Galileo Makers: Toys
Camp Galileo
2016 Star Science
(For rising 1st & 2nd grade campers)

This curriculum was developed by Galileo Learning in collaboration with the Maker Education Initiative.

© 2016 Galileo Learning
This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License. To view a copy of this license, visit: http://creativecommons.org/licenses/by-nc-nd/4.0/
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 following diagram illustrates the Galileo Innovator’s Process:

![Galileo Innovator’s Process Diagram]

**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
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 on the “Secret Sauce” page. This page clearly spells out the key ingredients that transform each project into an innovation-based Galileo lesson.

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. Detailed facilitation notes about how to introduce and support the Mindset Challenge are included as a core part of each lesson.

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!
Day 1: Marble Run, Part 1 of 3

Marble Run Play Sets are an intrinsically redesignable toy and a childhood classic for many kids. Today’s maker inspiration comes from Shawn Jordan and his project The Rube Goldberg Machine Ate My Homework.

Today: Assemble the Box and Create Three Ramps
Campers assemble a cardboard pegboard box and fold paper to create three ramps. Then they experiment with arranging the ramps into different configurations. Campers must:

- Try at least 3 different run configurations
- Create runs that allow the marble to roll from the topmost ramp to the bottommost one without falling off prematurely

What’s Next
Tomorrow (Day 2) campers build more ramps to create a full marble run set. On Day 3, campers will customize their pieces to make noise as the marble rolls down, and/or add new elements.
Today's Project: At-A-Glance

Work in pairs to assemble the cardboard pegboard box.

One person holding the box while the other person tapes the corners in place.

Tape a stand onto the back of the box.

Cardboard strip taped to the back of the box; makes the box more stable and helps prevent the marbles from falling off tracks.

Create the one-fold ramp, the two-fold ramp, and the funnel.

Heavy 4.5 x 5" cardstock folded once, folded twice, and bent into a funnel.
Create at least three successful ramp arrangements.

Successful basic ramp arrangement; another possible arrangement that includes a big drop.

Possible arrangement made by turning the box on its side.

Possible arrangement that causes marble to roll very slowly; possible arrangement that causes marble to fall very quickly.
Teaching the Lesson: Overview

OUR SECRET SAUCE: THE G.I.A.

KNOWLEDGE FOCUS
SKILLS AND TECHNIQUES: Paper Folding (Paper Tracks and Funnels)
Campers learn how to fold thick cardstock by bending it over the edge of a box, and how to create a simple funnel.
Why? – Folding a straight crease can be challenging for campers, even with thin copy paper. For campers to be successful with creating their marble run ramps, they will need to know the specific paper-folding techniques that will allow them to crease heavy cardstock.

PROCESS FOCUS
REDESIGN
Campers try to find as many different successful configurations as possible using only their three pieces. Specific LI prompts serve as inspiration for possible redesigns.
Why? – This project is specially designed to enable campers to easily redesign and endlessly create new marble runs; however, campers are unlikely to rearrange a working arrangement without prompting. Making redesign and exploration the goal for today will help campers recognize the infinite possibilities and make it more likely that they’ll be inspired to continue to construct new marble runs with their pieces after camp as intended.

MINDSET FOCUS
BE VISIONARY – I imagine things that don’t exist yet.
Campers don’t stick with one arrangement, but seek out new possibilities beyond the ones that are already working.
Why? – This Mindset goes hand in hand with the redesign focus for the day, helping campers see beyond the perceived limitation of only having three pieces.

Remember to include these special ingredients to transform today’s project into a Galileo, innovation-based lesson. Bam!
Lesson Breakdown & Camper Goals

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time</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>Guided Activity: Assemble the Pegboard Box</td>
<td>15 min</td>
</tr>
<tr>
<td>□ Facilitate working in pairs to assemble the box</td>
<td></td>
</tr>
<tr>
<td>□ Ensure that campers securely tape the stand onto the back of the box</td>
<td></td>
</tr>
<tr>
<td>Demo &amp; Discussion: Ramps and Runs</td>
<td>10 min</td>
</tr>
<tr>
<td>□ Demo how to make the one-fold ramp, the two-fold ramp, and the funnel ramp</td>
<td></td>
</tr>
<tr>
<td>□ Demo how to attach the ramps to the pegboard</td>
<td></td>
</tr>
<tr>
<td>□ Demo how to redesign the ramp arrangement</td>
<td></td>
</tr>
<tr>
<td>Independent Work Time: Building Ramps and Designing Runs</td>
<td>15 min</td>
</tr>
<tr>
<td>□ Make one of each of the ramp types</td>
<td></td>
</tr>
<tr>
<td>□ Arrange pieces to create a variety of successful marble runs; must:</td>
<td></td>
</tr>
<tr>
<td>• Try at least 3 different run configurations</td>
<td></td>
</tr>
<tr>
<td>• Create runs that allow the marble to roll from the topmost ramp to the bottommost one without falling off prematurely</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>

Timing Notes
Campers are on track so long as everyone assembles the pegboard box, builds one of each ramp type, and has some time to try multiple ramp arrangements.

If campers or groups are behind
• Have campers redesign their ramp arrangements just once or twice.

If campers or groups are ahead
• Allow campers to make one more ramp (but not more than that).
• Give campers an opportunity to test each other’s ramp arrangements.
• If campers haven’t tried already, have them rearrange the ramps on the pegboard while it’s turned on its side.
Welcome to Science (10 min)

Welcome campers, introduce the theme, and make a quick story connection

Ex: I hear ToyFest is coming up and Lucy and Finn have run into some trouble with their toy. Why don’t we inspire them to keep on making by doing some making ourselves? Let’s get the ball rolling by building some super-innovative toys!

Set expectations about the space and materials

Important to set clear expectations for the whole week

Go over daily procedures you’ll want campers to be familiar with; some ideas
- What they do when they first come in
- What materials they can and can’t touch
- How they treat plastic (leave it on; don’t poke holes in it!)
- How they treat materials

Where they put finished projects

Set expectations about behavior in the classroom

Come up with agreements about
- How everyone can stay safe
- How campers can make sure they all have fun

Emphasize respecting you, other staff, and each other

Introduce the GIA

Introduce the idea of being an innovator

• Ex: We’ll be learning about science all week, and we’ll also be practicing being innovators. Being an innovator is a really important job. Innovators think of really great ideas and can make those ideas real!

Point out your Innovator’s Process poster and quickly intro the Process
- Don’t go over each step in detail now
- Ex: 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 and intro the Mindset
- Again don’t go over each Mindset element in detail now
- Ex: This is how good innovators think and act. They try new ideas, they work together, and they don’t give up!

Ask campers if they’re ready to innovate!

Introduction (5 min)

Introduce the idea of makers and making

Announce this week is all about makers

Makers are people who make things themselves
- There are all kinds of makers
  - Game makers, tool makers, clothes makers, food makers, etc.
- This week campers will be toy makers who make their own toys!

Makers know they don’t have to go to a toy store to get toys or be part of a big toy company; anyone can be a toy maker!
Give context for today's project: Introduce the idea of marble run toys

Show color copy of Marble Run Toy and ask: Who has played with this toy before?

Emphasize a marble run is great because it's different each time you play with it; pieces are taken apart and put back together in new ways, like LEGO

Build excitement and give an overview of today's project

Announce making their own marble runs, Galileo-style!
- Made from things they can find at home (cardboard, paper)
- Will be able to rearrange pieces and make new runs, just like the real toy
- Will work on it for 3 days and take it home on Friday!

Explain today they will just make the box and 3 pieces
Will spend most time playing with those pieces to create as many different kinds of runs as possible (at least 3!)

★ 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
- Today we’re going to focus on being visionary so we can imagine new and surprising ways to use our pieces.

Introduce campers to a maker who created his/her own version of today’s project

Show today’s Maker Connection color copy for inspiration

Read the maker’s name and quickly describe the project
Pick one of the Q&As and share it with campers now
- Explain these are things the maker wanted to share with campers to inspire them as they make toys all week
- If necessary rephrase or sum up in age-appropriate language
Guided Activity

Assemble the Pegboard Box (15 min)

• You can read the other Q&A as campers work or if you have extra time later in the week

Have campers give a thumbs-up if they’re psyched to make their own toys like this maker!

Demo and have campers work in pairs to assemble the sides of the pegboard box together exactly as shown

➤ Work with TL to model this step

Have one person hold the flaps together, then the other person folds the short edge of the box over the flaps and inserts the tabs into the slots
• Make sure to tuck in the tabs as tightly as possible

Repeat on the other side

Instruct campers to switch roles and work on partner’s box when finished with one

Introduce tape dispenser safety and demo how to use the tape dispensers

Next will tape stand

Tape dispenser will let campers easily get their own tape; no waiting for LI or TL!
Hold tape dispenser where all campers can see
Show how the tape dispenser works
• Pull out a 3-4" piece of tape and tear it off
- Emphasize pulling tape down then to the side; not just down

Emphasize the correct way to safely dispense tape
- Avoid touching the blade

Always grab tape from the front; never reach from behind the tape dispenser as this can result in being cut by the blade

**Demo and have campers tape a cardboard stand onto the top edge of the box**

Explain purpose of stand
- Keeps the box from falling over
- Easier to keep marbles from falling out if the box is leaning back a little

Lay the box down as shown; place the cardboard piece on top of it

Put two pieces of tape on one side
Demo and Discussion

Ramps and Runs (10 min)

### Demo the box-edge creasing technique to create the one-fold ramp

- Show the 4 x 5" cardstock with holes; tell campers this is what they’ll use to make their ramps.
- Announce the first ramp they’ll make is a V-shaped ramp.
- Hold one piece over the edge of the box:
  - Emphasize making sure the holes are both on the same side.
  - Should be folding parallel to the holes.
- Fold the cardstock over the edge of the box.

### Demo how to use the same technique to create the two-fold ramp

- Announce the second ramp they’ll make is a U-shaped ramp with an edge.
- Hold the cardstock over the edge of the box, but this time fold just about 1".
Repeat on the other side

Demo how to create a funnel using the one-fold ramp and a piece of tape

Announce the second ramp they’ll make is a funnel; a little harder but adds more fun to the marble run set
Create another 1-fold ramp
Get a small piece of tape ready
Tape the corners of the cardstock together

Use your fingers to enlarge the narrow end of the funnel
• May need to do a little adjusting so marble can fit through hole
**Demo how to attach a paper ramp to the pegboard box using plastic pegs**

Show the plastic pegs to campers and point out holes in cardstock ramps
- Will line up cardstock hole with pegboard hole in location they want
- Then will push pegs through holes to hold ramp in place

Put the box in lap as you do this
- Emphasize easier to build with box in lap than with box standing up

**Add the other two ramps in an unsuccessful arrangement**

Hold up box so campers can see how pegs work

Remember to lay the box down in your lap as you build
Your unsuccessful example might look something like this:
Test and discuss the troubleshooting options of re-creasing or moving the piece

Prop your marble run on its stand on the floor in front of campers
Test it to show that it doesn’t work; marble falls off

Explain troubleshooting options:
• Fix the piece (crease it more)
• And/or move the piece to another position

(Note: you’ll focus more on troubleshooting tomorrow when campers have more pieces/longer runs, but good to intro the idea now)

Verbalize why/where your marble fell off and decide to both refold and move the piece

Demo how to remove and adjust the ramps to make a successful design

Emphasize redesign is easy; this toy is designed so pieces can quickly be taken off and moved around
Show how to remove the pegs and rearrange the pieces
• Do this with box upright so campers can see, but remind that they’ll put boxes on laps when redesigning

Your successfully redesigned run might look something like this:
Support REDESIGN by reintroducing the goal of creating as many different track arrangements as possible

Reiterate that a marble run is designed to be taken apart and remade

That’s why today’s design challenge is to see how many ways they can rearrange just three pieces into different and awesome marble runs

- Must make at least three different working arrangements
- For an arrangement to count marble must hit all three tracks without falling off early

★ Introduce the opportunity to practice BEING VISIONARY after creating a successful marble run

Give examples of not being visionary, pretend to have this attitude

- Ex: I can’t think of any other way to make my track besides what I already did. There aren’t very many options with just three pieces, so I don’t know how I’m supposed to come up with three new ideas.
- Ask: Will this attitude help us innovate and help us make lots of different marble runs? (No!)

