their vacuum cleaners at home.
- Recognize campers for their vision and celebrate all the hard work they put in on this very ambitious project to create a working vacuum cleaner!