Solving Problems Wherever We Go

A LEGO® Education Program
Advanced SPIKE™ Essential

Solving Problems Wherever We Go

LEGO® Education SPIKE™ Essential Advanced Program
5 days

Program Overview:
This 5-day camp outline will provide students with STEAM-focused, hands-on activities to promote 21st-century skills and social and emotional learning, as well as review math, language arts, and science concepts. Each day, students will participate in team building activities and opportunities for physical activity, as well as receive a team briefing for challenges aligned to standards. Daily challenges will help students develop skills and knowledge to complete the culminating project of solving the problems that arise when designing, testing, and presenting games.

	Big Questions	Daily Activities
Day 1	**Welcome and Orientation** • How do engineers design solutions to problems to make the world better? • What are some problems people might have when they try to explore and learn about their world? • How do people solve these problems, like getting to new places?	**Meet the Team: Minifigure Bios (Leo)** **Taxi! Taxi!**
Day 2	**What About My Stuff?** • How do engineers define problems to make them easier to solve? • What are the criteria and the constraints for solving problems? • What are some problems people might have when they try to bring things to a new place?	**Meet the Team: Minifigure Bios (Daniel)** **Big Little Helper**
Day 3	**Problems Are Natural!** • How can engineers use investigations to test solutions to problems? • How can they decide if their design solution works? • What are some problems people might have when they explore nature? What if they want to improve the environment?	**Meet the Team: Minifigure Bios (Sofie)** **Swamp Boat** **Trash Monster Machine**

Day 4	**Problems Are Fun!** • How can engineers identify more than one solution to a problem? • How do they decide which solution is best? • What are some problems people might have when they make or play games?	**Avoid the Edge**
Day 5	**Everyone Can Solve Problems** • How is designing solutions the same, whether the problem is going places, exploring the environment, or making a fun game? • How do people create new solution ideas and present them to others?	**Junior Pinball** Carnival Games Showcase

Prior to First Day of the Program:
(If the Advanced Camp follows the Introductory Camp, checking the sets and devices may be the only thing needed.)

1. Sort the LEGO® Education SPIKE™ Essential sets.
2. Go through the introduction to SPIKE Essential: https://education.lego.com/en-us/start/spike-essential#Introduction
3. Download and install the LEGO® Education SPIKE™ App on devices to be used for camp.
4. Determine a naming convention for each set and label each lid and inventory sheet. Suggestions include adding school initials and a number (Example: Millcreek Elementary set names could be MES1, MES2, and MES3.).
5. If you will not be using the cables, charge the SPIKE Essential hubs. You will need to charge the hub each day after use if they are Bluetooth-connected during the day.
6. Connect SPIKE Essential to iPad, Chromebook, or computer. Update the hub and rename each hub to match the name you assigned to the set.
7. Locate the building instructions in the SPIKE App, embedded both in the individual lessons and separately under Home>Building Instructions. If you wish to share printed building instructions, create one set per student pair for the lessons referenced in each day's Outline.
8. Gather any consumable materials (listed below) needed for the week.
9. Locate student journal ideas. Ideas for types of journals can be found online. You may want to consider engineering design journals, which contain structures commonly used in the engineering design process students will use during camp.
10. Print team logo templates to share with students.
11. Make sure devices are fully charged, Bluetooth is enabled (if needed), and that students can access the app.

12. Determine the procedure for when a LEGO® piece is dropped (e.g., “Everyone freeze; say LEGO down/LEGO found”) and where to place LEGO pieces found that do not belong to the finder.
13. While teams are working, assign each group a LEGO® Education SPIKE™ Essential set to use for the week.
14. Preview this course document. In particular:
    - Read the Big Questions for each day. Use them to understand each day’s content and to prepare for sharing each day’s final question with students.
    - Locate and read the referenced lessons in the LEGO® Education SPIKE™ App and on legoeducation.com/lessons. Read the Meet the Team: Minifigure Bios found in each lesson plan under Teacher Support>Additional Resources and consider how/when to reference them during the day.

Materials:

- SPIKE Essential sets
- Devices with SPIKE App
- Chart paper
- Student journals (could be paper stapled together, with students creating the outside of the journal using construction paper and other consumable materials)
- Pens
- Pencils
- Markers
- Sticky notes
- Timer/clock
- Tape
- Team logo templates
- Scissors
- Rulers/measuring tapes
- Paper
- Colored pencils
- Group Rules chart (created on Day 1)
- Children’s books or journal articles about
    - engineered solutions or inventions
    - design improvements
    - forces and motion
    - litter, pollution, or human impact on environment
- Craft materials, including construction paper
- Tape
- Folders (to use to hide small objects from view on Day 4)
- Certificates of Completion

Solving Problems Wherever We Go Day 1

Welcome and Orientation/Taxi! Taxi!

Big Questions:

- How do engineers design solutions to problems to make the world better?
- **To share with students:**
  - What are some problems people might have when they try to explore and learn about their world?
  - How do people solve these problems, like getting to new places?

Materials needed for the day:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Meet the Team: Minifigure Bios (under Teacher Support>Additional Resources in all lesson plans)
- Taxi! Taxi! lesson (Happy Traveler unit)
- Building instructions for Taxi! Taxi!
- Chart paper
- Student journals
- Pens
- Pencils
- Markers
- Sticky notes
- Tape
- Team logo templates
- Scissors
- Rulers/measuring tapes
- Paper
- Colored pencils
- Craft materials (including construction paper)
- Articles or books about engineered solutions or inventions

Day 1: Outline for the Day

Outline of Day	Tasks	Time	Materials
9:00 - 10:30	Introductions	30 min	• SPIKE Essential sets
	Establishing group rules and expectations	15 min	• Chart paper • Markers

			• Pens
	Team Building Activity	15 min	• LEGO® Education SPIKE™ Essential sets
	Team Briefing 1	5 min	• None
	Partner selection, team name and team logo	25 min	• Varies, based on the activity selected • Team logo templates • Markers • Pencils • Scissors • Construction paper • Other craft materials
10:30 - 10:35	Break		
10:35 - 11:25	Workplace Wellness (physical activity)	10 min	• Varies, based on the activity selected
	Design a journal for record keeping	20 min	• Student journals • Markers • Scissors • Construction paper • Other craft materials
	Reading and wondering about ways that engineers and inventors solve problems	20 min	• Articles or books about engineered solutions or inventions • Student journals
11:25	Get ready for lunch		
11:30 - 12:00	Lunch		
12:00 - 2:10	Team Briefing 2	10 minutes	• Meet the Team: Minifigure Bios (under Teacher Support>Additional

			Resources in each lesson plan)
	Challenge 1: Taxi! Taxi!—Drive the Taxi (through lesson Step 7)	30 min	• Student journals • LEGO® Education SPIKE™ Essential sets • Devices with LEGO® Education SPIKE™ App • Taxi! Taxi! lesson • Building instructions for Taxi! Taxi!
	Challenge 2: Taxi! Taxi—Follow that Map! (through lesson Step 8)	20 min	• Student journals • SPIKE Essential sets • Devices with SPIKE App • Taxi! Taxi! lesson • Building instructions for Taxi! Taxi! • Chart paper • Markers • Tape
	Break	5 min	• None
	Workplace Wellness (physical activity)	10 min	• Varies, based on the activity selected
	Team Briefing 3	5 min	• None
	Challenge 3: Taxi! Taxi!—A New Route (through lesson Step 9)	15 min	• Student journals • SPIKE Essential Sets • Devices with SPIKE App • Taxi! Taxi! lesson • Building instructions for Taxi! Taxi! • Chart-paper map from Challenge 2 • Markers • Tape

	Team Briefing 4	10 min	• None
	Challenge 4: Taxi! Taxi!—Map-Making Math (Extension)	15 min	• Student journals • LEGO® Education SPIKE™ Essential sets • Devices with LEGO® Education SPIKE™ App • Chart paper map from Challenges 2 & 3 • Rulers/measuring tapes • Chart paper • Pencils • Colored pencils
	Disassemble and inventory sets	10 min	• SPIKE Essential sets
2:10 - 2:30	Daily debrief and wrap up	20 min	• Student journals • Chart paper • Sticky notes • Pencils

Introductions
Time: 30 minutes
Materials:

- SPIKE Essential sets

This open-ended activity will help students get to know one another.

Distribute SPIKE Essential sets. Using the elements in their sets, have students build a model that shows something they'd like to explore or a problem they'd like to solve to help them learn about the world. When it is time to share, have each student say their name and share their model, explaining why they built their model and what it shows.

Group Rules and Expectations
Time: 15 minutes
Materials:

- Chart paper
- Markers
- Pens

Using a piece of chart paper, establish group rules and expectations for the week as a class. You can have campers sign the chart paper and then place the rules and expectations in a location that can be reviewed each day. Ask students to think about how they would like to be treated and the role of a

partner. Consider the role of feedback and how it can help to improve ideas. Have two people work together when building with LEGO® elements so they each have the opportunity to find pieces and to put pieces together.

Team Building Activity
Time: 15 minutes
Materials:

- LEGO® Education SPIKE™ Essential sets

Explain to students that each day will include a team building challenge. Working together is an important skill and just like other skills, we can practice it to get better and better.

Build the Tallest Tower
Have students work in pairs. Make sure each group has the same bricks or give a constraint of using a specific number of bricks. Challenge students to build the tallest tower they can within 5 minutes. At the end of the 5 minutes, encourage students to reflect on:

- What was challenging?
- How did you overcome the challenge?
- What was successful?
- How did you work together?
- If you were to do this tower build again, what would you change?

Have a short discussion on how individuals work together as a team. Ask students what works well and what does not.