Remind that what will help is using their powers of being visionary

- They’ll know their powers are on if they are imagining how they can try something different from the runs they just made
- Pretend to turn on your visionary powers

Model what it looks like to be visionary

- Encourage asking lots of “what if” questions and thinking of the opposite of what you just tired
- Ex: Cool! Having all the pieces close together works. What else can I try that’s different? What about the opposite, having one ramp super far away? What if I try to make a track where the marble goes super slow or fast? What if I flip the funnel around? What if I turn the box so it’s sideways? What if I start at the very corner or the middle?

★ Review the Mindset Challenge: BE VISIONARY

Challenge campers to use powers of being visionary to keep imagining something new they can try each time they make a successful run

Have campers turn on their powers of being visionary

Independent Work Time

Building Ramps and Designing Runs (15 min)

<table>
<thead>
<tr>
<th>What campers will do: Create and arrange three ramps</th>
<th>CREATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fold three pieces of cardstock to create each of the three ramp types: one-fold, two-fold, and funnel.</td>
<td>TEST AND EVALUATE</td>
</tr>
<tr>
<td>2. Attach the ramps to the pegboard box using the plastic pegs in any arrangement.</td>
<td>3. Place the marble onto the top ramp and observe if it makes it to the bottommost ramp without falling off.</td>
</tr>
<tr>
<td></td>
<td>REDESIGN</td>
</tr>
<tr>
<td>4. Rearrange the ramps until the marble rolls from the top to the bottom.</td>
<td>5. Change the arrangement of ramps based upon their own ideas and/or prompts from the LI.</td>
</tr>
</tbody>
</table>
### 6. Continue experimenting with different ramp arrangements until the end of the Work Time.

<table>
<thead>
<tr>
<th>Facilitate CREATE</th>
<th>Make sure campers keep both holes on the same side of the crease Help campers recognize if they need to crease the cardstock more Remind about building with pegboard in their lap</th>
</tr>
</thead>
</table>
| Facilitate TEST AND EVALUATE | Remind about leaning the pegboard box back on its stand when testing; easier to keep the marble on the track this way Help campers troubleshoot as necessary if runs aren’t working  
  - Don’t hesitate to tell campers where marble fell off (can be hard for campers to see because marbles move quickly)  
  - Remind about options of re-creasing or moving a piece  
  - Help them determine which piece they might need to re-crease or move |
| ★ Facilitate REDESIGN and support BEING VISIONARY | Call out fun/unique camper examples to motivate campers to explore similar ideas and to spark new ideas  
Recognize visionary campers; be specific about how they are being visionary  
  - Ex: Wow! You’ve thought of five totally different ways to use your three pieces. Way to be visionary!  
Present prompts that support redesign and being visionary (can suggest these challenges one-on-one or to the whole class):  
  - What if you turn the box sideways?  
  - How can you make the marble fall a long distance?  
  - How can you get the marble to go as slow/fast as possible?  
  - What if you start in the very corner/in the middle/on the bottom? |

### Clean Up (5 min)

<table>
<thead>
<tr>
<th>Clean Up</th>
<th>You can store the boxes by lining them up like books, or stacking them like this:</th>
</tr>
</thead>
</table>
|          | Campers can keep their ramp pieces attached  
Collect a few samples of run arrangements that are very different |
## Lesson Wrap Up (10 min)

| ★ Summarize the importance of BEING VISIONARY and have campers recall how they practiced this today | Show examples and point out all the different ideas in each  
| | • Invite campers to share if they tried something else not shown in the examples  
| | • Recognize everyone for coming up with so many different ways of making their marbles run!  
| | Highlight effect of practicing Mindset during today’s project  
| | • Ex: *One thing that helped us come up with so many fun and interesting ways to use our pieces was using our visionary powers!*  
| | Have campers put on their visionary goggles if they practiced being visionary today by:  
| | • Coming up with at least 3 different ways of arranging pieces  
| | • Coming up with an idea no one had tried yet  
| | Review why vision is important for innovation  
| | • Ex: *Remember to use your visionary powers to keep imagining different possibilities even when it might seem like there’s only one way to do something. This will help you discover new and exciting ways to create!*  

| Revisit today’s maker connection | Remind campers about the toy maker they learned about earlier  
| Ask: *Do you think this maker had to be visionary when making his toy? How?*  
| If there’s a relevant Q&A read/revisit it now  

| ★ Invite campers to recognize each other for BEING VISIONARY | Can recognize teammates they saw being visionary or who helped them be more visionary by helping them get new ideas about what to try  
| | • Encourage specificity about how person was visionary  
| | You and TL can recognize campers as well |
Get Ready!

Lesson Materials

* (starred) materials appear multiple times in this list

Copies
- copy, color, Maker Connection (2 per classroom)
- copy, color, Marble Run Toy (2 per classroom)

General/Adhesives/Tools
- tape, masking, 1" (50" per camper)
- tape dispenser, multi-roll (1 per 2 campers)
- container, deli, 16 oz., for holding pegs and marbles (2 per 4 campers)
- tray, lunch, for holding building materials (1 per 4 campers)

Required Materials
- box, cardboard pegboard (1 per camper)
- cardboard, corrugated, 18 x 4", for box stand (1 per camper)
- paper, heavy cardstock, 4 x 5" with holes (3 per camper)
- Conical Plastic Anchor, 10-12 X 1-Inch (6 per camper)
- marble, asst. colors & sizes (1 per camper)

Advance Materials Preparation

Start prepping the wires for Day 4 (see details in the Day 4 prep). This prep is intensive and it’s recommended that you start now.

Setting Up the Space

It’s recommended that campers work on the floor for today and the next three days. Push desks and tables to the edge of the room.
- If campers are working at a table, marbles will drop to the floor and roll around more easily; working on the floor prevents time wasted scrambling after marbles.
- This project may take up too much table space for tables.
- You can have some campers work at tables if there’s not enough floor space.

Set up trays with building supplies (1 per 4 campers):
- tape dispensers (2 per tray, facing opposite directions so campers can safely get tape from either direction)
- paper, heavy cardstock, 4 x 5" with holes (3 per camper)
- Conical Plastic Anchor, 10-12 X 1-Inch, in deli containers (6 per camper)
- marble, asst. colors & sizes, in deli containers (1 per camper)
Set aside box and stand materials so they can be easily passed out during the Guided Activity:

- box, cardboard pegboard (1 per camper)
- cardboard, corrugated, 18 x 4", for box stand (1 per camper)

Gather materials for the Demo & Discussion:

- box and stand
- set of all building supplies

Put up the following color copies on your copies display board

- Marble Run Toy
- Maker Connection

Notes

Materials Management
You have been supplied with extra marbles in case some get lost, but campers should only be given one at a time.

On the Board

Design Challenge
Campers must:

- Try at least 3 different run configurations
- Create runs that allow the marble to roll from the topmost ramp to the bottommost one without falling off prematurely

Mindset of the Day
BE VISIONARY – I imagine things that don’t exist yet.

Check In With Your TL

➢ Make sure your TLs are clear about their role in helping today’s lesson run smoothly. Specific things your TL can help with today:

- Help you model how to assemble the pegboard box in pairs
Today’s maker inspiration comes from Chase Bent and his Multi-Action Marble Machine project.

**Today: Create New Ramps and Build Up the Marble Run**
Today campers make at least 5 additional ramp pieces (including two new ramp designs) in addition to the 3 from yesterday. The marble run must:
- Use all 8 of the ramp pieces
- Allow the marble to roll from the top to the bottom without falling off

**What’s Next**
Tomorrow (Day 3) campers will customize their pieces to make noise as the marble rolls down, and/or add new elements.
Today’s Project: At-A-Glance

Create a tube out of cardstock

Example of cardstock tube with holes punched with a three-hole puncher

Create a cone out of cardstock

Example of a cardstock cone with holes punched with a hole puncher

Build at least 3 more ramps

A total of 8 ramps (including 3 ramps made yesterday)
Arrange ramps on the pegboard

Test after each addition

Marble dropped after adding another piece

Build until all 8 pieces have been used
Teaching the Lesson: Overview

OUR SECRET SAUCE: THE G.I.A.

KNOWLEDGE FOCUS

SKILLS AND TECHNIQUES: Paper Folding (Tubes and Cones)
Campers learn how to fold paper into a tube and a cone, and then integrate both of these pieces into their marble runs.

Why? – Variety is what makes a marble run fun to play with. Giving campers more options for their marble runs will make them more redesignable and enjoyable.

PROCESS FOCUS

TEST AND EVALUATE: Test in Stages, Evaluation Checklist
Campers test the marble run each time a new piece is added, and make sure the whole series of ramps works before adding a new piece. If the marble falls off campers check two elements, the piece itself and the placement of the piece.

Why? – Campers may be inclined to build the entire marble run before testing it, which can result in a messy pileup of issues. In addition, campers don’t always know where to start when they do encounter an issue in a project like this. Building and testing one piece at a time allows campers to isolate problems early. Giving them specific things to check when they find a problem enables them troubleshoot more independently and successfully.

MINDSET FOCUS

BE DETERMINED – I persevere until I achieve my goal.
Campers work diligently to troubleshoot each ramp until it works and redesign as necessary to include all eight pieces in the design.

Why? – It takes a lot of tinkering and adjusting to build a successful marble run, especially a long one. Campers will encounter a lot of issues with their ramps and arrangements today and are likely to become frustrated. Today’s Mindset Focus helps enable campers to work through their unsuccessful attempts so they can enjoy eventual success.

Remember to include these special ingredients to transform today’s project into a Galileo, innovation-based lesson. Bam!
## Lesson Breakdown & Camper Goals

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td>5 min</td>
</tr>
<tr>
<td><strong>Demo &amp; Discussion: New Ramp Types</strong></td>
<td>15 min</td>
</tr>
<tr>
<td>□ Demo how to make the tube ramp</td>
<td></td>
</tr>
<tr>
<td>□ Demo how to make the cone</td>
<td></td>
</tr>
<tr>
<td>□ Discuss how to test and redesign in stages</td>
<td></td>
</tr>
<tr>
<td><strong>Independent Work Time: Constructing New Ramps and Marble Runs</strong></td>
<td>35 min</td>
</tr>
<tr>
<td>□ Build at least 5 new ramps, including both of the new designs</td>
<td></td>
</tr>
<tr>
<td>□ Add and test one ramp at a time to the marble run; the final marble run must:</td>
<td></td>
</tr>
<tr>
<td>• Use all 8 ramps</td>
<td></td>
</tr>
<tr>
<td>• Keep the marble from falling off prematurely</td>
<td></td>
</tr>
<tr>
<td><strong>Wrap Up (includes trying each other’s marble runs)</strong></td>
<td>10 min</td>
</tr>
<tr>
<td><strong>Clean Up</strong></td>
<td>5 min</td>
</tr>
</tbody>
</table>

### Timing Notes

Campers are on track so long as everyone has created 8 pieces and has started creating their marble runs.

If campers or groups are behind

- It’s okay if campers don’t have all 8 pieces on the board yet. They’ll have time to keep building tomorrow.
- Skip the extended Wrap Up option of having campers try each other’s runs.