Team Briefing 1:
Time: 5 minutes
Materials: None

Say this:

Welcome to orientation! Your first tasks for today are to:

- *Determine a partner for training exercises*
- *Work with your partner to determine a name for your design company and a logo*
- *Design a journal for keeping important records this week*
- *Explore different everyday problems and how people solve them to learn about the world and improve their lives.*

Share these Big Questions to frame the day:

- *What are some problems people might have when they try to explore and learn about their world?*
- *How do people solve these problems, like getting to new places?*

Over the next days, you will work to define problems, carry out investigations to test your design ideas, and present solutions to your fellow problem solvers.

Be sure to work together, take good notes, and have fun!

Partner Selection, Design Company (Team) Name, and Team Logo
Time: 25 minutes
Materials:

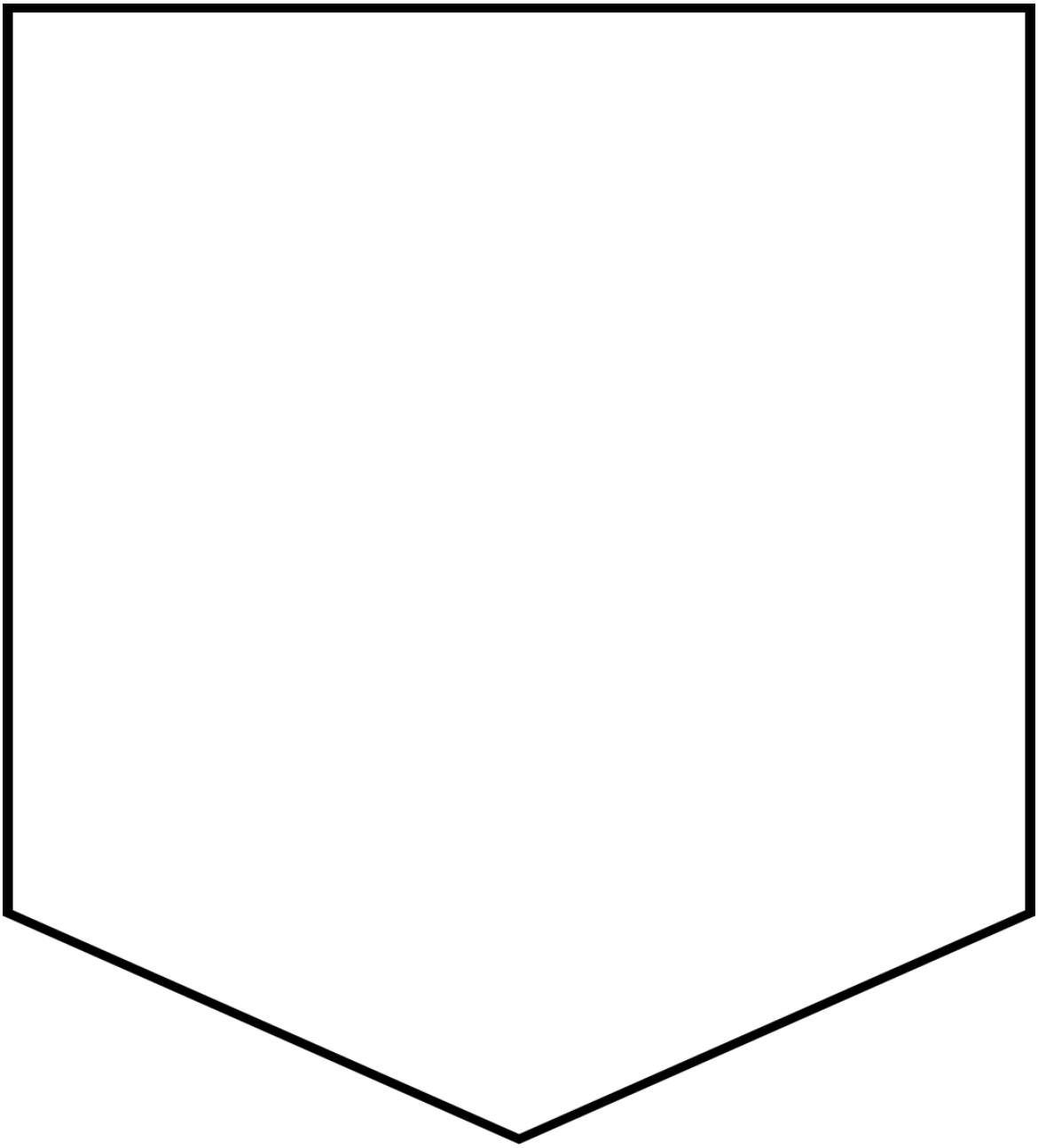
- Team logo templates
- Markers
- Pencils
- Scissors
- Construction paper
- Other craft materials

You can use several different activities to help students find a partner to work with for the week.

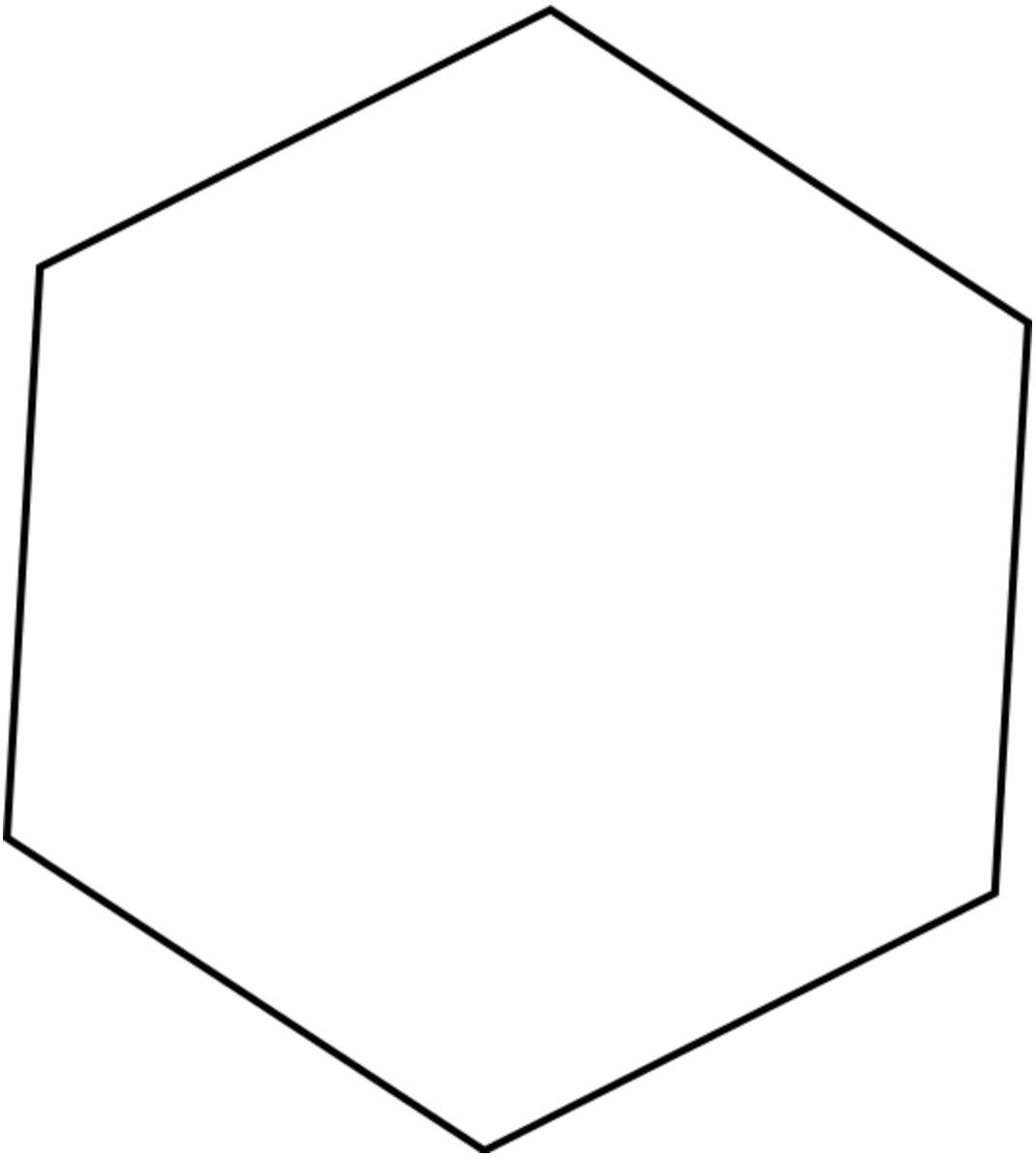
Once partners have been established, student teams can determine a design company name (team name) for their team and design a logo.

While teams are working, assign each group a LEGO® Education SPIKE™ Essential set to use for the week. Share general guidelines for using the sets (what to do if you drop a piece on the floor, where do you put a piece you have found, what sharing looks like, etc.).

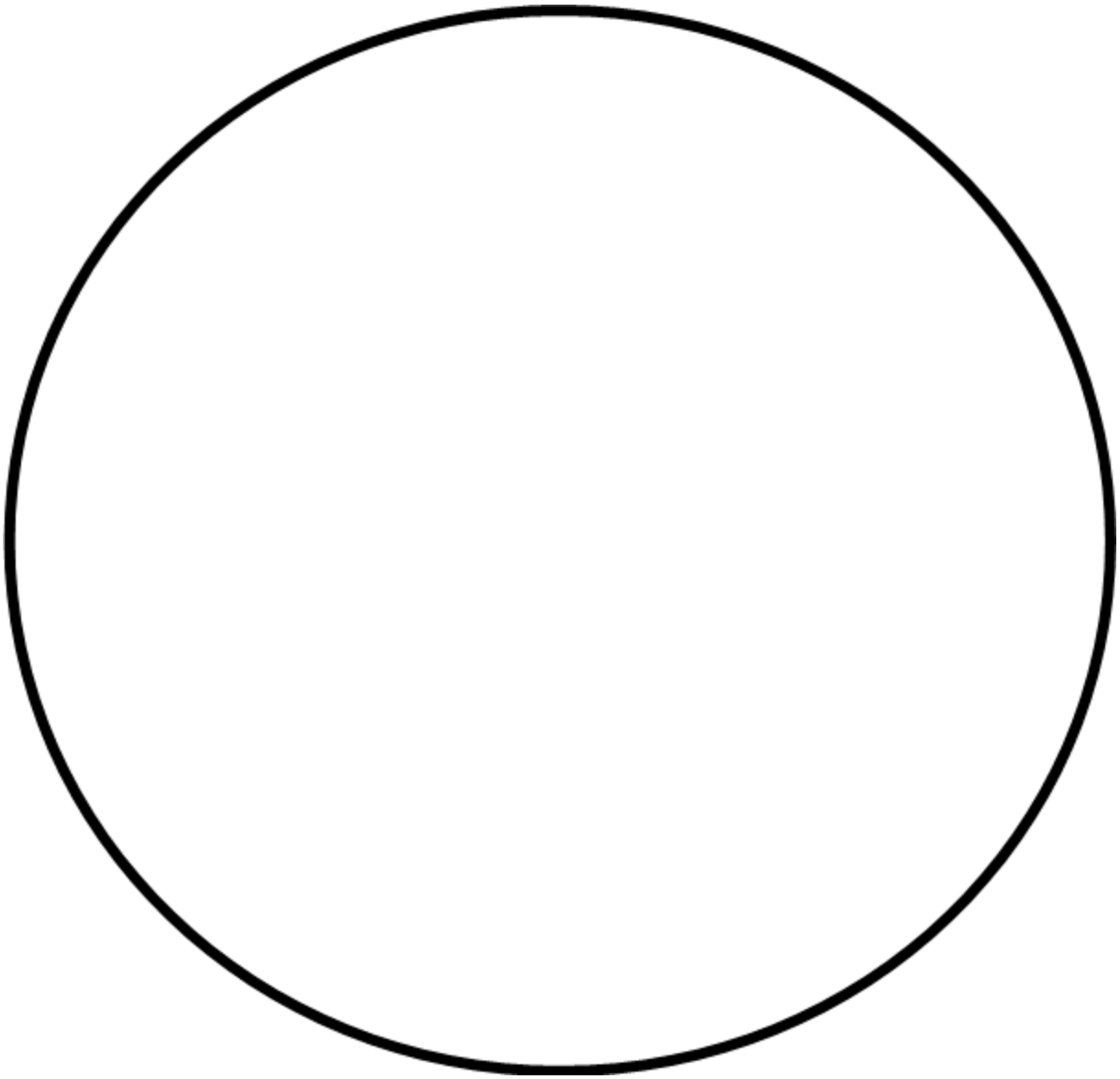
Logo Templates



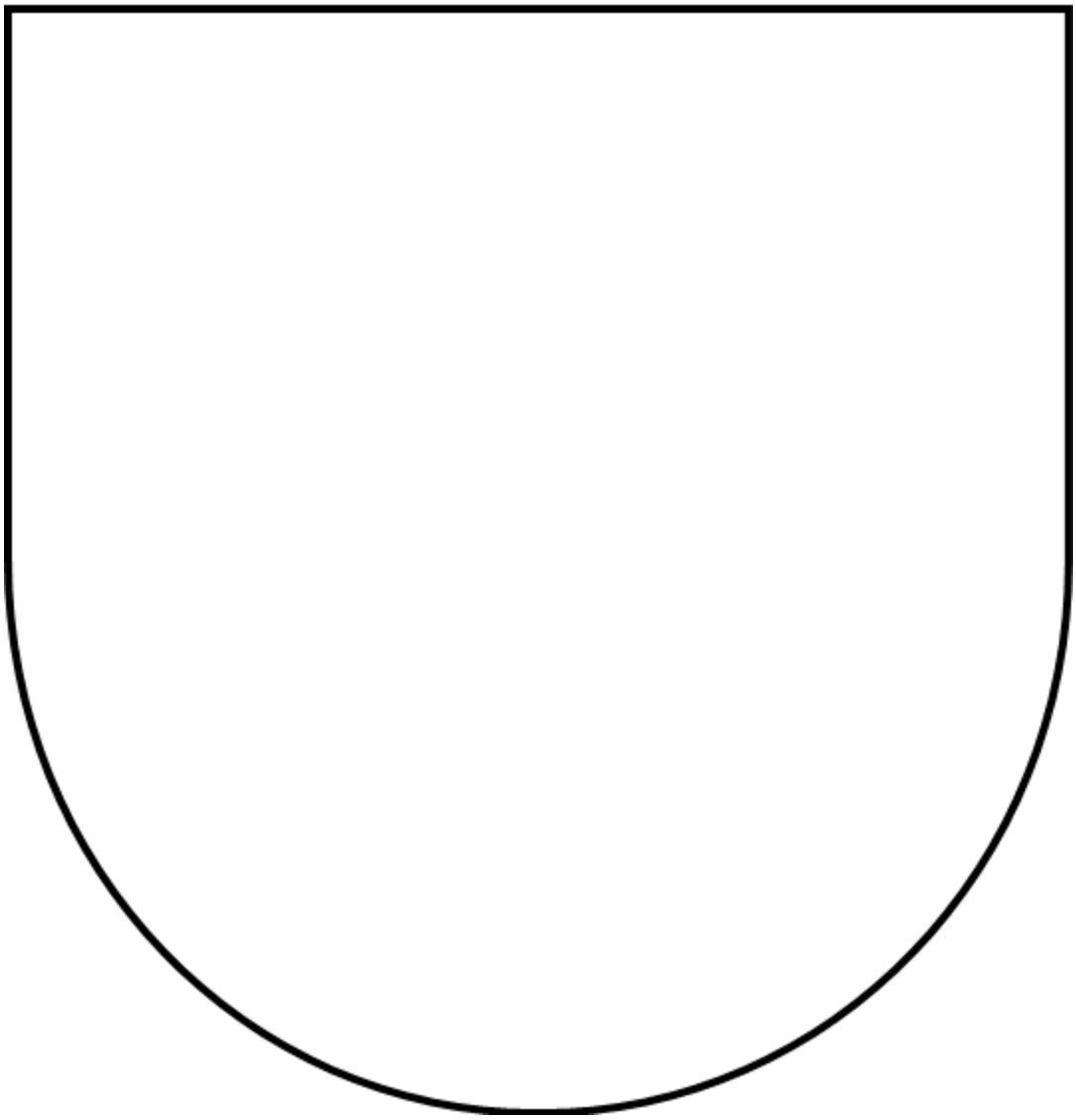
Logo Template



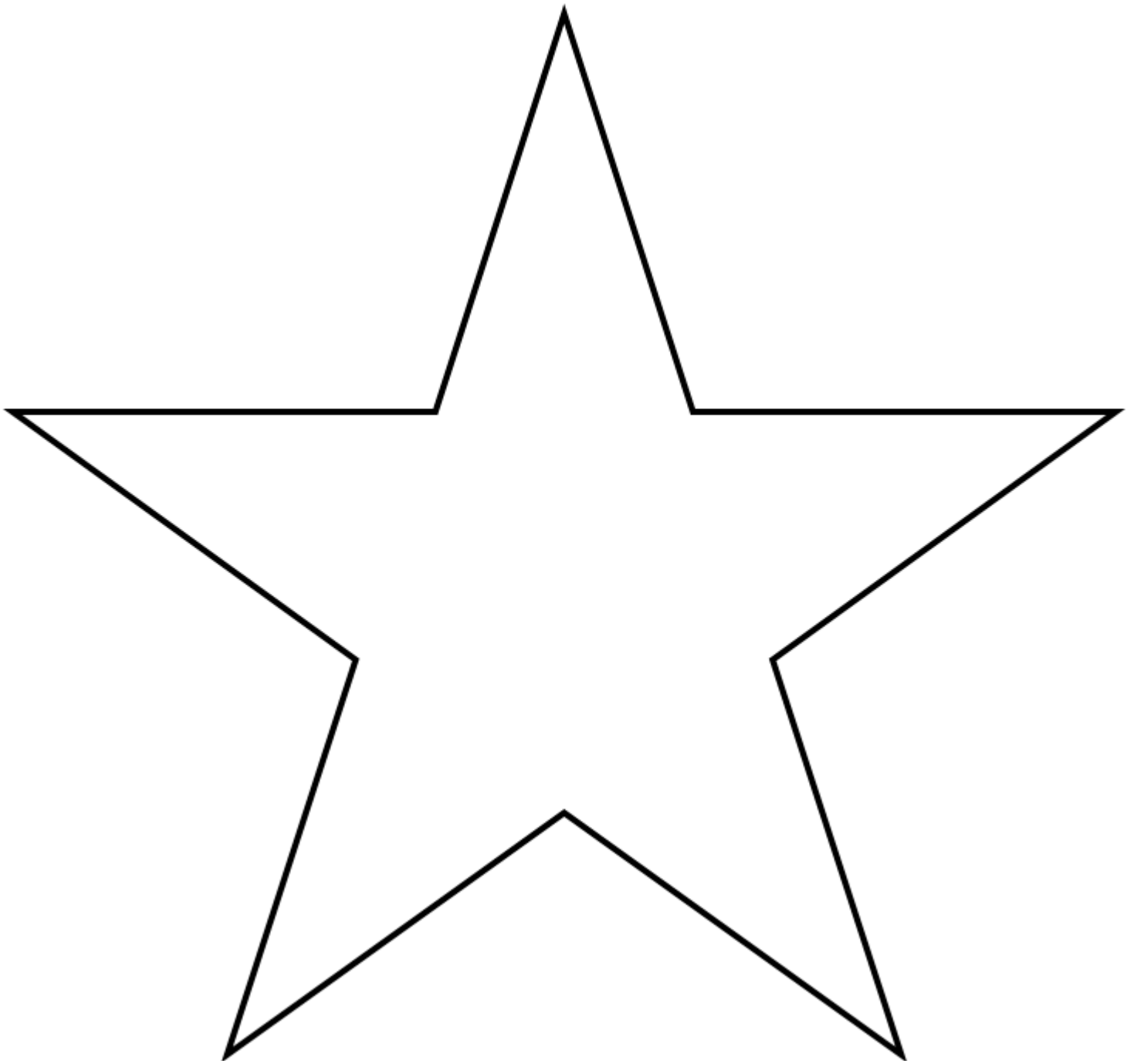
Logo Template



Logo Template



Logo Template



Break
Time: 5 minutes

Workplace Wellness: Physical Fitness
Time: 10 minutes
Materials:

- May vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas could include simple exercises like jumping jacks or running in place. Many companies encourage physical activity during the workday.