If campers or groups are ahead

- Allow campers to make up to two extra ramp pieces.
- Extend the time during the Wrap Up for trying each other’s runs (see Wrap Up for details).
# Teaching the Lesson: Play-by-Play

## Introduction (5 min)

| Build excitement and give an overview of today’s project | Emphasize building toys is more fun if they have more pieces/a variety of pieces  
• Ask: What’s more fun, a LEGO set that has 30 pieces, or a set that has 300 pieces? (More pieces)  
• Ask: What’s more fun, having just square LEGO bricks, or lots of different kinds of pieces? (Different kinds)  
Announce improving marble runs by adding new and more pieces!  
• Will add tunnels and cones  
• Will have 8 pieces total by end of today (counting 3 pieces from yesterday)  
Instead of making a lot of different marble runs like yesterday, today’s building goal will be to make one working marble run using all their new pieces  
At the end of class, will get to try each other’s marble runs |
| --- | --- |
| ★ 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.  
• Today we’re going to focus on being determined. This means doing what it takes and working hard to get our marbles to successfully roll down all 8 of our ramps. |
| Introduce campers to a maker who created his own version of today’s project | Show today’s Maker Connection color copy for inspiration  
Read the maker’s name and quickly describe the project  
Pick one of the Q&A’s and share it with campers now  
• Explain these are things the maker wanted to share with campers to inspire them as they make toys all week  
• If necessary rephrase or sum up in age-appropriate language  
• You can read the other Q&A as campers work or if you have extra time later in the week  
Have campers give a thumbs-up if they’re psyched to make their own toys like this maker! |
**Demo & Discussion**

**New Ramp Types (15 min)**

| Demo how to make the new tube option | Get a piece of tape ready  
Bend a quarter piece of cardstock into a tube as shown and tape it in place |
| Demo and discuss punching holes in the tube using the single or 3-hole punchers | Unlike yesterday this cardstock doesn’t have premade holes; need to make holes to attach to pegboard  
Point out the hole-punching station they’ll go to when they need to use hole punchers  
Demo how to use a 3-hole punch to create several holes above the tube  
- Having several holes will give them more flexibility when arranging pieces  
- Place the piece in the 3-hole punch to make one set of holes  
- Then move it over and punch again to make more holes  
Can also use a single hole punch  
- Will need to punch several times  
- At least 5 holes |
| Demo how to make the new cone option | Get a piece of tape ready  
Cut a slit from the side to the center of a quarter piece of cardstock |
Fold the paper as shown until it starts to form a cone shape

Tape the paper together to hold the cone shape
Cut off the tip of the cone so a marble can fall through

Use a hole puncher to make several holes on the wide end of the cone
Review today’s ramp-building requirements and goals

Must make five new pieces today
- Must try making at least one cone and one tube
- Other three pieces can be more tubes and cones or ramps from yesterday

Review materials options for each ramp type
- Use heavy cardstock with holes for ramps from yesterday
- Can use regular cardstock for cones/tubes

Will have eight pieces total including three ramps from yesterday
Will build all the pieces first before constructing the marble run

Introduce TESTING each time they add a new ramp to the run

Emphasize when building the run they’ll add and test one ramp at a time
If marble falls off when testing they should redesign before adding the next piece
Much easier to find/fix problems one at a time vs. waiting until the whole run is done

Support EVALUATE by reviewing the two elements to check when troubleshooting (the piece itself and its placement)

Ask: Who remembers from yesterday what two things to check if the marble falls off the track?
- Check the piece itself (Is it creased enough, does the funnel have a big enough opening, etc.?)
- Check the placement of the piece (Does it need to be moved, is it falling off the board, etc.?)

Support TEST as you demo adding and testing one ramp that isn’t creased well

Gather 8 sample ramps made during yesterday’s demo
Add one ramp piece that is badly creased so the marble falls off
Ask: What should I do once I’ve added one ramp?
- Test!
Test to show that the marble falls off!

★ Introduce the opportunity to practice BEING DETERMINED if the marble run isn’t successful

Give examples of not being determined; pretend to have this attitude
- Ex: Aw man! I can’t even get one ramp to work and I have 7 more to go! This is too hard! I give up!
- Ask: Will this attitude help us innovate and help us create a fun marble run? (No!)

Remind that what will help is using their powers of determination
- They’ll know their powers are on if they are focusing on solving problems and working hard until they do
- Pretend to turn on your determined powers

Model what it looks like to be determined
- Ex: Aw man! It didn’t work, but I bet I can fix it. I have some ideas of adjustments I can make that I think will help.

Support EVALUATE by using the two-item checklist to troubleshoot your run

Review the evaluation checklist; check:
- The piece itself (does it need to be re-creased/re-taped/remade?)
- The placement of the piece (does it need to be moved/secured?)

Notice that the piece isn’t creased very much
Re-crease it so the marble doesn’t fall off and try again; success!

Support TEST and EVALUATE as you demo adding, testing, and troubleshooting one ramp that isn’t positioned well

Add another piece that doesn’t work because it’s place poorly, like this:
Reiterate it’s time to test again because you’ve added another ramp
Test to show the marble falls off again; time for more determination!
Check to make sure the piece is creased well (Yes)
Next check the placement
  • Is it attached securely to the pegboard? (Yes)
  • Is it in the right spot to catch the marble? (No)
Change the position of the piece so it’s now below the preceding piece, and attach it securely

Success!
Place a third ramp in a way that will make it hard to fit the rest of your pieces

Example of a marble run that doesn’t have room to add pieces after the last piece added

★ Introduce the opportunity to practice BEING DETERMINED if they notice they don’t have space for all their pieces

Give examples of not being determined; pretend to have this attitude

- Ex: Oops! I don’t think I can fit the rest of my pieces with the ramp this way. Oh well. I don’t feel like fixing it. I’ll just have 3 ramps instead of 8.
- Ask: Will this attitude help us innovate and help us create a fun marble run? (No!)

Remind that what will help is using their powers of determination

- They’ll know their powers are on if they are redesigning to make sure they can meet today’s goal
- Pretend to turn on your determined powers

Model what it looks like to be determined

- Ex: Uh oh! I won’t be able to fit all my pieces. Let me remove this piece and add it on in a different way so I can make my run as long and fun as possible!

Discuss the importance of zigzagging as they build to fit all eight pieces

Redesign your piece and quickly add the remaining pieces

- Reiterate campers will test after adding each ramp, but you won’t now to save time
- Build so the ramps are going back and forth a lot
Call out that “zigzagging” back and forth makes it easier to fit all 8 pieces, and makes the marble run more fun to watch!

### ★ Review the Mindset

**Challenge: BE DETERMINED**

- Challenge campers to use powers of determination to work towards the goal of getting a marble to successfully roll down 8 ramp pieces
- Have campers turn on their powers of determination

### Independent Work Time

**Constructing New Ramps and Marble Runs (35 min)**

**What campers will do: Create new ramps and assemble a working marble run using all their ramps**

<table>
<thead>
<tr>
<th>CREATE (ramps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fold and tape one cone ramp out of regular cardstock.</td>
</tr>
<tr>
<td>2. Punch holes using a hole punch.</td>
</tr>
<tr>
<td>3. Fold and tape one tube ramp out of regular cardstock.</td>
</tr>
<tr>
<td>4. Punch holes using a hole punch.</td>
</tr>
<tr>
<td>5. Create at least 3 more ramps using any technique from today or yesterday.</td>
</tr>
</tbody>
</table>

**CREATE, TEST, EVALUATE & REDESIGN (marble run)**

| 6. Add one ramp to the pegboard box. |
| 7. Roll a marble to test whether or not it’s working. |
| 8. If the marble makes it to the bottom without falling off, then add another piece. If not, decide how to adjust the actual piece and/or its placement. |
| 9. Continue to add ramps and test until all 8 have been added. |

**Extension**

- Make and add up to two extra ramp pieces.

**Facilitate CREATE (ramps)**

- Make sure campers build all 5 new pieces before they start adding onto their marble runs.
Remind about how to make ramps, especially those from yesterday, as necessary
➤ Campers may have difficulty cutting off the tip of the cone; you and your TL can help with this

Make sure hole punchers stay at the station; help campers with hole punching as necessary

Facilitate CREATE TEST, EVALUATE & REDESIGN (marble run)

Ask campers if you can try out their marble runs
• If marble falls, remind them to test and fix each piece before adding more

Crease/re-crease ramps for campers having trouble folding

Remind about what to check (the piece itself and its placement)

Remind about zigzagging (going from one end of the box to the other) to get more pieces to fit

Ask guiding questions that support test and evaluate:
• Where is the marble falling off?
• What if you try re-creasing the piece?
• What can you do to make the piece stay in place on the board?
• How can you move the piece so it catches the marble/leaves room for more pieces?

If campers can’t tell where or why marble is falling off show/tell them
• Often too hard for campers to see fast-moving marbles
• Can still leave it up to them to decide how to redesign
• Ex: I see your marble is falling off when it’s on this track. I see the side of the track is bending when the marble gets there and it’s falling off the edge. What might you do to fix this?

Support BEING DETERMINED

Celebrate incremental progress to keep campers motivated
• Ex: You have four working ramps. You’re halfway there!

Recognize determined campers; be specific about how they are being determined
• Ex: You’ve been working so hard adjusting that piece to get it to catch the marble. You’re almost there! Great job being determined!

Step in to support campers who are getting overly frustrated (but don’t do it all for them!)

Lesson Wrap Up (10 min)

If time allows, give campers a few minutes to try each other’s marble runs out

Recognize everyone for being so determined to make successful marble runs; their hard work has led to runs that will be really fun to play with!

Set expectations for trying other people’s runs
• Only roll marbles down the ramps; don’t move any ramps
• Be gentle; if a box falls over, stand it upright
• Pay attention to what makes a marble run feel fun
★ Summarize the importance of BEING DETERMINED and have campers recall if/how they practiced this today

- Highlight effect of practicing Mindset during today's project
  - Ex: One thing that made our marble runs so fun is that we were determined to make sure they worked, and to make them really long!

- Have campers flex their muscles if they practiced being determined today by:
  - Working hard to fix/change/adjust something that wasn’t working
  - Removing a piece after noticing they didn’t have space
  - Focusing on how to solve a problem instead of getting frustrated/getting angry/giving up

- Have a few campers show their marble runs to the group
  - Have them explain where something wasn’t working and what they did to change it
  - Recognize their determination

- Review why determination is important for innovation
  - Ex: When you use your powers of determination nothing can stop you from creating what you’re imagining, even if not everything goes as planned at first.

Revisit today’s maker connection

- Remind campers about the toy maker they learned about earlier
  - Ask: Do you think this maker had to be determined when making his toy? How?
  - If there’s a relevant Q&A read/revisit it now

Clean Up (5 min)

Clean Up

- Like yesterday, you can store the boxes by lining them up like books, or stacking them like this:

Campers can keep their ramp pieces attached and keep loose ramp pieces inside their boxes
Get Ready!

Lesson Materials

* (starred) materials appear multiple times in this list

General/Adhesives/Tools
- tape, masking, 1", for building the new ramps and for repairing pegboard boxes (12" per camper)
- tape dispenser, multi-roll (1 per 2 campers)
- hole punch, single, 1/4" (1 per classroom)
- hole punch, 3-hole (1 per classroom)
- container, deli, 16 oz., for holding anchors and marbles (2 per 4 campers)
- cutter, paper, guillotine, 12", for cutting cardstock in prep (LI and TL only) (1 per classroom)

Required Materials
- paper, heavy cardstock, 4 x 5" with holes, for one-fold, two-fold, and funnel ramps (5 per camper)
- paper, cardstock, brights, asst. colors, 8.5 x 11", for cones and tubes (two ¼ pieces per camper)
- Conical Plastic Anchor, 10-12 X 1-Inch (16 per camper)
- marble, asst. colors & sizes (1 per camper; from yesterday)

Materials Preparation

Use the paper cutter to cut the regular cardstock sheets into quarters (2 pieces per camper).

Advance Materials Preparation

Continue prepping the wires for Day 4 (see details in the Day 4 prep). This prep is intensive and it’s recommended that you start now.

Setting Up the Space

Set up a station with hole punchers.

Set up trays with building supplies (1 per 4 campers).
- tape dispensers (2 per tray, facing opposite directions so campers can safely get tape from either direction)
- paper, heavy cardstock, 4 x 5" with holes, for one-fold, two-fold, and funnel ramps (5 per camper)
- paper, cardstock, brights, asst. colors, 8.5 x 11", for cones and tubes (two ¼ pieces per camper)
- Conical Plastic Anchor, 10-12 X 1-Inch, in deli containers (16 per camper)
- marble, asst. colors & sizes, in deli containers (1 per camper)

Gather materials for the Demo & Discussion:
- an assembled pegboard
- 6 of the ramps that you made yesterday for your demo
- a set of the building materials listed above
- 3-hole puncher
On the Board

Design Challenge
The marble run must:
  • Use all 8 of the ramp pieces
  • Allow the marble to roll from the top to the bottom without falling off

Mindset of the Day
BE DETERMINED – I persevere until I achieve my goal.

Evaluation Checklist
Check:
  • The piece itself (Does it need to be re-creased/re-taped/remade?)
  • The placement (Does it need to be moved/secured?)

Check In With Your TL

➢ Make sure your TLs are clear about their role in helping today’s lesson run smoothly. Specific things your TL can help with today:
  • Remind campers how to make today’s new ramps and yesterday’s ramps
  • Help cut the tips off of the cones
  • Supervise campers as they play with each other’s marble runs
Today campers add special elements to their ramps such as sound makers, hoops, swishing fringe, and tunnels. Campers must:

- Create at least 3 improvements to the marble run to make it more fun to play with
Today's Project: At-A-Glance

Option 1: Add noisemaking elements

- Beils strung on pipe cleaners make a jingly noise

Option 2: Add other ramp additions

- Corrugated paper taped to the bottom of the ramp makes a zipping noise
- Pipe cleaner hoops added for balls to travel through
Option 3:
Decorate the box and ramps

Box decorated with foam shapes
Teaching the Lesson: Overview

OUR SECRET SAUCE: THE G.I.A.