Design a Journal
Time: 20 minutes
Materials:

- Student journals
- Markers
- Scissors
- Construction paper
- Other craft materials

Have students create a design journal to take notes, share wonderings, write reflections, and collect ideas. If you model them on engineering design journals, introduce the format and clarify that it contains structures commonly used in the engineering design process that students will use during camp.

Readings and Wonderings
Time: 20 minutes
Materials:

- Book or high-interest articles about engineered solutions or inventions that helped people solve real problems, especially to learn about, explore, or improve the world
- Student journals

Read a book or kid friendly journal article about a design solution or invention that helped people solve a problem. In their journals, have students write questions about design solutions and list problems they'd like to solve or objects they know solve an everyday problem.

Lunch
Time: 30 minutes

Team Briefing 2
Time: 10 minutes
Materials:

- Meet the Team: Minifigure Bios (under Teacher Support>Additional Resources in each lesson plan)

Say this:

> *Now that you have your team and some background information about designing solutions to learn about and explore the world, you can start solving some new problems!*
>
> (Draw students' attention to the four minifigures in the kits.). *These characters, Maria, Daniel, Sofie, and Leo, represent people like you who sometimes experience problems as they explore. Many of these problems can be solved by developing new and creative designs.*

Challenge 1: Taxi! Taxi!—Drive the Taxi

Time: 30 minutes
Materials:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Taxi! Taxi! lesson (Happy Traveler unit)
- Building instructions for Taxi! Taxi!
- Student journals

Guide students to the introductory story in the app about Leo wanting to reach the art museum even though he missed the bus. Ask:

> *If you missed the bus, how might you solve your problem? What are some ways you could get somewhere you needed to go? How could Leo get to the art museum?*

Prompt students to share ideas or to write or draw them in their journals.

Tell students that their first challenge is to build a taxi to take Leo to the art museum.

In the app, have students complete Taxi! Taxi! through lesson Step 7:

- Build the taxi.
- Program the taxi by adding three Coding Blocks to make the taxi move forward and then turn.
- Conduct an initial test in lesson Step 7.
- Record observations about their taxi and its movement in their student journals, reflecting on whether their current design and program will solve Leo's problem of getting to the art museum.

Challenge 2: Taxi! Taxi!—Follow that Map!

Time: 20 minutes
Materials:

- SPIKE Essential sets
- Devices with SPIKE App
- Taxi! Taxi! lesson (Happy Traveler unit)
- Building instructions for Taxi! Taxi!
- Student journals
- Chart paper for each group, taped to the floor or a table
- Tape

- Markers

In the app, have students complete lesson Step 8. Point out the map in Step 8 (also shown under Tips in the teacher lesson plan) they can use as route inspiration, as well as the two shrubs they can use as guideposts.

Before building begins, ask, *Why is it important to test a program to make sure it works? How can you use the results of your tests to improve your program?*

Ask students to:

- Program their taxi to follow a path—turning forward, right, or left—to reach the art museum.
- Modify the program to follow the route shown on Leo's map in Step 8.
- Test their program with the provided chart paper by:
  - Marking the location of the two shrubs and
  - Recording the taxi's path by marking the starting and ending points, turns, and straight movements.
- Carefully record the program modifications and new route for Leo's trip in their student journals, including observations about their taxi and its movement.
  - *What worked? What did their testing show?*
- Reflect on whether their current design and program will solve Leo's problem of getting to the art museum.

Break
Time: 5 minutes

Workplace Wellness: Physical Fitness
Time: 10 minutes
Materials:

- May vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas could include simple exercises like jumping jacks or running in place. Many companies encourage physical activity during the workday.

Team Briefing 3
Time: 5 minutes
Materials: None

Facilitate a quick discussion about different routes we can use to get from one place to another, like moving between classrooms or home and school. Ask questions like: *What problems have you experienced going from one place to another? For example, what happens if the road is blocked and you have to use a different route to school or to a friend's house?*

Challenge 3: Taxi! Taxi—A New Route
Time: 15 minutes
Materials:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Taxi! Taxi! lesson (Happy Traveler unit)
- Building instructions for Taxi! Taxi!
- Student journals
- Each group's chart-paper map from Challenge 2
- Markers
- Tape

In the app, have students complete lesson Step 9. Clarify that they can use their map from Challenge 2 to test, keeping the starting and ending points and the shrub locations the same and then programming a new route.

Ask students to:

- design a new route for Leo's taxi that reaches the same destination: the art museum.
- program the taxi's new route and record it on the chart paper.
- record the new taxi route in their student journals.

Probe with questions like:

- *How was your second program different from the first one?*
- *In what way does the current design and program solve Leo's problem of getting to the art museum?*

Team Briefing 4
Time: 10 minutes
Materials:

- None

Explain that Leo wants to remember his new path and he also wants to know which is the shortest path. Use questions to invite ideas about how to solve these problems for Leo:

- How would you solve this problem?
- What would you need to know?
- What data or measurements would you need?

In this challenge, you'll get to explore some ways to solve these problems for Leo.

Challenge 4: Taxi! Taxi!—Map-Making Math

Time: 15 minutes
Materials:

- Taxi! Taxi! lesson Extension (Happy Traveler unit)
- Each group's chart-paper map from Challenges 2 and 3

- Student journals
- Rulers/measuring tapes
- Pencils
- Paper
- Colored Pencils
- Chart paper (or other way to post ideas, such as on a white board)

Teacher Preparation: Depending on the space, you may allow students to access their taxis or only use their chart-paper data for taking measurements. Also consider student age when determining units of measurement. For example, third-grade math standards require students to measure to the nearest ½ inch or ¼ inch.

Facilitate discussion of measurement, demonstrating as needed how to use a ruler and a completed chart map to determine the distance the taxi travelled. Elicit ideas for ways to show distance information on a map and to determine the total distance that the taxi travelled on each route. As students share ideas, post their ideas for shared reference.

Ask students to:

- Determine the best way to record their taxi's new route for Leo.
- Use their journal records from Challenges 2 and 3 to gather measurement data that tell Leo which route was faster.
- Record ideas in their student journals for ways to solve Leo's problems—remembering his paths and determining how far he went each time.
- Briefly reflect in their journals by writing a response to these questions:
  - What was easy about this challenge?
  - What was difficult about this challenge?
  - What did you learn about measuring distances and map making?

Disassembly and Inventory Check
Time: 10 minutes
Materials:

- LEGO® Education SPIKE™ Essential sets

Ask students to disassemble the Taxi! Taxi! models and correctly replace the elements into the trays. Devices should be powered off and plugged in or stored for the day.

Students should make sure that all the:

- major components are present in the lower half of the set (hub, motors, wheels, etc.).
- pieces are in the correct color compartments in the top trays.

Note: For a full inventory: Have students place items from one compartment on the lid of the box. Then, using the paper insert in the kit (the one that is placed under the lid of the box), have students count and replace pieces into the compartment. Teams should be able to complete two compartments in five minutes. If pieces are missing, have students search other compartments,

look to see if the piece is stuck in or on another piece, and/or check the LEGO® lost and found area in your classroom.

Daily Debrief and Wrap Up
Time: 20 minutes
Materials:

- Sticky notes
- Student journals
- Chart paper
- Pencils

Label three pieces of chart paper with “Enjoyed” or “Learned” or “Wondering” so students can place their responses together.

Have students use sticky notes to write:

- One thing they enjoyed
- One thing they learned
- One thing they are wondering about

Place sticky notes in charts labeled.

Go through some of the responses on each chart.

Solving Problems Wherever We Go Day 2

What About My Stuff?—Big Little Helper

Big Questions:

- How do engineers define problems to make them easier to solve?
- What are the criteria and constraints for solving problems?
- **To share with students:** What are some problems people might have when they try to bring things to a new place?

Materials needed for the day:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ app
- Big Little Helper lesson (Quirky Creations unit)
- Building instructions for Big Little Helper
- Student journals
- Group Rules chart
- Posted sticky notes from Day 1
- Book or journal article about design improvements
- Timer/clock
- Tape
- Chart paper
- Pencils
- Sticky notes

Day 2: Outline for the Day

Outline of Day	Tasks	Time	Materials
9:00 - 10:40	Welcome	5 min	• Student journals • Posted sticky notes from Day 1
	Team building activity	15 min	• SPIKE Essential sets • Timer/clock
	Review group rules and expectations and activities from yesterday	5 min	• Group Rules chart
	Team Briefing 1	10 min	• None

	Challenge 1: Big Little Helper—Build It! (through lesson Step 8)	50 min	• LEGO® Education SPIKE™ Essential sets • Devices with LEGO® Education SPIKE™ App • Building instructions for Big Little Helper • Student journals
	Workplace Wellness (physical activity)	15 min	• Varies, based on the activity selected
10:40 - 10:45	Break		
10:45-11:25	Team Briefing 2	10 min	• Student journals
	Challenge 2: Big Little Helper—Can It Carry More? (lesson Step 9 in the app)	30 min	• SPIKE Essential sets • Devices with SPIKE App • Big Little Helper lesson • Building instructions for Big Little Helper • Student journals
11:25	Get ready for lunch		
11:30 - 12:00	Lunch		
12:00 - 2:10	Readings and Wonderings	10 min	Book or journal article about design improvements
	Team Briefing 3	10 min	• Student journals
	Challenge 3: Big Little Helper—Delivery	40 min	• Student journals • SPIKE Essential sets • Devices with SPIKE App • Big Little Helper lesson • Building instructions for Big Little Helper • SPIKE Essential set lid (one per group) • Tape

	Break	5 min	• None
	Workplace Wellness (physical activity)	10 min	• Varies, based on the activity selected
	Team Briefing 4	10 min	• Student journals
	Challenge 4: Big Little Helper 2.0 (Extension)	35 min	• Student journals • LEGO® Education SPIKE™ Essential sets • Devices with LEGO® Education SPIKE™ App
	Disassemble and inventory sets	10 min	• SPIKE Essential sets
2:10 - 2:30	Daily debrief and wrap up	20 min	• Student journals • Pencils

Welcome
Time: 5 minutes
Materials:

- Student journals
- Posted sticky notes from Day 1

Welcome students back. Have students take a minute to read over the sticky notes placed on charts the previous day. Have students share their favorite moments from the previous day with a partner.

Team Building Activity: Timed Builds
Time: 15 minutes
Materials:

- SPIKE Essential sets
- Timer/clock

Place students in groups of 4–5 for a team building activity.

Explain that you will name an item (see below for suggestions) and students will have one minute to individually build the object using only the pieces in their set. When you call time, students will share their builds in their team. They can take turns sharing what they liked about each design. Repeat this for several rounds.

If one minute is too easy, consider decreasing the time to 30 seconds after the first few rounds.

Item suggestions: frog, giraffe, dog, car, robot, house, chair, bed, airplane, boat (or use others that reflect your students' needs and interests)

Review Group Rules Chart
Time: 5 minutes
Materials:

- Group Rules chart (from Day 1)

Quickly review the group rules and expectations created by the students on Day 1. Highlight positive moments from Day 1 (times when students helped each other, asking great questions, teamwork, helping to clean up…)

Team Briefing 1
Time: 10 minutes
Materials: None

Share this Big Question to frame the day: *What are some problems people might have when they try to bring things to a new place?*

Then say:

> *Today we continue to help solve the problems of our minifigure characters, like how to bring things with them when exploring. You can use some engineering skills to design and test ways to solve that problem.*
>
> *Engineers solve problems by designing new objects or improving them—like a bouncier ball, a tire that can drive better in the snow, or a brighter flashlight. They consider two big ideas for every problem: the criteria and the constraints.*

Facilitate discussion as you share:

> *The criteria are the basic requirements of the design. This is what it must do to be a success. Think about our team building activity. What were the criteria for your design?* (Use LEGO® bricks to build the object that was named.)
>
> *The constraints are the limitations of the design. This could be the materials that can be used, the cost of those materials, the amount of time available to solve the problem, etc. What were the constraints for your team-building design?* (Use only the bricks at your table; finish in 30–60 seconds.)
>
> *Today when we design solutions to solve problems, we will define our criteria and our constraints.*

Challenge 1: Big Little Helper—Build It!
Time: 50 minutes
Materials:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Big Little Helper lesson (Quirky Creations unit)
- Building instructions for Big Little Helper
- Student journals

Share the introductory story in the app about Daniel needing to take things home from his locker. Ask:
How have you carried a bunch of stuff somewhere? What did you do? Did you have help? How can you help Daniel solve his problem? Write or draw ideas in your journal.

Explain that today's first challenge is to build a robot to help Daniel carry his things home.

Ask students to:
- Write in their journals to answer these questions:
  - *What are the criteria or requirements for this design? How will we know when a design idea succeeds?*
  - *What are the constraints of this project? Do you have limitations?*
- Build the Big Little Helper model through lesson Step 4.
- Program it to take Daniel's things from school to his house (lesson Step 6).
- Test in lesson Step 7.
- Program in Step 8 and test again.
- Record observations in their journals about their Big Little Helper and its movement.
- Reflect on whether their current design and program:
  - meet the criteria of helping Daniel carry his things home and
  - work within the constraints they identified.

Workplace Wellness: Physical Fitness
Time: 15 minutes
Materials:
- May vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas could include simple exercises like jumping jacks or running in place. Many companies encourage physical activity during the workday.

Break
Time: 5 minutes

Team Briefing 2
Time: 10 minutes
Materials: Student journals

Tell students:
Recall that engineers develop NEW objects and tools and also IMPROVE existing designs. Consider our success criteria for Daniel's robot helper—to carry things from the school locker

home. Was your helper completely successful? Could it carry all the items? Could it carry more? How could you improve the design to be even MORE successful?

Consider your first build, where your robot carried the cone, the hockey stick, two balls, and a dog. What else from your SPIKE™ Essential sets could your robot carry? What would be hard to carry?

Have groups brainstorm ways to improve the helper's design so it can carry more, recording ideas in their student journals. Elicit brainstorming ideas.

Challenge 2: Big Little Helper—Can It Carry More?
Time: 30 minutes
Materials:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Big Little Helper lesson (Quirky Creations unit)
- Building instructions for Big Little Helper
- Student journals

In the app, have students complete lesson Step 9. Explain that they will have 20 minutes to design and test improvements to the robot and then share their improvement ideas with other teams.

Ask students to:

- Make improvements to the original Big Little Helper build, using the inspiration images in Step 9 or their own ideas.
- Record observations in their journals about their improved Big Little Helper.
- Test if their improved design can carry more items than the original.

Encourage them to continue to improve the design throughout the build time and prompt thinking by asking, *Why is it important to test a program to make sure it works?*

After 20 minutes, facilitate a design share.
First 5 minutes:

- One half of each team stays at their table as the other half circulates to examine other designs.
- Students at tables will explain and demonstrate the design improvements that their team made, while circulating students listen and ask questions.

Second 5 minutes:

- Switch roles and repeat the design share.

Do not disassemble the Big Little Helpers, but the devices should be powered off to prepare for lunch.

Lunch
Time: 30 minutes

Readings and Wonderings
Time: 10 minutes
Materials:

- Book or high-interest articles in which engineers identify the criteria and constraints for solving real problems.

  Read a book or a kid friendly journal article about ways that engineers define problems for a solution or product that has improved over time. Some examples are improved skateboards, video games, and phones. Facilitate discussion of the criteria and constraints the engineers were working with.

Team Briefing 3
Time: 10 minutes
Materials: Student journals

Say:

> *Who remembers what criteria and constraints are?* (Criteria—basic requirements of the design for it to succeed. Constraints—limitations of the design, including materials, cost, or time.)
>
> *Daniel realizes that his helper could be useful in many ways, such as running errands for him. But he recognizes a new problem: How will the robot return to him on its own? Consider your second build, where you changed the design of your Big Little Helper to help Daniel carry more stuff home. How could you modify your design further to deliver items and return to you? What are the new criteria and constraints?*

Have groups brainstorm ways to improve the helper design to deliver items for Daniel and return to him. They can record ideas in their student journals.

Explain that students will have 40 minutes to design and test improvements to the robot.

Challenge 3: Big Little Helper—Delivery
Time: 40 min
Materials:

- Student journals
- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Big Little Helper lesson (Quirky Creations unit)
- Building instructions for Big Little Helper
- SPIKE Essential set lid (one per group)
- Tape (one per group)

Teacher Preparation:
For each team, use tape to mark a one-foot-square box on the floor as a starting point for each robot. Have the students place their SPIKE Essential box lid about three feet away from the starting box.

Encourage students to reflect on how to modify the program to meet the criteria of delivering Daniel's things and returning to him, and if they can work within the constraints.

Ask students to:

- write in their journals to answer these questions:
  - *What are the criteria or requirements for this design? How will we know when a design idea succeeds?*
  - *What are the constraints of this project? Do you have limitations?*
- program their Big Little Helper to travel to the box lid, go around it, and return to the starting box.
- test their program, make changes if it doesn't work, and retest until they have a working program.
- record the new route in their student journals.
- determine how many deliveries (from the start box around the lid and back) they can make in a set amount of time.

Probe or have students write to reflect on questions like:

- *How was your second program different from the first one?*
- *In what way does the current design and program solve Daniel's problem of getting the helper to return to him?*

Break
Time: 5 minutes

Workplace Wellness: Physical Fitness
Time: 10 minutes
Materials:

- May vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas could include simple exercises like jumping jacks or running in place. Many companies encourage physical activity during the workday.

Team Briefing 4

Time: 10 minutes
Materials: Student journals

Say to the students:

> *In our earlier challenges today, you solved two problems for Daniel: carrying his stuff home and delivering items for him and then returning. For this challenge, explore problems you could solve if you had your own Big Little Helper, like how to bring things with you to learn about and explore the world. You may change the robot and/or the program to help you solve one of those problems.*

Lead brainstorming or invite students to write or draw ideas in their journals, and then to circle/list one that they will build.