PROCESS FOCUS

SHARE
At the end of the rotation campers share with a partner some of the special features they’ve worked hard on. Then partners try out each other’s marble runs!

Why? – Knowing they’re going to share their final projects provides extra motivation for campers to make their toys as awesome as possible. In addition, giving campers a chance to articulate what they’re proud of will help them reflect on the value of putting in effort to create something special.

MINDSET FOCUS

BE DETERMINED – I know innovation and mastery require effort.
Campers stay committed to making their play sets more fun by continuing to find ways to add to and improve on what they have, even if they’re already working.

Why? – Campers often fixate on the goal of being “done,” and are quick to call a project finished once it’s reached the most basic level of functionality, like their marble runs have. Today’s Mindset encourages campers to seek out opportunities to keep pushing their play sets to the next level, making it more likely their projects are something they’ll want to have and use long after camp.

Remember to include these special ingredients to transform today’s project into a Galileo, innovation-based lesson. Bam!
## Lesson Breakdown & Camper Goals

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td>5 min</td>
</tr>
<tr>
<td><strong>Demo &amp; Discussion: Fun Additions</strong></td>
<td>10 min</td>
</tr>
<tr>
<td>- Demo how to add materials that make noise (bells and corrugated paper)</td>
<td></td>
</tr>
<tr>
<td>- Demo how to add other ramp additions (hoops, fringe, tunnels)</td>
<td></td>
</tr>
<tr>
<td><strong>Independent Work Time: Finishing the Marble Run Play Set</strong></td>
<td>30 min</td>
</tr>
<tr>
<td>- Add to and improve the marble run play set; must</td>
<td></td>
</tr>
<tr>
<td>- Make at least 3 improvements to make the play set more fun</td>
<td></td>
</tr>
<tr>
<td><strong>Guided Activity: Share the Marble Runs</strong></td>
<td>10 min</td>
</tr>
<tr>
<td>- Pair up to share about improvements and play with each other’s toys</td>
<td></td>
</tr>
<tr>
<td><strong>Clean Up</strong></td>
<td>5 min</td>
</tr>
<tr>
<td><strong>Wrap Up</strong></td>
<td>10 min</td>
</tr>
</tbody>
</table>

### Timing Notes

Campers are on track so long as everyone has a working marble run with several pieces.

If campers or groups are behind:
- Have them spend time finishing things from yesterday before adding new things.
- Shorten the group share.

If campers or groups are ahead:
- Challenge them to try to invent a totally new special addition.
- Extend the group share by having campers pair up with more people.
# Teaching the Lesson: Play-by-Play

## Introduction (5 min)

| Welcome campers and make a quick story connection | Ex: How are Lucy, Finn and the makers doing with their Super Duper Toy? (Pretty well, but Mr. Eville is trying to keep them from winning at ToyFest.) Do you think they could use some motivation to keep on making? Let’s show them how it’s done by doing some great work on our toys today. Our innovative ideas might even inspire their designs! |
| Build excitement and give an overview of today’s project | Explain marble runs are pretty good, but they can be even better! |
| Don’t want these toys to just be fun for 5 minutes or today; should be a fun toy to play with for a long time after camp |
| Also should be something they want to keep and show off |
| Will have all day to work on taking play sets to the next level |
| Can add some special features to make toy more fun and interesting to play with for a long time |
| Can decorate the box and ramp pieces to make their toys look exciting |
| At the end of the day they’ll play each other’s marble runs |
| Will want to work hard to make something they’re excited to share |
| Should be able to point out features that make their toys extra fun |

* 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 |
| Today we’re going to focus on being determined. This means we’re going keep working to improve our toy sets to make them even more fun and awesome than they already are. |

## Demo & Discussion

### Fun Additions (10 min)

| Review the goal of making 3 improvements and outline options for how to do this | Must make at least 3 improvements to make marble run more fun to play with; more than 3 is even better! |
| Can add fun sounds |
| Will demo adding bells and bumpy paper for this in a moment |
| Also can invent other ways to make sounds |
| Can add fun special features on and around ramps |
| Will demo ways to add hoops, fringe, and tunnels in a moment |
| Also can invent other ways to add special things to some of their ramps |
| Can add fun decorations |
| Show markers, foam shapes, and star stickers available for this |
| Can redesign/fix anything from previous days to make it work better |

| Demo one sound option of adding small jingle bells to the marble run | Show how to do this by threading a pipe cleaner through a bell |
| Fold and twist the pipe cleaner to keep the bell on |
| Cut the pipe cleaner to size |
Tape the pipe cleaner to a ramp piece

Roll a marble down the ramp piece a few times to show how it makes noise

**Demo another sound option of adding a large bell to the marble run**

Show how to add this by threading a pipe cleaner through the bell
Fold and twist the pipe cleaner to keep the bell on
Cut the pipe cleaner to size
Fold the pipe cleaner in half
Insert the folded pipe cleaner into a pegboard hole near the end of a ramp

Roll a marble to show how to test to make sure the marble hits the bell

Start with a two-fold ramp piece
If necessary, trim the prepared 2 x 5" corrugated paper to fit onto the bottom of the ramp
Attach a strip of corrugated paper with two small pieces of tape; make sure tape is half on the corrugated paper and half on the bottom of the ramp
Can also try with other ramp pieces

Reiterate they can also think of other ways to make sounds other than bells and paper

One option for special ramp additions is a pipe cleaner hoop

Show how to do this by folding the ends of the pipe cleaner in half once or twice to make it thicker

Insert a pipe cleaner into a pegboard hole

Insert the other end into a different pegboard hole

Another special ramp addition is fringe for the ball to go through

Show how to do this by cutting a piece of cellophane into about a 2 x 3" rectangle

Make several lengthwise cuts to form a fringe; make sure not to cut all the way to the top

Cut a pipe cleaner in half, then fold a half-piece in half

Tape the fringe to the pipe cleaner

Cut and attach a second fringe piece

Insert the pipe cleaner into a pegboard hole above a ramp piece
Roll a marble down the ramp with the fringe to show how the marble swishes through it; super fun!

**Demo another ramp addition**

**Option of cutting cups to create tunnels or hoops**

Use scissors to cut the bottom of the cup off; now it’s a tunnel.

Can be hole punched and used as an individual piece; can also be taped onto an existing ramp.

Cut the cup in half; now it’s a hoop.

Can also be hole punched and used as its own piece or taped onto an existing ramp.
Show a cup can also be added with a plastic peg at the bottom of the marble run to catch the marble

Reiterate these are just some options; they are free to come up with any ramp features they want using the available materials

★ Introduce the opportunity to practice BEING DETERMINED when redesigning the marble run

Give examples of not being determined; pretend to have this attitude
- Ex: Some of those ideas sound fun, but I don’t feel like adding anything else. My marble run is good enough. I’m just going to leave it.
- Ask: Will this attitude help us innovate and help us make our marble runs the best toys possible? (No!)

Remind that what will help is using their powers of determination
- They’ll know their powers are on if they’re working on ways to make their marble runs even better than they already are
- Pretend to turn on your determined powers

Model what it sounds like to be determined
- Ex: My marble run is working, but I know if I put more effort into it I can make it even more fun. I’m going to fix some ramps and add some new features so that it can be the best toy ever!

Challenge campers to use powers of being determined by doing everything they can to make their marble runs as fun as possible

Have campers turn on their powers of determination
## Independent Work Time
### Finishing the Marble Run Play Set (30 min)

<table>
<thead>
<tr>
<th>What campers will do: Add new features and/or decorate to make the play set more fun</th>
<th>CREATE</th>
</tr>
</thead>
</table>
| | 1. Make at least 3 improvements to the marble run. This can include:  
   • Fixing previous pieces or arrangements to make them work better  
   • Adding bells and/or corrugated paper to make fun noises  
   • Adding pipe cleaner hoops, cellophane fringe, and/or paper cup tunnels for the ball to go through  
   • Adding other features using the available materials  
   • Decorating the marble run using markers, foam shapes, and/or stickers to make it look more fun and exciting |
| | TEST, EVALUATE & REDESIGN |
| | 2. Like yesterday, tinker with the ramp pieces themselves, or the position of pieces as necessary. |

<table>
<thead>
<tr>
<th>Facilitate CREATE</th>
<th>This part of the activity is very open-ended and straightforward; use this time to focus on helping campers who are behind.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Remind campers to fold the ends of the pipe cleaners so they fit better into the pegboard holes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Facilitate TEST, EVALUATE &amp; REDESIGN</th>
<th>Remind campers to continue to test regularly to make sure new additions don’t interfere with the ball traveling down the path.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Like yesterday, help campers troubleshoot, telling them where/why the marble is falling if they can’t figure it out</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>★ Support BEING DETERMINED</th>
<th>Use the fact they’ll be sharing their toys later as motivation to make it as fun as possible, not just for themselves, but for another person.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Encourage uninspired campers to start small with just one small change/addition</td>
</tr>
<tr>
<td></td>
<td>Invite campers to look at what others are trying for some inspiration; also call out cool additions you see campers making to inspire others to try them out</td>
</tr>
</tbody>
</table>
| | Recognize determined campers; be specific about how they are being determined  
  • Ex: Wow! Look how hard you’re working on adding all those tunnels, and I even see you’ve added some fringe to a few! Way to be determined! |
| | Ask guiding questions that support being determined:  
  • What would make your marble run even more fun to use/look at?  
  • How can you adjust something to make your pieces/arrangement work even better?  
  • What do you notice about other marble runs that look fun? |

<table>
<thead>
<tr>
<th>Transition to the upcoming Guided Activity</th>
<th>Give 5, 3, and 1 minute warnings about stopping to share runs</th>
</tr>
</thead>
</table>
| | Have TL help organize the marble runs for sharing  
  • If campers are working on the floor, have everyone line up the marble runs against the walls |
Guided Activity
Share the Marble Runs (10 min)

Support SHARING by discussing its importance
Announce getting to show off all their hard work by sharing their toys!
Feels good to share after so much hard work
Also a good way for innovators to stay inspired to keep working on something or to start a new project!

Review the process for sharing their marble run play sets
Explain they’ll find a sharing partner and quickly share one or two features they worked on today to make their toys extra special/more fun than before
Then they’ll visit the person’s marble run and play with it to test it out!
  • Won’t rearrange any pieces; just roll marbles down the run
When they hear the “back to the floor” signal they’ll return to the center to get a new partner
  • Practice this signal now so the transition is easy

Have campers pair up, share about special features, and play with each other’s toys
Remind campers to share about one or two features they’re excited about before they move to projects
Give the signal after 2-3 minutes
Have campers pair up with a new partner and repeat
  ➤ Have TL help campers partner up as quickly as possible
Repeat until clean up time

Clean Up (5 min)
Clean Up
Have campers return any unused materials to the materials station
You can stack marble run boxes just like previous days
  • Store the marble run boxes as efficiently as possible; you will need some space to store the spin art machines from Days 4-5

Lesson Wrap Up (10 min)
★ Summarize the importance of BEING DETERMINED and have campers recall if/how they practiced this today
Recognize everyone for creating such fun marble run play sets!
Highlight effect of practicing Mindset during today’s project
  • Ex: Our marble runs were pretty good by the end of yesterday, but now they are even more fun and awesome-looking because you made a determined effort to improve them!
Have campers flex their muscles if they practiced being determined today by:
  • Making the effort to make at least 3 new improvements
Making more than 3 improvements
• Working hard the whole time instead of wanting to be “done”

Point out they can keep being determined to keep working on play sets at home
• Innovators know their work is never done; everything can always be better!
• Ask campers how they might keep building things for their marble sets at home

Review why determination is important for innovation
• Ex: When we use our powers of determination to keep putting in effort we can turn a good project into a great one!