Challenge 4: Big Little Helper 2.0
Time: 35 min
Materials:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Big Little Helper lesson (Quirky Creations unit)
- Building instructions for Big Little Helper
- Student journals

Ask students to:

- Write in their journals to answer these questions.
  - *What are the criteria or requirements for your design? How will you know when a design idea succeeds?*
  - *What are the constraints of this project? Do you have limitations?*
- Change the Big Little Helper model or program to try their new design idea.
- Program and test their new design, make changes if it doesn't work, and retest until they have a working program.
- Record the changes in their notebook, including how the changes meet the project criteria.

After 25 minutes, facilitate a design share.
First 5 minutes:

- One half of each team stays at their table as the other half circulates to examine other designs.
- Students at tables will explain and demonstrate the design improvements that their team made, while circulating students listen and ask questions.

Second 5 minutes:

- Switch roles and repeat the design share.

Probe or have students write or draw to reflect on questions like:

- *How did your program change during design and testing?*
- *In what way does the current design and program solve the problem you defined?*

Disassembly and Inventory Check
Time: 10 minutes
Materials:

- SPIKE Essential sets

Have students disassemble the Big Little Helper models and correctly replace the elements into the trays. Devices should be powered off and plugged in or stored for the day.

Daily Debrief and Wrap Up
Time: 20 minutes
Materials:

- Student journals
- Pencils

Make sure that models have been disassembled and all pieces are correctly placed in the sets. Devices and hubs should be powered off and plugged in or stored for the day.

Have students write three words in their journals that reflect what they have learned today. Have them choose one of these words and draw a sketch that illustrates why they chose the word.

Solving Problems Wherever We Go Day 3

Problems Are Natural!—Swamp Boat & Trash Monster Machine

Big Questions:

- How can engineers use investigations to test solutions to problems?
- How can they decide if their design solution works?
- **To share with students:**
  - What are some problems people might have when they explore nature?
  - What if they want to improve the environment?

Materials needed for the day:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Swamp Boat lesson (Happy Traveler unit)
- Building instructions for Swamp Boat
- Trash Monster Machine lesson (Quirky Creations unit)
- Building instructions for Trash Monster Machine
- Student journals
- Book or journal article about litter, recycling, or human impact on the environment
- Group Rules chart
- Timer/clock
- Chart paper
- Pencils
- Pens
- Markers
- Colored pencils
- Sticky notes

Day 3: Outline for the Day

Outline of Day	Tasks	Time	Materials
9:00 - 10:30	Welcome	5 min	• Student journals
	Team building activity	15 min	• SPIKE Essential sets • Timer/clock
	Review group rules and expectations and activities from yesterday.	5 min	• Group Rules chart

	Team Briefing 1	10 min	• Student journals • LEGO® Education SPIKE™ Essential sets • Devices with LEGO® Education SPIKE™ app • Start menu Tutorial Activities: The Color Sensor • Start menu Tutorial Activities: The Light
	Challenge 1: Swamp Boat—Using Sensors (through lesson Step 8)	45 min	• SPIKE Essential sets • Devices with SPIKE App • Swamp Boat lesson • Building instructions for Swamp Boat • Student journals • Pencils
	Workplace Wellness (physical activity)	10 min	Varies, based on the activity selected
10:30 - 10:35	Break		
10:35-11:25	Team Briefing 2	10 min	• Student journals • SPIKE Essential sets
	Challenge 2: Swamp Boat—More Than Just Crocodiles (lesson Step 9 in the app)	30 min	• SPIKE Essential sets • Devices with SPIKE App • Swamp Boat lesson • Building instructions for Swamp Boat • Student journals
	Disassemble and inventory sets	10 min	• SPIKE Essential sets
11:25	Get ready for lunch		
11:30 - 12:00	Lunch		
12:00 - 2:10	Readings and Wonderings	10 min	• Book or journal article about the effects of litter or trash on

			the environment
	Team Briefing 3	10 min	• Student journals
	Challenge 3: Trash Monster Machine—Trash of Many Colors! (through lesson Step 8)	40 min	• Student journals • LEGO® Education SPIKE™ Essential sets • Devices with LEGO® Education SPIKE™ App • Trash Monster Machine lesson • Building instructions for Trash Monster Machine
	Break	5 min	• None
	Workplace Wellness (physical activity)	10 min	• Varies, based on the activity selected
	Team Briefing 4	5 min	• Student journals
	Challenge 4: Trash Monster Machine 2.0 (lesson Step 9 in the app)	40 min	• Student journals • SPIKE Essential sets • Devices with SPIKE App • Trash Monster Machine lesson • Building instructions for Trash Monster Machine • Chart paper • Pencils • Pens • Markers
	Disassemble and inventory sets	10 min	• SPIKE Essential sets
2:10 - 2:30	Daily debrief and wrap up	20 min	• Student journals • Pencils or pens

Welcome
Time: 5 minutes
Materials:

- Student journals

Welcome students back. Have students briefly share the words they wrote in their journals on Day 2 with a new partner. As a group, compile a list of the words on chart paper. Discuss what words were repeated, if any.

Team Building Activity: Timed Build
Time: 15 minutes
Materials:

- LEGO® Education SPIKE™ Essential sets
- Timer/clock

Build a Bridge
In pairs, challenge students to build a LEGO® bridge between two tables that will carry the minifigures from one table to another. Allow pairs only 5 minutes to complete their bridge. Then prompt class sharing and invite listeners to say what they liked about each design.

Suggested extensions:

- Build the longest bridge.
- Build the tallest bridge.
- Build a bridge that can hold the most weight (use a bucket and some weights to test).

Then summarize by asking:

Did you test it to make sure that it worked? If it didn't work, how did or could you make it more successful? (I used the information from my first try to make changes that made the next attempt more successful.)

Review Group Rules Chart
Time: 5 minutes
Materials:

- Group Rules chart (from Day 1)

Quickly review the group rules and expectations that students created on Day 1. Highlight positive moments from Day 2 (times when students helped each other, asked great questions, showed teamwork, helped to clean up…)

Team Briefing 1
Time: 10 minutes
Materials:

- Student journals
- Devices with SPIKE™ App
- Start menu Tutorial Activities: The Color Sensor

- Start menu Tutorial Activities: The Light

Share these Big Questions to frame the day:
- *What are some problems people might have when they explore nature?*
- *What if they want to improve the environment?*

Then say and facilitate discussion:

Today we'll continue to help solve the problems our minifigure characters sometimes have, including when they explore nature. You will use your engineering skills to design and test ways to solve problems for exploring the water. Are you ready?

After engineers define a problem and select possible solutions, they use investigations to test and evaluate the solutions. Depending on the results of their tests, they make changes and then retest to see if the changes improved the design.

Today we'll explore ways to design and then complete investigations to test our solutions. Think about these questions:
- *How will you know if your boat works?*
- *Why is it important to test a program?*
- *How will you know if you are successful?*

But don't forget about criteria and constraints! They're still important.

Challenge 1: Swamp Boat—Using Sensors
Time: 45 min
Materials:
- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Swamp Boat lesson (Happy Traveler unit)
- Building instructions for Swamp Boat
- Student journals
- Pencils

Share the introductory story in the app about Sofie wanting to explore the Spike Swamp for crocodiles, since she found some eggs. Ask:

How would you explore the water? How could you solve Sofie's problem? Write or draw ideas in your journal. (Ideas might include a boat, canoe, kayak, or paddle board).

Before students build, briefly review how students use the light and the color sensor, either by using the Start menu Tutorial Activities in the app or by showing the sensors and discussing their functions. Explain that students will use these functions to help Sofie find crocodiles and tell her when they are nearby.

Then ask students to:
- Build the Swamp Boat model through lesson Step 7.
- Program the boat to tell Sofie when a crocodile is near.

- Test in step 7.
- Program again in lesson Step 8 and test again.
- Carefully record in their journals:
    - Program modifications that change the way that Sofie is alerted when a crocodile is near.
    - Observations about how their Swamp Boat alerts Sofie.
- Reflect in their journals on:
    - What worked and what their testing showed.
    - Which design and program will best solve Sofie's problem to help her find crocodiles in the swamp.
    - Whether their design still meets the criteria and constraints they identified.

Workplace Wellness: Physical Fitness
Time: 10 minutes
Materials:

- May vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas include simple exercises like jumping jacks or running in place. Many companies encourage physical activity during the workday.

Break
Time: 5 minutes

Team Briefing 2
Time: 10 minutes
Materials:

- LEGO® Education SPIKE™ Essential sets
- Student journals

Tell students:

> *Recall that engineers develop NEW objects and tools, but they also IMPROVE existing designs. In our first challenge today, we helped Sofie find crocodiles in the swamp. What if she wants to find other animals near the boat? What would make the swamp boat even better?*

Facilitate brainstorming about how to:

- Design different colored animals.
- Improve the Swamp Boat design to make it detect the different colored animals near the boat.

Encourage students to reference their sets as they think, and to write or draw ideas in their journals. Elicit sharing if time allows.

Say:

> *As you make new animals for Sofie's boat to detect, you'll have to test that your boat still detects crocodiles as well as the other colored animals. Remember that engineers test, make changes, and retest while they are working toward new designs and solutions.*

Explain that students will have 20 minutes to design and test improvements and will then share improvements with each other.

Challenge 2: Swamp Boat—More Than Just Crocodiles
Time: 30 min
Materials:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Swamp Boat lesson (Happy Traveler unit)
- Building instructions for Swamp Boat
- Student journals

In the app, have students complete lesson Step 9 to improve the Swamp Boat and program to detect new animals, using the app inspiration images or ideas of their own.

Ask students to:

- Build different colored animals
- Program the Swamp Boat to detect the different animals.
- Record in their journals:
    - Observations about their Swamp Boat and animal designs.
    - How their designs successfully distinguished crocodiles from the other animals.