★ Invite campers to recognize each other for BEING DETERMINED

Can recognize teammates they saw being determined or who helped them be more determined
Encourage specificity about how person was determined
You and TL can recognize campers as well
**Get Ready!**

**Lesson Materials**

**General/Adhesives/Tools**
- tape, masking, 1" (20" per camper)
- scissors, medium, 5", pointed (1 per camper)
- marker, washable, asst. color, set of 8, *for decorating* (3 per classroom)
- marker, washable, metallic, asst. colors, set of 6, *for decorating* (2 per classroom)

**Camper Choice Materials**
(Campers will choose some of these materials, but not all of them. You have not been supplied with enough choice materials for every camper to use each option. Choice materials are supplied for variety under the assumption that not every camper will choose every material.)
- bells, jingle, silver, 3/8" (2 per camper)
- bell, silver, 1" (1 per camper)
- paper, corrugated, asst. colors, 10 x 14" (two 5 x 2" pieces per camper)
- pipe cleaner, asst. colors, 12" (3 per camper)
- cellophane, asst. colors, 8.5 x 11" (1 per 4 campers)
- cup, paper, 3 oz. (1 per camper)
- foam, geometric shape, asst. colors, sticky back (5 per camper)
- sticker, star, metallic, 440 pk. (1 pack per theme)

**Materials Preparation**

Use the paper cutter to cut corrugated paper into 5x2" pieces. Make sure it’s cut with the corrugations going across the 2" width so the marble will make noise as it rolls down it (as pictured).

**Advance Materials Preparation**

Start prepping the wires for Day 4 (see details in the Day 4 prep). This prep is intensive and it’s recommended that you start now.
Setting Up the Space

Set up a materials station with all of the choice materials. Label how many of each material campers are able to take.

- paper, corrugated, asst. colors, cut into 5 x 2" pieces (2 per camper)
- cup, paper, 3 oz. (1 per camper)
- bells, jingle, silver, 3/8" (2 per camper)
- bell, silver, 1" (1 per camper)
- pipe cleaner, asst. colors, 12" (3 per camper)
- cellophane, asst. colors, 8.5 x 11" (1 per 4 campers)
- foam, geometric shape, asst. colors, sticky back (5 per camper)
- sticker, star, metallic, 440 pk. (1 pack per theme)

Gather materials for the Demo & Discussion:
- a sample of each choice material
- a sample two-fold ramp
- scissors
- tape

On the Board

Design Challenge
Make at least 3 improvements that make the marble run more fun.

Mindset of the Day
BE DETERMINED – I know that innovation and mastery require effort.

Check In With Your TL

➤ Make sure your TLs are clear about their role in helping today's lesson run smoothly. Specific things your TL can help with today:
  - Help set up for and facilitate the group share
The first spin art machine was introduced in the 1960s and was called “The Painting Machine.” It was first used in museums and galleries but is now a common toy.

**Today: Building the Spin Art Machine**
Campers build a simple circuit to power a motor that spins a cardboard circle. They use their machines by drawing on the circle as it spins.

**What’s Next**
Tomorrow (Day 5) campers use their spin art machines to experiment with a variety of optical illusion designs.
Today’s Project: At-A-Glance

Construct a basic circuit

Campers will practice wire twisting by twisting together pipe cleaners before making circuits.

Attach the propeller onto a disk and connect it to a motor

Campers will use three glue dots to adhere propeller to disk
Attach circuit components onto a cardboard base.

Use the machine!
Teaching the Lesson: Overview

OUR SECRET SAUCE: THE G.I.A.

KNOWLEDGE FOCUS

CONCEPTS AND FACTS: Circuits and Electricity
Campers learn the basics of how electricity travels through a circuit to power a component.

Why? – Understanding this will help give campers context for each of the steps you’ll be guiding them through and will help them understand the importance of strong connections. In addition, this knowledge lays a foundation for taking on other, more complex electronics projects in the future.

SKILLS AND TECHNIQUES: Wire Twisting
Campers learn how to twist wires by twisting pipe cleaners together.

Why? – Campers will need tightly twisted wires in order to create successful circuits. However, Stars are still developing their motor skills and so working with wires, a thin and flexible material, can be challenging. Offering them an opportunity to practice twisting with pipe cleaners first will make it easier for them to complete real circuits independently and correctly.

MINDSET FOCUS

BE DETERMINED – I know that innovation and mastery require effort.
Campers are committed to completing each step carefully, including double-checking each connection for security and safety and redoing something if necessary to get it just right.

Why? – Creating successful circuits involves care, precision, and fine motor skills like twisting that can be hard for Stars. Yet, campers may be tempted to rush through these steps so they can play with their machines. Today’s Mindset ensures campers put in the initial effort required to create a well-made circuit, even though they won’t get to enjoy the fruits of their labor until the end of the day.

Remember to include these special ingredients to transform today’s project into a Galileo, innovation-based lesson. Bam!
# Lesson Breakdown & Camper Goals

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td>5 min</td>
</tr>
<tr>
<td><strong>Guided Activity: Electricity and Circuits</strong></td>
<td>15 min</td>
</tr>
<tr>
<td>☐ Facilitate the Human Circuit Game</td>
<td></td>
</tr>
<tr>
<td>☐ Introduce concepts of wires, batteries, motors, and buttons during the game</td>
<td></td>
</tr>
<tr>
<td><strong>Guided Activity: Twisting Practice</strong></td>
<td>5 min</td>
</tr>
<tr>
<td>☐ Practice twisting wires with pipe cleaners</td>
<td></td>
</tr>
<tr>
<td><strong>Guided Activity: Circuit and Machine Construction</strong></td>
<td>30 min</td>
</tr>
<tr>
<td>☐ Facilitate connecting the battery, motor, and button</td>
<td></td>
</tr>
<tr>
<td>☐ Introduce short circuits and safety</td>
<td></td>
</tr>
<tr>
<td>☐ Facilitate insulating wires with masking tape</td>
<td></td>
</tr>
<tr>
<td>☐ Facilitate adding the spinning disk to the motor</td>
<td></td>
</tr>
<tr>
<td>☐ Facilitate attaching the circuit onto the cardboard base</td>
<td></td>
</tr>
<tr>
<td>☐ Facilitate drawing with spin art machines</td>
<td></td>
</tr>
<tr>
<td><strong>Clean Up</strong></td>
<td>5 min</td>
</tr>
<tr>
<td><strong>Wrap Up</strong></td>
<td>10 min</td>
</tr>
</tbody>
</table>

## Timing Notes

Campers are on track so long as they have a working circuit with a spinning cardboard surface.

If campers or groups are behind
- Reduce the time playing the Human Circuit Game, but make sure all key concepts are still included.
- Have campers already done with their circuits help others.

If campers or groups are ahead
- Spend more time drawing spin art circles.
Teaching the Lesson: Play-by-Play

Introduction (5 min)

- **Give context for today’s project: Introduce spin art machines**
  - Ask: *Who has heard of or ever done any spin art?*
  - Show Spin Art Example color copy
  - Spin art uses machines to spin and fling color
    - First spin art machine was called “The Painting Machine”; a machine for anybody to be a painter
    - Spin art originally was used in museums and galleries, but today it’s a common toy!

- **Build excitement and give an overview of today’s project**
  - Demo your spin art machine (prepped ahead of time)
    - Show how it spins when you push the button; ohhh...ahhh!
    - Draw on a paper disk as it spins and show the resulting spin art circle
  - Inform that today will be focused on building the spin art machine itself
  - Tomorrow they’ll have more time to experiment with different spinning designs

- **★ 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
    - *Today we’re going to focus on being determined! We’re going to take our time and double-check our work so we can be sure we do our best job on every single step.*

Guided Activity

**Electricity and Circuits (15 min)**

- **Introduce circuits and the need to create a circuit to power the spin art machine**
  - Ask: *Can you guess how this spin art machine works? What makes it spin? Where does the electricity come from? How does electricity get to the motor?*
    - Electricity travels from the battery, through wires, to motor, and back to battery
    - This loop/path is called a circuit
  - Ask: *Can you see the electricity that moves through the wires when I turn it on?*
    - No! But you’ll play a game to help them understand how it works
    - Will help them understand how their own circuits work
<table>
<thead>
<tr>
<th><strong>Have campers get into position and assign roles for the Human Circuit Game</strong></th>
<th><strong>Introduce the rules of the Human Circuit Game</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrange campers in a tight circle with their knees touching</td>
<td>Announce that the foam balls are electricity</td>
</tr>
<tr>
<td>Designate one camper to be the spinning motor</td>
<td>Must pass balls by placing them in the hand of person next to them</td>
</tr>
<tr>
<td>Inform campers that your TL is the battery</td>
<td>• Can only pass balls in one direction (to the right)</td>
</tr>
<tr>
<td>Make sure that the spinning motor and battery are sitting on opposite sides of the circle</td>
<td>• Can only pass ball if they’re touching knees with the person next to them; if not must hold ball in lap</td>
</tr>
<tr>
<td>Inform campers that everybody else is a wire</td>
<td>• Can only pass ball if neighbor doesn’t have a ball yet; otherwise must hold ball in lap</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Start the Human Circuit Game</strong></th>
<th><strong>Introduce what happens when wires are not connected by having some campers step out of the circle</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Give the battery the foam balls</td>
<td>Call out a few campers’ names and have them step out of the circle</td>
</tr>
<tr>
<td>Have battery pass balls one by one to the camper to the right</td>
<td>Review campers can’t pass balls if they’re not touching knees with a neighbor or if neighbor already has a ball</td>
</tr>
<tr>
<td>• Encourage campers to maintain a steady pace in passing balls</td>
<td>Play again; as balls get to gaps in human circuit all balls will stop</td>
</tr>
<tr>
<td>Have campers pass balls for 30 seconds or so; make sure there is a continuous flow of balls and whirling by motor</td>
<td>Ask: <em>What happens to the electricity? Why?</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Introduce the purpose of a button</strong></th>
<th><strong>Right now you’re turning the motor off and on by disconnecting and reconnecting parts of the wire</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Right now you’re turning the motor off and on by disconnecting and reconnecting parts of the wire</td>
<td>Point out this would not be very efficient in real life</td>
</tr>
<tr>
<td>Point out this would not be very efficient in real life</td>
<td>• Imagine cutting wires apart every time you wanted to turn a light off and twisting them back together when you wanted to turn it back on</td>
</tr>
</tbody>
</table>
Show the button they’ll be using to easily turn their motors off and on

Ask campers: *What happens when a button is added to part of the circuit?*
  - When button is up, that part of the circuit is not connected (no electricity gets to motor)
  - When button is down that part of the circuit is connected (electricity gets to motor)

Assign one camper to be the human button and introduce rules for the button

Have the button stand so s/he is not touching knees with anybody in the circle and say “off”

Ask campers: *What happens when the button is standing?*
  - This means the circuit is not complete
  - Remind that if the circuit is not complete, electricity stops flowing (everyone places balls in their laps)

When the button is ready, s/he will sit to complete the circuit and say “on”
  - Everybody then will unfreeze and continue to pass the balls

The button can sit down or stand up at any time

Play a few rounds of the Human Circuit Game with the button

Before restarting the game, remind campers to pass, not toss the balls

Feel free to assign different campers to be the motor or button to ensure everybody gets a chance to participate

Remind the button to say “off”/“on” when standing/sitting

Debrief the game by reviewing what each of the electrical components (wires, battery, motor, button) do

Announce game has ended and instruct them to pass balls to TL

Show that when you press down on the button on your prepped circuit, it activates the motor just like in the Human Circuit Game

Go through each component and have campers share what it does
  - The Wires: Transfer electricity; connect all components (battery to motor, motor to button, button to battery)
  - The Battery: Stores/dispenses electricity
  - The Motor: Uses electricity, spins
  - The Button: Turns flow of electricity on and off

Guided Activity

**Twisting Practice (5 min)**

Pass out pipe cleaners and introduce wire twisting practice

Campers can stay in a loose circle for this activity

Inform that before they start working with their real wires, they’ll practice by twisting pipe cleaners together
  - Twisting small wires can be hard; starting with bigger pipe cleaners is good warm up/practice
  - Good to practice because if real wires aren’t twisted tightly the electricity won’t flow through

Provide each camper 1 black pipe cleaner and 1 red pipe cleaner, making sure you have a set as well

➤ Have TL help pass out pipe cleaners; one red and one black per camper
**Demo twisting pipe cleaners and introduce the opportunity to practice BEING DETERMINED when practicing twisting**

Give examples of not being determined; pretend to have this attitude
- Ex: *I don’t care about this step. I’m just going to rush through it.* (Sloppily twist pipe cleaners, then lightly tug at them so they fall apart)
  
  *Hmm...they came apart, but I don’t want to redo it. This is just practice anyway so it doesn’t matter.*
- Ask: *Will this attitude help us create circuits that work well? (No!)*

Remind that what will help is using their powers of determination
- They’ll know their powers are on if they’re making sure their twisting technique is good
- Pretend to turn on your powers of determination

Model what it sounds/looks like to be determined
- Ex: *I’m going to work carefully and do a good job even though this is just practice. And if my pipe cleaners come apart when I test them I’m going to try again to make sure I have my technique down for the real deal.*
- Verbalize how you are carefully doing each step: create an X, hold it at the middle with one hand, use your other hand to twist

- Show how to test the connection by tugging the ends of each pipe cleaner lightly
• Emphasize if it breaks apart it’s fine and they can be determined to try again; good twisting takes practice

★ Support BEING DETERMINED while campers twist pipe cleaners together

Instruct campers to make two tight twists and test
- Point out once done with two twists, go to TL or LI to check
- If camper work is checked, can go to workstations but should not start

Have campers start twisting their pipe cleaners together

Recognize determined campers; be specific about how they were determined:
- Ex: I noticed your first connection came loose and you’re redoing it with tighter twists. Way to be determined! That extra practice will set you up for success when we use real wires in a bit.