As they work, encourage students to continuing to improve the design, prompting them with questions like, *Why is it important to test a program to make sure it works?*

After 20 minutes, facilitate a design share.
First 5 minutes:

- One half of each team stays at their table as the other half circulates to examine other designs.
- Students at tables will explain and demonstrate the design improvements that their team made, while circulating students listen and ask questions.

Second 5 minutes:

- Switch roles and repeat the design share.

Disassembly and Inventory Check
Time: 10 minutes
Materials:

- SPIKE Essential Sets

Have students disassemble the Swamp Boat models and correctly replace the elements into the trays. Devices should be powered down for lunch.

Lunch
Time: 30 minutes

Readings and Wonderings
Time: 10 minutes
Materials:

- Book or high-interest articles about the impact of litter or trash on the environment

Read a book, article, or a fictional story about the effects of litter or trash on the environment.

Team Briefing 3
Time: 10 minutes
Materials:

- Student journals

With students, recap the engineering design process they've used so far. Prompt with questions for discussion or reflection in student journals.

Say:

> You *just read a book about the impacts of trash on the environment, which presents real-world problems that engineers and scientists are working to solve. In our next activity, we'll explore ways we can help solve those problems. Think about the engineering design process we've used this week and the following questions. Write or draw in your journal if you wish:*
>
> - *How do engineers use investigations to test solutions and make changes?*
> - *How will you know if your designs work?*
> - *Why is it important to test designs or programs? What could happen if you didn't test them?*
> - *What could you do if your design doesn't work or only works sometimes?*
> - *Why could it be important to test your designs more than once? How many tests are enough to show success?*

Challenge 3: Trash Monster Machine—Trash of Many Colors!
Time: 40 minutes
Materials:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Trash Monster Machine lesson (Quirky Creations unit)
- Building instructions for Trash Monster Machine
- Student journals

Share the introductory story in the app about Sofie wanting to get people at school to throw away their trash at school. Ask:

> *How could you encourage people to throw away their trash? How can you make it fun for students? Write or draw ideas in your journal.*

Explain that students will build a trash-collecting machine for Sofie so she can get people at school to pick up their trash.

Then ask students to:

- Build the Trash Monster Machine model (lesson Step 4).
- Program the machine to accept blue trash only (lesson Step 6).
- Test in lesson Step 7.
- Carefully record in their journals observations about their Trash Monster and its success.
- Advance to lesson Step 8 and program their model to detect other colors of trash.
- Again, carefully record observations about how their Trash Monster and its success. Did it successfully detect as many colors as possible?
- Reflect in their journals on:
    - What worked and what their testing showed.
    - Whether their design still meets the criteria of encouraging Sofie and her friends to throw out trash.

Throughout building, encourage students to continue improving their design.

Have students return any stray pieces to their kits, but keep their models assembled to use after the break.

Break
Time: 5 minutes

Workplace Wellness: Physical Fitness
Time: 10 minutes
Materials:

- May vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas could include simple exercises like jumping jacks or running in place. Many companies encourage physical activity during the workday.

Team Briefing 4

Time: 5 minutes
Materials:

- Student journals

Say:

> *You did a great job designing and building a Trash Monster Machine for Sofie. Now you can try your own ideas to make it even better. You can change the design or the program, but keep the criterion of being able to detect all four colors of trash.*
>
> *Remember that we're exploring ways to test our designs today. Look for ways to investigate if your designs will work every time.*

Discuss ways that students might record testing in the journals.

Share that students will have 20 minutes to design and test improvements to their Trash Monster Machine. Then they will test their "trash" with each other's designs to see which Trash Monster Machine works best.

Challenge 4: Trash Monster Machine 2.0
Time: 40 minutes
Materials:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Trash Monster Machine lesson (Quirky Creations unit)
- Building instructions for Trash Monster Machine
- Student journals
- Chart paper
- Pencils
- Pens
- Markers

In the app, have students advance to lesson Step 9. Explain that they may make physical changes to the Trash Monster Machine or the program but must then test their new designs.

As they work, probe with questions like:

- *How was your second design and/or program different from the last one?*
- *How does it better solve Sofie's problem of encouraging her classmates to throw out trash?*

In their journals, encourage students to record changes and test results and to reflect on whether they met their design goals.

After 20 minutes, facilitate a group testing session.

First 10 minutes:

- One half of each team stays at their table as the other half circulates to test other designs. Circulating students will bring different colored pieces of "trash" for testing.
- Students at tables will use circulating classmates' supplied "trash" to test their Trash Monster Machine.
- All students will record data about whether each Trash Monster Machine detects the new "trash."

Next 5 minutes:

- Switch roles and repeat the design share.

Next 10 minutes:

- Groups share the data from their tests. As they share, lead the class in creating a scaled bar graph of success by brick color. You can use chart paper or another posting method.
- Facilitate discussion comparing the success of the different Trash Monster Machines. Use prompts like these or have students respond in their journals:

- *How many Trash Monster Machines could detect all four colors?*
- *Were there colors that had more pieces detected? How many more?*
- *Were there colors or pieces that the Trash Monster Machines couldn't detect?*
- *Which Trash Monster Machines detected the most pieces?*

Disassemble and Inventory Check
Time: 10 minutes
Materials:
- LEGO® Education SPIKE™ Essential sets

Have students disassemble the Trash Monster Machine models and correctly replace the elements into the trays. Devices should be powered off and plugged in or stored for the day.

Daily Debrief and Wrap Up
Time: 20 minutes
Materials:
- Student journals
- Pencils or pens

Confirm that models have been disassembled, all pieces correctly replaced in the sets, and that devices and hubs are powered off and plugged in or stored for the day.

In their journals, have students write two things they learned today and if either learning surprised them.

Solving Problems Wherever We Go Day 4

Problems Are Fun!—Avoid the Edge

Big Questions:

- How can engineers identify more than one solution to a problem?
- How do they decide which solution is best?
- **To share with students:** What are some problems people might have when they make or play games?

Materials needed for the day:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Avoid the Edge lesson (Crazy Carnival Games unit)
- Building instructions for Avoid the Edge
- Student journals
- Folders
- Group Rules chart
- Book or journal article about force and motion
- Rules/measuring tapes
- Chart paper
- Pencils
- Sticky notes

Day 4: Outline for the Day

Outline of Day	Tasks	Time	Materials
9:00 - 10:30	Welcome	5 min	• Student journals
	Team building activity	15 min	• SPIKE Essential sets • Folders
	Review group rules and expectations and activities from yesterday	5 min	• Group Rules chart
	Team Briefing 1	10 min	• None

	Challenge 1: Avoid the Edge—Add More Fun (through lesson Step 8 in the app)	45 min	• LEGO® Education SPIKE™ Essential sets • Devices with LEGO® Education SPIKE™ App • Avoid the Edge lesson • Building instructions for Avoid the Edge • Student journals
	Workplace Wellness (physical activity)	10 min	• Varies, based on the activity selected
10:30 - 10:35	Break		
10:35-11:25	Team Briefing 2	10 min	• Student journals
	Challenge 2: Avoid the Edge—Best Bat Testing (through lesson Step 9 in the app)	40 min	• SPIKE Essential sets • Devices with SPIKE App • Avoid the Edge lesson • Building instructions for Avoid the Edge • Student journals • Rulers/measuring tapes
11:25	Get ready for lunch		
11:30 - 12:00	Lunch		
12:00 - 2:10	Readings and Wonderings	10 min	• Book or journal article about force and motion
	Team Briefing 3	10 min	• Student journals
	Challenge 3: Avoid the Edge—Path and Goal Testing	40 min	• Student journals • SPIKE Essential sets • Devices with SPIKE App • Avoid the Edge lesson • Building instructions for Avoid the Edge

	Break	5 min	• None
	Workplace Wellness (physical activity)	10 min	• Varies, based on the activity selected
	Team Briefing 4	5 min	• None
	Challenge 4: Avoid the Edge 2.0	40 min	• Student journals • LEGO® Education SPIKE™ Essential sets • Devices with LEGO® Education SPIKE™ App • Avoid the Edge lesson • Building instructions for Avoid the Edge
	Disassemble and inventory sets	10 min	• SPIKE Essential sets
2:10 - 2:30	Daily debrief and wrap up	20 min	• Student journals • Pencils

Welcome
Time: 5 minutes
Materials:

- Student journals

Welcome students back. Have students take a minute to read over their journals from the previous day. Have students share their learnings or favorite moments from the previous day with a partner.

Team Building Activity
Time: 15 minutes
Materials:

- SPIKE Essential sets
- Folders [one per group]

Teacher Preparation: Build an object for each student group, making it something not too easy to copy. (Object suggestions: frog, giraffe, dog, car, robot, house, chair, bed, airplane, boat, or other

ideas that reflect your students' needs and interests.) Keep the built objects hidden from view behind a standing book or folder. Determine and share timing to ensure all students will have a turn.

Relay Race Game
Organize groups of 4–5 and allocate sets. Explain that each team will get a hidden teacher-built LEGO® object and a LEGO® Education SPIKE™ Essential set. The team's goal is to build something like the hidden object faster than other teams. Facilitate these steps:

- Teams line up opposite the hidden objects.
- When you start the relay, one student from each team examines the hidden model. The student can then place one brick to begin the build.
- Signal each team member to repeat the process, adding *or* taking away ONE brick on their turn.
- Continue until the model has been created. The winner is the first to match their teacher-built object.

Elicit class sharing and invite listeners to say what was fun or challenging about the game.