Collect practice pipe cleaners
- Test camper connections
- Have campers move to workstations if twists are secure

Guided Activity
Circuit and Machine Construction (30 min)

★ Support BEING DETERMINED

Have campers follow along to twist the wires together to create a circuit

Ask: How can we be determined/put in effort while we twist our real wires?
- Twist wires slowly and with care
- Double-check to see if the connection is secure by tugging gently
- Re-twist if the connection is loose

Demo and have campers connect the red wire from the battery pack to one of the black wires of the button
- Doesn’t matter which one of the black wires you connect to of the button
Demo and have campers connect the other black wire from the button to the red wire of the motor

Demo and have campers connect the black wire from the motor to black wire of the battery pack

Remind campers to test their connections; ask campers to do so if their connections look loose

➤ Have TL help check camper circuits

Proceed when all campers have secure connections
Introduce the danger of short circuits and the importance of ensuring wires don’t touch one another

Electricity can be dangerous if the circuit isn’t created correctly
If wires that aren’t supposed to be touching, touch each other when the battery is in, it can create a short circuit
Short circuits can makes batteries and wires very hot, with the potential for causing a fire

Discuss how masking tape can be used to insulate the wires

To make sure short circuits don’t happen, they’ll cover or insulate each wire so it can’t accidentally touch another wire it’s not supposed to
They’ll be wrapping wires in masking tape
• Electricity can’t move through masking tape
• If two wires wrapped in masking tape touch nothing will happen as long as no wires are peeking through the tape

Reiterate short circuits are only a danger once batteries are in so an adult will double check all wires are covered before handing out batteries

★ Introduce the opportunity to practice BEING DETERMINED while insulating wires

Demo how to make masking tape sandwiches to insulate their wires

Reiterate the importance of making sure no wire is seen

Give examples of not being determined; pretend to have this attitude
• Ex: I’m just going to speed through this step. It’s okay that all this wire is showing. I bet it’s not going to cause a short circuit. (Tape one connection sloppily)
• Ask: Will this attitude help us create safe circuits that work? (No!)

Model what it looks like to be determined
• Ex: I’m going to double-check my taping. Oh! I still see some wires poking through! I can’t have that! I’m going to add more tape, and this time I’m going to be super careful to cover up those holes!
Have campers insulate their wires with tape

• Point out campers should not be able to see any copper wire, all should be covered with tape

Point out that LI or TL will check circuits and then give campers batteries to test

• Show how to attach batteries by connecting flat end of battery with the spring on the holder
• If camper needs help attaching/removing batteries, ask someone at table
• Keep in mind campers might not be able to read +/- signs on holder

Show how to put in batteries and have campers insert batteries to test and remove one if they're working

Call out that campers will need to remove battery after successful test

• If doesn’t spin, hold machine in the air to get TL/LI attention
• Motor may be hard to notice spinning; lightly press finger against motor to check if you don’t think it spins

Have campers tape each twisted wire connection (3 total)

➤ Have TL help check and test camper circuits; s/he can keep troubleshooting non-working circuits so you can move on once all other campers are ready

• Check if wires are connected or loose
• May need to cut off insulation, re-strip wire, and redo for camper

Celebrate completed circuits!

• Have campers high-five you/TL and/or a neighbor (also a good wiggle break)

Introduce the opportunity to practice BEING DETERMINED while attaching circuits

Have campers attach the circuit onto the cardboard base

Last assembly step is to attach circuit to board

Give examples of not being determined; pretend to have this attitude

• Ex: I can’t wait to use my spin art machine! I’ll just throw all my circuit components onto my base. Who cares if it’s a messy pile?

Model/discuss what it looks like to be determined

• Lay out components; verbalize making sure button, spinning surface, and batteries are not in the way of each other
• Make sure everything is securely attached with glue dots (use 2 glue dots for battery back and 1 each for button and motor)
• Take time to tape wires with masking tape so they’re neat and flat against the cardboard

Demo how to tape motor on after attaching with glue dots
• Need to stay determined to make sure it’s strongly attached!
• Put a strip of tape on each side of the motor

Call out that once campers are done, to hold cardboard disk in air

Watch out for campers clumping components too close together

Have campers follow along as you attach the propeller to the cardboard disk using glue dots

Place three glue dots, one on each propeller blade, making sure glue dots are attached on the side that doesn’t have the cylinder poking out

Attach the propeller to the cardboard disk by pinching the edge of the circle against the propeller
• Poke the hole out in the cardboard disk if already not done in prep
• Make sure that campers can see the hole in the propeller through the cardboard disk hole; will have to redo if they can’t
• Remind campers to not press the propeller down, but just to pinch the sides to adhere; pushing it down will cause the propeller not to move

Demo and have campers adhere a tape loop onto the spinning surface

Demo and have campers adhere a tape loop onto the spinning surface

Press it down in the center of the spinning surface

Explain a tape loop will keep drawing paper stuck to surface disk as it spins

Demo how to make a tape loop using a 4" strip of blue tape
Demo and have campers draw on the spin art machine while it’s spinning

Celebrate that they've been so determined to put their machines together well; now they can use them!

Allow campers to reinsert the battery
- Remind campers to insert so flat end of battery touches spring coil in the battery pack

Demo drawing on the spin art machine by holding the button down while using a marker to draw
- Emphasize just touching marker gently to surface; pushing too hard can stop/damage the motor
- Emphasize not holding button down for more than 5 seconds otherwise batteries will run out right away
- Encourage experimenting with moving marker slowly as they draw (can create a spiral by starting in center and moving outward!)

Let campers know they can each have 3 circles max
➤ Have TL pass out lunch trays with blank circles, markers, and newsprint envelopes to store created circles

Clean Up (5 min)

<table>
<thead>
<tr>
<th>Clean Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have campers place their circles inside a newsprint envelope and use a paper clip to clip it to the spin art machine base</td>
</tr>
<tr>
<td>Have campers remove one battery from the battery pack as an extra safety precaution</td>
</tr>
<tr>
<td>Make sure campers have their names written on the cardboard bases before storing them</td>
</tr>
<tr>
<td>Have campers help you prep for the next rotation by placing one of each material needed to construct the machine at each seat</td>
</tr>
<tr>
<td>Remove trays with circles and markers to prep for next rotation</td>
</tr>
</tbody>
</table>
## Lesson Wrap Up (10 min)

| Recognize campers for completing their circuits and recap what they learned today | Celebrate the fact that campers have created real electronic spin art machines and will be able to use them tomorrow!  
  | • Hint at using it in a completely different way than today!  
  | Quickly review some of the concepts learned today; ask:  
  | • *What is the loop that electricity travels through called?* (A circuit)  
  | • *What happens if a part of the circuit is not connected?*  
  |
| ★ Summarize the importance of BEING DETERMINED and have campers recall if/how they practiced this today | Highlight the importance of being determined during today’s project  
  | • Ex: *Assembling circuits isn’t easy! You have to be very careful and pay attention to a lot of things. We were determined to put in a lot of careful effort today so we were able to create real, working circuits!*  
  | Have campers flex their determination muscles if they practiced being determined today by:  
  | • Having no copper show when they insulated wires  
  | • Double-checking their work after finishing a step  
  | • Redoing a step if they made a mistake (such as fixing a wire)  
  | Have a few share ways they put in extra effort today to learn something tricky or do something just right  
  | Review why determination is important for innovation  
  | • *When you use your powers of determination to get the job done right you can put together some pretty complex projects!*  
  |
| ★ Invite campers to recognize each other for BEING DETERMINED | Have campers recognize peers they noticed being determined or who helped them be more determined  
  | Encourage specificity about how the camper was determined  
  | You and TL can recognize campers as well |
# Get Ready!

## Lesson Materials

* (starred) materials appear multiple times in this list

### Copies
- copy, color, Spin Art Example (2 per classroom)

### General/Adhesives/Tools
- glue dots, 1/2", *for adhering components to cardboard* (7 per camper)
- tape, masking, 1", *for wire insulation and taping propeller* (8" per camper)
- wire stripper, automatic (1 per classroom)
- marker, washable, asst. color, set of 8, *for coloring spin art disks* (1 per 4 campers)
- paper clips, *for clipping drawn disks to machines* (1 per camper)
- tray, lunch (1 per 4 campers)
- tape, blue, 1", Uline, *for holding paper circles on the spinner* (4" per camper)

### Required Materials
- ball, foam, uncoated, 4", *for Human Circuit Game* (8 per classroom)
- pipe cleaner, black, 12", *for practice twisting* (1 per camper)
- pipe cleaner, red, 12", *for practice twisting* (1 per camper)
- motor (1 per camper)
- holder, battery, 2 AA, w/ leads (1 per camper)
- battery, AA (2 per camper)
- switch, pushbutton, momentary, w/ wire leads (1 per camper)
- cardboard, corrugated, circle, w/ 5/16" hole, 5", *for spinning surface* (1 per camper)
- propeller, 3-blade, flat (1 per camper)
- cardboard, corrugated, 9 x 9", *for base* (1 per camper)
- paper, circles, 5", *for spin art disks* (3 per camper)
- paper, newsprint, 9 x 12" (one 9 x 6" sheet per camper)
**Materials Preparation**

NOTE: Before using the wire strippers, make sure you have read the instructions found in Using Self-Adjusting Wire Strippers in the Notes section below.

1. Strip the ends of wires for all electrical components. Remember this includes the wires of the motor, battery holder, and the button. Wires should be stripped at each end so that there is about 0.5” to 0.75” of exposed wire. Be sure to watch the video on Telescope: Automatic Wire Strippers.

2. Create the final version of the spin art machine for today’s Demo & Discussion. Follow all the instructions in this lesson to create the circuit and attach components onto a cardboard base.

5” cardboard circles will come with holes still attached in the center. Poke out these holes for campers.

Attach a 3-bladed propeller to a motor (each camper will need one set). Make sure that the propeller blades are pointed upwards and that the propeller has only been attached half to ¾ of the way. Pushing a propeller in too much will cause it to not move when used.
Cut newsprint to make envelopes to store spin art circles for this day and the second day of this activity.

- Hold newsprint so it’s wider than taller. Cut newsprint in half to make 9 x 6" sheets. You can cut multiple sheets at a time. Each camper will need one half sheet.
- Fold half sheets using a top to bottom fold. You can fold multiple sheets at a time.

Prepare 7 glue dots per camper. Make sure to have a solution for campers to easily dispose of glue dot backing trash. If you’ve received glue dots in rolls prepare glue dot gardens with strips of 7 glue dots. (See Prep and Materials for the Summer for details.) If you’ve received glue dots in sheets just cut strips of 7 glue dots and place them in a container.

### Setting Up the Space

Set aside the AA batteries (2 per camper) that will be distributed after campers have insulated their wires. For safety reasons these should not be on the tables with the rest of the circuit supplies. An adult must double-check each camper’s circuit for exposed wires before giving him/her batteries.

Set the circuit-building materials at each workstation:

- motor (1 per camper)
- holder, battery, 2 AA, w/ leads (1 per camper)
- switch, pushbutton, momentary, w/ wire leads (1 per camper)
- cardboard, corrugated, circle, w/ 5/16" hole, 5", for spin art disk (2 per camper)
- cardboard, corrugated, 9 x 9", for spin art machine base (1 per camper)
- propeller, 3-blade, flat (1 per camper)
Set aside drawing materials on a lunch tray to be handed out after machines are completed:
- paper, circles, 4”, for spin art disks (3 per camper)
- marker, washable, asst. color, set of 8, for coloring spin art disks (1 per 4 campers)
- prepped newsprint envelopes (1 per camper)

Place the following materials near the front of the room for each of the Guided Activities:
- sample finished spin art machine
- ball, foam, uncoated, 4”, for Human Circuit Game (8 per classroom)
- pipe cleaner, black, 12”, for practice twisting (1 per camper)
- pipe cleaner, red, 12”, for practice twisting (1 per camper)
- a set of circuit-building materials (1 per rotation)

Put up the following color copies on your copies display board
- Spin Art Example

**Notes**

**Suggestions for Large Classes**
Abbreviate the time spent on the Human Circuit game. Teaching circuit construction to a large class can be slower and so it’s important to offer them more time

**Using Self-Adjusting Wire Strippers**
This tool makes stripping wires fast and effortless. To use it, hold a piece of wire inside the wire stripper as shown, then slowly clamp down on it. Continue applying pressure to the trigger until the wire stripper removes the insulation.

Experiment to find the best speed for stripping wires. Pulling the trigger too quickly can cut the wire. Once you get a feel for it, you can try stripping two wires of equal width at once. If the wire is getting cut even when you are pulling the trigger slowly, then try adjusting the metal knob located behind the wire stripper.
On the Board

Mindset of the Day
BE DETERMINED – I know that innovation and mastery require effort.

Check In With Your TL

➤ Make sure your TLs are clear about their role in helping today’s lesson run smoothly. Specific things your TL can help with today:

• Help campers in a general sense with circuit construction; make sure that your TL understands a circuit and feels comfortable constructing one
• Participate in the Human Circuit Game; review the rules with them so they’re clear on their role within the game
Optical illusion toys were popular forms of entertainment during the 19th century, before the age of cinema and television, and are still fun today!

Today campers will experiment with drawing on disks to get three different types of illusions (color blending, appearing rings, and disappearing lines) and then create a final disk design. The final disk must:

- Include elements or ideas from all three of their top three exploration disks
Today’s Project: At-A-Glance

Choose a challenge card

Example of color blending cards (campers will experiment with this effect first)

Example of appearing ring cards (campers will experiment with this effect second)

Example of disappearing line cards (campers will experiment with this effect third)

Experiment to create the effect shown on the card

Dots drawn on disk to try to achieve a ring on the outside as shown on the card

Spin the disk to test

Ring matching the card successfully created
Create final disks that fuse favorite elements from experiments

Example custom illusions that combine color mixing, lines, and dots
Teaching the Lesson: Overview

OUR SECRET SAUCE: THE G.I.A.

KNOWLEDGE FOCUS

CONCEPTS AND FACTS: Persistence of Vision
Campers understand that multiple images can blend into a single image when they are in motion.

Why? – Understanding this will enable campers to achieve specific goals and help them be more strategic in creating designs, resulting in more interesting projects.

PROCESS FOCUS

EVALUATE: Create and Compare
Campers make multiple disk designs according to three types of challenges and evaluate them according to a set of LI prompts. They choose their top three based on what they find most interesting or successful.

Why? – Campers can easily get caught up in the fun of spinning disks without gaining any insights. Providing concrete challenges helps campers experiment purposefully and focuses their attention on key variables. In addition, campers will have created a lot of disks by the end of today’s exploration activity and may not know how to approach synthesizing so much information. Giving campers a structured way to pull out their best discoveries will help them create more successful and exciting final illusions.

MINDSET FOCUS

BE REFLECTIVE – I take time to think about what is and isn’t working in my design.
Campers notice what happens as they test and think about why certain designs do or don’t work well to create a certain effect. They take time to carefully consider which disks they like the best and why.

Why? – This Mindset enables campers to get the most out of today’s exploration and evaluation process and helps ensure they have the insights they need to create their own custom disks.

Remember to include these special ingredients to transform today’s project into a Galileo, innovation-based lesson. Bam!
Lesson Breakdown & Camper Goals

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>5 min</td>
</tr>
<tr>
<td>Demo and Discussion: Spinning Illusions</td>
<td>10 min</td>
</tr>
<tr>
<td>□ Demo and explain color blending</td>
<td></td>
</tr>
<tr>
<td>□ Demo and explain persistence of image (appearing rings)</td>
<td></td>
</tr>
<tr>
<td>□ Demo and explain disappearing lines</td>
<td></td>
</tr>
<tr>
<td>Guided Activity: Spin Art Experiments</td>
<td>15 min</td>
</tr>
<tr>
<td>□ Facilitate creating disks based on color mixing challenge cards (make a secondary color appear using only primary colors)</td>
<td></td>
</tr>
<tr>
<td>□ Facilitate creating disks based on appearing ring challenge cards (make rings appear using only dots/circles)</td>
<td></td>
</tr>
<tr>
<td>□ Facilitate creating disks based on disappearing line challenge cards</td>
<td></td>
</tr>
<tr>
<td>Guided Activity: Top Three Exploration Designs</td>
<td>5 min</td>
</tr>
<tr>
<td>□ Facilitate choosing their top three designs</td>
<td></td>
</tr>
<tr>
<td>□ Discuss ways to combine elements of each for the final disk</td>
<td></td>
</tr>
<tr>
<td>Independent Work Time: Designing Final Illusions</td>
<td>15 min</td>
</tr>
<tr>
<td>□ Create spin art disks that combine all techniques; the disk must</td>
<td></td>
</tr>
<tr>
<td>• Include elements or ideas from all of their top three exploration disks</td>
<td></td>
</tr>
<tr>
<td>Clean Up</td>
<td>5 min</td>
</tr>
<tr>
<td>Wrap Up (includes an extended share)</td>
<td>15 min</td>
</tr>
</tbody>
</table>

Timing Notes

If campers or groups are behind
- During the experimenting activity, share just one working example instead of two for each illusion type.
- Skip the extended share during the Wrap Up.

If campers or groups are ahead
- Have campers create more spin art circles in the same way as yesterday (drawing on the machine while it’s spinning). They can glue these circles to their marble run boxes as decoration.
# Teaching the Lesson: Play-by-Play

## Introduction (5 min)

<table>
<thead>
<tr>
<th>Welcome campers and make a quick story connection</th>
<th>Ex: Are the makers ready for ToyFest today? (Hope so!) We should be sure to be ready, too. Let's finish the week strong by wrapping up our toy engineering and showing everyone at ToyFest what awesome results can come from truly innovative making.</th>
</tr>
</thead>
</table>
| Give context for today’s project: Introduce optical illusions | Inform they’ll be using spin art machines in a different way today
- Yesterday drew on disk while it was spinning
- Today will draw on disk first then spin it
- This will allow them to experiment with creating optical illusions!
Define optical illusions as when our eyes see something that’s not actually physically there
- Ask campers if they’ve ever seen an optical illusion |
| Build excitement and give an overview of today’s project | Demonstrate the Color Blending Disk (prepped ahead of time) as one kind of illusion campers will try to create
- Spin to show an orange circle is created
- Stop the disk to show there’s no orange on it
- It’s an illusion; our eyes are tricked into seeing orange when the disk spins!
Inform campers will experiment with trying to create color illusions and two other kinds of illusions
- Will have to experiment to discover what designs work best for different effects
- May also discover a new kind of illusion/effect they like
Then they’ll choose their best ideas/discoveries and combine them to create a final disk with multiple illusions! |
| ★ 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
- Today we’re going to focus on being reflective! This means noticing what is and isn’t working when we’re trying to make certain illusions, and also thinking about what we like best. This will help us make important discoveries and give us ideas for how to make the coolest final illusions. |
## Demo & Discussion
### Spinning Illusions (10 min)

| Discuss how the color blending illusion works | Announce that the first illusion they’ll experiment with is color blending like what you just showed  

Ask: *Why do you think we saw orange when the disk was spinning?*  
- As the disk spins the colors appear to blur; when colors are next to each other they appear to blur or mix together  
- Yellow and red on the disk appear to mix together and we start to see orange |
| Give directions for the color blending challenge cards | Explain when they get to tables they’ll pick a color blending challenge card and try to make the color that’s down on the card  

Hold up a few color blending cards so campers can see what they look like  

Explain challenge is to try to make that color appear when disk is spinning  
- Color should not be there when disk is stationary  
- Can’t put two colors on top of each other when coloring |
| Introduce variables they’ll need to experiment with to create a color blending illusion | Point out there are lots of ways to get this illusion but not everything will work; will need to experiment with  
- Where they add colors on the disk  
- How much of a color they add  
- Adding different shapes/patterns of color vs. random scribbles  

Show the Color with Shapes Disk (prepped ahead of time) as an example of drawing then coloring in shapes for different effects |
| Demo persistence of vision and discuss how it works to make rings appear | The second illusion they’ll experiment with is called persistence of image (not important for campers to remember this term)  

Demo the Appearing Rings Disk (see materials prep)  
- *Ask: What do you think this disk will look like when I spin it?*  
- Spin the disk to show a solid ring  
- Stop the disk and confirm there is no ring; just some dots |
Explain the idea of persistence of vision

- Human eye and brain hold on to images for a short time even after that image is gone
- Even though the dots are moving from one place to another our eyes and brains still hold on to the image of where they were for a while

Explain how persistence of vision can make a series of images look like one

- When images are shown fast enough it makes it look like separate images are one single complete picture
- The disk is spinning fast enough that our brains see the dots as a complete circle

**Give directions for the appearing ring challenge cards**

Explain when you give instructions they’ll trade in their color blending cards for appearing ring ones

Hold some up so campers can see what they look like

Explain challenge is to make rings using only dots and circles

- No ring should be visible when disk is not spinning
- Rings must appear in the place shown on the card
- Rings must be the color shown on the card

**Introduce variables they’ll need to experiment with to make rings appear**

Where they add dots/circles

How many dots/circles they add

The size of dots/circles they add

**Demonstrate disappearing lines and discuss how it works**

The third and last experiment will be about making things disappear!

Show the Disappearing Lines Disk (see materials prep)

- Ask: *What do you think this will look like when I spin it?*
- Spin the disk
- Point out that the thin line on the outside disappeared completely but thick line in the middle can still be seen
• Explain the part of the line close to the center of the circle is seen by your eye and brain, but the part of the line at the edge isn’t
• Takes more/ thicker marks for your eye and brain to see something the farther from the center you go

Give directions for the appearing ring challenge cards
Explain when you give instructions they’ll trade in their appearing ring cards for disappearing line ones
Hold some up so campers can see what they look like
Explain challenge is to draw lines on the disk that disappear
• Have to draw the number of lines it says on the card
• All the lines have to disappear

Outline variables to experiment with to make lines disappear
Where they add lines/marks
The thickness of lines/marks they add

Guided Activity
Spin Art Experiments (15 min)
Set expectations for the upcoming guided experiments
Recap they’ll do three kinds of experiments then get to make their own custom illusions based on what they discover
Give an overview of how they’ll wrap up exploring one illusion type and move on to the next
• Will do this all together when you give the signal
• Will quickly share some discoveries as a group
• Then one person from their group will collect their cards and trade them in to you or the TL for the next set of cards
Campers will store finished spin art circles in envelopes from yesterday
Emphasize importance of stopping when directed
Practice attention-getter for this now to ease transitions later
• Should involve an action that forces campers to stop drawing/ spinning
• Ex: Call out “Circles up!” and have campers hold their last spin art circles in the air
Review how they’ll experiment using challenge cards

Remind campers they will pick a challenge card at random and try to create that color or pattern

Reiterate unlike yesterday they’ll draw on the disk first before putting it on the machine
- When done drawing they’ll attach disks to machine with blue tape like yesterday to test
- Can take disk off machine and draw more if it’s not working quite right yet/if they want to keep working on the challenge

When successful put the card back and pick a new one so someone else can try that card

Can use up to 3 blank disks per challenge
- Can use a new disk if one is all filled up
- Can also use a new disk if they move on to a new challenge

★ Introduce the opportunity to practice being REFLECTIVE as they test and evaluate their designs

Give examples of not being reflective; pretend to have this attitude
- Ex: My disk doesn’t really make orange like the card says. Oh well. I’m not going to try to figure out why it doesn’t work or think of what else I could try. I’ll just draw randomly and forget about making orange.
- Ask: Will this attitude help us innovate and discover how to create cool illusions? (No!)

Remind that what will help is using their powers of being reflective
- They’ll know their powers are on if they’re trying to make good guesses about why a design is or isn’t working and what they might change to make it work better
- Pretend to turn on your reflective powers

Model what it looks like to be reflective
- Ex: You can kind of see orange in my disk but not that well. I wonder why that is. Well, I notice my colored shapes are kind of far apart and small. That might be the problem. Maybe I’ll try putting more colored shapes closer together.

★ Support BEING REFLECTIVE

Have campers each pick a color challenge card and design disks accordingly

Remind campers to store circles in the newsprint envelopes used yesterday

Make sure campers return cards face down once done with the challenge

Ask guiding questions that support being reflective:
- Where do you notice new colors appearing? What do you notice about your design there?
- What do you notice about how much color you’ve used/where you put your colors?
- What if you add more color/add colors closer together?
- What if you try filling in squares, circles, or triangles of color instead of scribbling?

Use the “Circles up!” attention-getter to get campers to stop their work

Explain before moving on they’ll take time to reflect on what worked
- Important to notice what is working, not just what’s not working
- Will allow them to use these ideas to make color illusions in their final disks if they want

★ Support BEING REFLECTIVE by showing working color blending examples and having campers share what worked best

Support BEING REFLECTIVE!
Have campers share anything they discovered worked well for color blending and other interesting things they noticed/tried; should mention
- Having colors close together works best
- More color/having big blocks of colors is helpful

Have campers gather color cards and have one camper from each table exchange them for ring cards

Direct campers to gather all color blending in a stack
Designate one camper at each workstation as the “runner” to take the color blending cards to the TL and exchange them for the Appearing Ring cards
Remind campers to store spin art circles in envelopes
Campers can start new challenge as soon as cards arrive at table

★ Support BEING REFLECTIVE
Have campers pick appearing ring challenge cards and design disks accordingly

Ask guiding questions that support being reflective:
- Where do you notice rings appearing? What do you notice about your design on that part of your disk?
- What do you notice about where you put dots/what kind of dots you’ve used?
- What if you add more dots? What if you change their location/size/color?

★ Support BEING REFLECTIVE by showing working appearing ring examples and having campers share what worked best

Use the “Circles up!” attention-getter to get campers to stop their work
Announce reflecting again on what worked for making rings
Have campers share anything they discovered worked well for rings and other interesting things they noticed/tried; should mention
- More/bigger dots are needed farther away from the circle
- Dots made from the same distance away from the center will become part of the same ring
- Color blending techniques can be used to make secondary color rings

Have runners exchange their table’s ring cards for disappearing line cards

Have campers gather all cards in one stack
Instruct the runners at each group to bring the stack of cards to the TL to exchange for the disappearing line cards
Remind campers to store spin art circles in envelopes
Campers can start new challenge as soon as cards arrive at table

★ Support BEING REFLECTIVE
Have campers pick disappearing lines challenge cards and design disks accordingly

Ask guiding questions that support being reflective:
- Where do you notice lines disappearing? What do you notice about your design on that part of the disk?
- What if you draw thicker/thinner lines?
- What if you draw lines closer to the middle/edge of the disk?
- What if you draw lines going in a different direction?

★ Support BEING REFLECTIVE by showing working disappearing line examples and having campers share what worked best

Use the “Circles up!” attention-getter to get campers to stop their work
➤ During this short discussion have TL pick up all line cards, keeping them in their respective sets
Announce reflecting again on what worked for making lines disappear

Support BEING REFLECTIVE by showing working disappearing line examples and having campers share what worked best

Have runners exchange their table’s ring cards for disappearing line cards

Have campers gather all cards in one stack
Instruct the runners at each group to bring the stack of cards to the TL to exchange for the disappearing line cards
Remind campers to store spin art circles in envelopes
Campers can start new challenge as soon as cards arrive at table

★ Support BEING REFLECTIVE
Have campers pick disappearing lines challenge cards and design disks accordingly

Ask guiding questions that support being reflective:
- Where do you notice lines disappearing? What do you notice about your design on that part of the disk?
- What if you draw thicker/thinner lines?
- What if you draw lines closer to the middle/edge of the disk?
- What if you draw lines going in a different direction?
Have campers share anything they discovered worked well for disappearing lines and other interesting things they noticed/tried; should mention
- Lines closer to the edge of the circle are more likely to disappear
- Thinner lines are more likely to disappear

Guided Activity

**Top Three Exploration Designs (5 min)**

| ★ Introduce the opportunity to practice being REFLECTIVE as they choose their best designs | Next step is to pick their top three experiment disks so they can combine the best ideas in each to create their final ultimate illusions
Give examples of not being reflective; pretend to have this attitude
- Ex: *I made all of these disks but I’m not going to think about what I did or which ones I really like best. I’m just going to pick some randomly.*
- Ask: *Will this attitude help us innovate and help us come up with the best final illusions possible? (No!)*
Remind that what will help is using their powers of being reflective
- They’ll know their powers are on if they’re observing their disks carefully and thinking about what they liked best and why
- Pretend to turn on your reflective powers
Model what it looks like to be reflective
- Ex: *This was a really good color blending one and I liked that it had colored heart shapes on it! And the disappearing lines was my favorite kind of illusion. This line disk didn’t work so well, but this one did.* |
| ★ Support BEING REFLECTIVE and EVALUATING | Tell campers to put their top three circles on their spin art machines
Ask the following prompts to support evaluating and being reflective:
- *Which illusions did you like the best/have the most fun making?*
- *Which disks are the best examples of that illusion-worked the best?*
- *Did any disks have a surprising/new effect you liked (different from the three we were experimenting with)?*
- *Did any disks have a cool element (like a shape or pattern) you liked?*
Discuss possible ways to combine elements of each style for the final illusion
Reiterate ideas from all three disks they picked should be included in final illusion in some way
Can redo a very specific thing from a disk like a pattern or shape
- Ex: *Combine a dot arrangement from one disk and a series of colored triangles from another on the final disk*
Can include the same type of illusion on the disk without recopying exactly how they did it on the experiment disk
- Ex: *Use the same technique/coloring pattern they used to make green but make purple instead*
A lot of room for how to incorporate all three disks, but campers should be able to say at least one idea they got from each disk
Have campers make a plan for their final disks
Have campers take a moment to think about one idea they’re going to include from each disk
Have a few share one idea they’re going to include from one disk |
**Review steps for creating and finishing their final disks**
Inform campers can use up to 3 blank disks for their final illusions
- Can make multiple versions of the same idea if the first tries aren’t exactly what they were hoping
- Can make a few different illusions combining different ideas from their three experiments in different ways
Instruct campers to show their final illusions to you or TL when they’re done and you’ll give them other options to work on if they’re done early

**Independent Work Time**

**Designing Final Illusions (15 min)**

<table>
<thead>
<tr>
<th>What campers will do: Combine their best ideas to create a final illusion</th>
<th>CREATE, EVALUATE &amp; REDESIGN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Create a spin art disk that fuses attributes of previous experiments.</td>
<td></td>
</tr>
<tr>
<td>2. Redesign the disk if needed so that it fits the goal or create additional illusions that combine experiment disks in different ways.</td>
<td></td>
</tr>
</tbody>
</table>

**Extension**
Create spin art circles to attach onto the marble run game by drawing on the machine while it’s spinning, and gluing the circles to the game.

**Facilitate CREATE, EVALUATE & REDESIGN**
Ask campers about their plans and which ideas they’re using from each experiment; help campers create a vision as necessary
Encourage campers to ask other campers if they can guess what techniques they used in the spin art disk while it spins

**Facilitate Extension**
Be sure to talk to campers about their final illusions to make sure they’ve spent some time thinking about them/designing meaningfully
If they have, hand out glue sticks and have them make new spin art disks to glue to marble run box as decorations

**Clean Up (5 min)**

<table>
<thead>
<tr>
<th>Clean Up</th>
<th>Have campers put aside a final disk to share in a moment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have campers store circles in the newsprint envelopes and use a paper clip to clip the envelope to the spin art machine base</td>
<td></td>
</tr>
<tr>
<td>➤ Have TL put color blending challenge cards back on tables for next rotation</td>
<td></td>
</tr>
</tbody>
</table>
### Lesson Wrap Up (15 min)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Instructions</th>
</tr>
</thead>
</table>
| Have campers take turns sharing their spin art masterpieces in their work groups | Announce sharing final illusions with a neighbor; campers should stay where they are for ease of facilitation  
➤ Have TL partner with a camper if you have an odd number  
Instruct each person will tell partner about illusions/effects they were trying to create then demo final disk on the spin art machine  
Have pairs pick who will share first and have them start  
Have pairs switch after a minute or two |
| ✪ Summarize the importance of BEING REFLECTIVE and have campers recall if/how they practiced this today | Use the “Circles up” attention-getter and get campers to raise their spin art circles in the air  
Recognize how different and diverse everybody’s circles are!  
Highlight effect of practicing Mindset during today’s project  
  • Ex: *One thing that helped us invent such interesting illusions that really work was using our powers of reflection.*  
Have campers hold their spin art circles in the air if they practiced being reflective today by:  
  • Trying to make a good guess about why a design wasn’t working if they couldn’t match the effect on one of the challenge cards  
  • Thinking about what else they could try if a design wasn’t working  
  • Noticing what worked well to get a specific effect  
  • Thinking about what they liked best/what worked best  
Have campers popcorn-share some awesome/interesting/useful discoveries they made by reflecting on their designs  
Review why reflection is important for innovation  
  • Ex: *When you use your powers of reflection you can make valuable discoveries that help you get new ideas and create projects that work just the way you want!* |
| ✪ Invite campers to recognize each other for BEING REFLECTIVE | Have campers recognize teammates they saw being reflective or who helped them be more reflective  
Encourage specificity about how person was reflective  
You and TL can recognize campers as well |
# Get Ready!

## Lesson Materials

* (starred) materials appear multiple times in this list

### Copies

- copy, color, Spin Art Example (2 per classroom)

### General/Adhesives/Tools

- glue stick, washable, for adhering spin art to marble run as extension (1 per 4 campers)
- marker, washable, asst. color, set of 8, for coloring spin art disks (1 per camper)
- tape, masking, 1" (4 per camper)

### Required Materials

- paper, circles, 4", for drawing illusions (12 per camper)
- challenge cards (1 set per 4 campers)

## Materials Preparation

Create example spin art disks to be used in the Demo & Discussion; replicate the following:

**Color Blending Disk**

![Color Blending Disk](image-url)
Color with Shapes Disk

Appearing Ring Disk

Disappearing Lines Disk
Advance Materials Preparation

Preview the Materials Prep for the Week Ahead (at the start of each theme), especially Monday’s prep, which needs to be completed by the end of the day Friday.

Review the essential resources for your upcoming theme in your Telescope Library and complete any tasks prescribed there including highlighting key points in lessons, creating samples, and/or watching videos. If this is your second time teaching the theme make sure to check the curriculum updates section even if you’ve already looked at the other resources previously.

Setting Up the Space

Set out the drawing materials for the Guided Activity: Spin Art Experiments.
- 4” paper circle (6 per camper)
- markers, asst. colors (1 set per 4 campers)

Gather materials for the Demo & Discussion:
- Your spin art machine from yesterday (check that it works fine)
- Color Blending Disk example
- Colors with Shapes example
- Appearing Ring Disk example
- Disappearing Lines example

Put up the following color copies on your copies display board
- Spin Art Example

On the Board

Design Challenge
The final disk must:
- Include elements or ideas from all three of their top three exploration disks

Mindset of the Day
BE REFLECTIVE – I take time to think about what is and isn't working in my design.

Order of Today’s Activity
- Experiment 1: Color Blending
- Experiment 2: Appearing Rings
- Experiment 3: Disappearing Lines
- Compare and choose your top 3 experiments
- Create your final illusion!

Check In With Your TL

➤ Make sure your TLs are clear about their role in helping today’s lesson run smoothly. Specific things your TL can help with today:
- Help facilitate campers with Challenge Cards, such as helping to explain the cards and ensuring that campers share
- Help campers exchange Challenge Cards in between experiments; a camper will be designated as the runner who will bring a set of cards to exchange for the next set