Review Group Rules Chart
Time: 5 minutes
Materials:

- Group Rules Chart (from Day 1)

Quickly review the group rules and expectations students created on Day 1. Highlight positive moments from Day 1 (times when students helped each other, asked great questions, showed teamwork, helped to clean up…)

Team Briefing 1
Time: 10 minutes
Materials: None

Share this Big Question to frame the day: *What are some problems people might have when they make or play games?*

Say:

> *We have designed solutions to many problems this week. Next, we'll explore what happens when engineers design more than one solution. How do they decide which one is best?*
>
> *Today, you'll use your engineering skills to improve the designs of carnival games, such as to make them more fun or challenging. What do you know about carnivals or fairs? What are some games people play at these events?*
>
> *As we work, remember to test your designs to make sure that they are working correctly. Consider these questions:*
>
> - *How will you test if your game works?*
> - *Why is it important to test a program?*

- *How will you know if your design succeeds?*

Challenge 1: Avoid the Edge—Add More Fun!
Time: 45 minutes
Materials:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Avoid the Edge lesson (Crazy Carnival Games unit)
- Building instructions for Avoid the Edge
- Student journals

In the app, show students the introductory story about Leo wanting to build a carnival game that is fun and challenging. Explain that they will build and program a game and then use problem-solving to make it more fun or more challenging.

Ask students to:

- Build, program, and modify the Avoid the Edge model through lesson Step 8.
- Test their models and programs.
- In their journals, record observations about:
  - What worked? What did their testing show?
  - Whether their modified game is fun and/or challenging.

Then facilitate a design share, encouraging students to reflect in their journals about which design is the most fun or challenging.

Workplace Wellness: Physical Fitness
Time: 10 minutes
Materials:

- May vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas include simple exercises like jumping jacks or running in place. Many companies encourage physical activity during the workday.

Break
Time: 5 minutes

Team Briefing 2
10 minutes
Materials:

- Student journals

Say:

Engineers identify multiple solutions to a problem. In the next challenge you'll think about more improvements to the Avoid the Edge game to make it more fun or challenging.

Facilitate a quick discussion about energy changing from potential or stored energy to kinetic or motion energy. Ask students:

- *What are the ball and bat doing at the beginning of the game?*
- *What causes the ball to begin moving?*
- *Why does the ball stop at the target?*
- *What would happen if you changed the bat in some way, like changing its shape? Could you change the way it moves?*

Encourage brainstorming possible changes to the bat and how these might affect the ball's motion, as well as the fun or challenge of winning the game. Elicit sharing and/or suggest that students record and draw ideas in their student journals.

Challenge 2: Avoid the Edge—Best Bat Testing
Time: 40 minutes
Materials:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Avoid the Edge lesson (Crazy Carnival Games unit)
- Building instructions for Avoid the Edge
- Student journals
- Rulers/measuring tapes

In the app, have students advance to lesson Step 9.

Ask them to:

- Make changes to the bat in their original model, using inspiration images in lesson Step 9 or their own ideas.
- Carefully notice how their changes to the bat impact the game.
- Play the game, measuring and recording the length of each trial with their new bat design.

As they work, remind them to test solutions multiple times and record results before testing the next solution. Also prompt with questions like:

- How does changing the size of the bat affect the motion of the ball?
- How does changing an object's texture affect the motion of the ball?
- How do changes to the bat affect how fun or challenging it is to win the game?

After 20 minutes, facilitate a design share.

First 5 minutes:

- One half of each team stays at their table as the other half circulates to examine other designs.
- Students at tables will explain and demonstrate the design improvements that their team made, while circulating students listen and ask questions.

Second 5 minutes:

- Switch roles and repeat the design share

Do not disassemble the Avoid the Edge games, but devices should be powered off to prepare for lunch.

Lunch
Time: 30 minutes

Readings and Wonderings
Time: 10 minutes
Materials:
- Book or high-interest articles about force and motion. In their journals, have students list ways that forces might affect the motion of objects like a ball. Encourage them to record wonderings about force and motion and/or connect to the Avoid the Edge game.

Team Briefing 3
Time: 10 minutes
Materials:
- Student Journals

Say to the students:

Recall that engineers use investigations to test solutions and then make changes to improve. Then they retest to see if these changes work.

In the previous challenge, you explored what happens in Leo's game when the bat hits the ball and how changes in energy will occur when you change the bat.

But so far, you've only redesigned the bat. That was really fun, but some bat designs maybe made the game impossible to win. Then the design wouldn't meet our criterion for a fun game.

In your next challenge, you'll use your test findings to make more changes to the game so that it's more fun without being too challenging.

Facilitate a quick discussion about further changes to the game. Ask:
- *How could you change the pathway of the ball? How about the placement of the goal?*
- *How can you use learning about force and motion to predict the ball's motion as you consider new designs?*
- *How will you know if your solution is a success?*

In their student journals, ask students to write or draw their ideas. Then elicit brainstorming.

Challenge 3: Avoid the Edge—Path and Goal Testing
Time: 40 min
Materials:
- LEGO® Education SPIKE™ Essential sets

- Devices with LEGO® Education SPIKE™ App
- Avoid the Edge lesson (Crazy Carnival Games unit)
- Building instructions for Avoid the Edge
- Student journals

Ask students to:
- Modify the model or program of their Avoid the Edge game.
- Carefully notice how their changes impact the game.
- Play the game, measuring and recording the behavior of each new design trial.

As they work, remind students to test solutions multiple times and record their results before testing the next solution. Also prompt with questions like:
- *How does changing the path affect the ball's motion?*
- *How does changing the goal affect the game?*
- *How do your changes (bat, path, goal) work together to change the motion of the ball?*
- *Which game design is fun and/or challenging but not impossible to win?*
- *How will you decide which solution is best?*

Break
Time: 5 minutes

Workplace Wellness: Physical Fitness
Time: 10 minutes
Materials:
- May vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas include simple exercises like jumping jacks or running in place. Many companies encourage physical activity during the workday.

Team Briefing 4
5 minutes
Materials: None

Say:

Today, you've been designing multiple solutions to make the Avoid the Edge game more fun and/or challenging. Now you and your team must choose the best solution.

You'll use experimental testing to determine your choice, and then build and present your best solution to a team of carnival creators. You'll want to test multiple solutions to put your best design forward.

Remember, the game should be challenging but not impossible to win—that wouldn't be fun, right?

Challenge 4: Avoid the Edge 2.0
Time: 40 min
Materials:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Avoid the Edge lesson (Crazy Carnival Games unit)
- Building instructions for Avoid the Edge
- Student journals

Ask students to

- Make additional changes to their Avoid the Edge game to make it more fun and/or more challenging.
- Test their new designs.
- Record changes and results in their journals.

As they work, probe with questions like:

- *How was your second design different from the last one?*
- *In what way does the current design and program make the game more fun and/or challenging?*
- *How did you test different solutions?*

After 25 minutes, facilitate a design share to a team of carnival creators.
First 5 minutes:

- One half of each team stays at their table as the other half circulates to examine other designs.
- Students at tables will explain and demonstrate their team's design improvements, while circulating students listen and ask questions.

Second 5 minutes:

- Switch roles and repeat the design share to a team of carnival creators.

Disassembly and Inventory Check

Time: 10 minutes
Materials:

- SPIKE™ Essential sets

Have students disassemble their Avoid the Edge models and correctly replace the elements into the trays. Devices should be powered off and plugged in or stored for the day.

Daily Debrief and Wrap Up
Time: 20 minutes
Materials:

- Student journals
- Pencils

Preview that tomorrow students will build a new carnival game! Ask them to think about their favorite games—from a carnival, the mall, school, or even something like tag or hide and seek. Why do they like that game? What makes it fun? How can they make the game they will build tomorrow fun too?

In their journals, ask students to sketch themselves playing their favorite game and to write a few words or a sentence about why that game is fun.

Solving Problems Wherever We Go Day 5

Everyone Can Solve Problems—Junior Pinball & Creative Carnival Games Showcase

Big Question:

- How is designing solutions the same, whether the problem is going places, exploring the environment, or making a fun game?
- **To share with students:** How do people create new solution ideas and present them to others?

Materials needed for the day:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Junior Pinball lesson (Crazy Carnival Games unit)
- Building instructions for Junior Pinball
- Creative Carnival Games lesson (for support—Crazy Carnival Games unit)
- Group Rules chart
- Chart paper
- Sticky notes
- Markers
- Student journals
- Craft materials
- Tape
- Certificates of Completion

Day 5: Outline for the Day

Outline for Day	Tasks	Time	Materials
9:00 - 10:20	Welcome and Team Building Activity	20 min	• Student journals • SPIKE Essential sets • Chart paper • Sticky notes • Markers
	Review Group Rules Chart	5 min	• Group Rules chart
	Team Briefing 1	5 min	• None
	Challenge 1: Junior Pinball	50 min	• SPIKE Essential sets • Devices with SPIKE App • Junior Pinball lesson

			• Building instructions for Junior Pinball • Student journals
10:20 - 10:25	Break		
10:25-10:40	Workplace Wellness	15 min	• Varies, based on the activity selected
10:40 – 10:45	Team Briefing 2	5 min	• None
10:45 – 11:25	Showcase Discussion, Planning, and Building	40 min	• LEGO® Education SPIKE™ Essential sets • Devices with LEGO® Education SPIKE™ App • Craft materials • Tape
11:25	Get ready for lunch		
11:30 - 12:00	Lunch		
12:00 – 1:00	Showcase Preparation	60 min	• SPIKE Essential sets • Devices with SPIKE App • Crazy Carnival Games unit • Creative Carnival Games lesson (for support) • Student journals • Pencils • Construction paper or other craft materials • Tape
1:00 – 1:05	Break		
1:05-1:15	Workplace Wellness		• Varies, based on the activity selected
1:15 – 1:45	Showcase	30 min	• SPIKE Essential sets • Devices with SPIKE App • Student journals • Student projects—SPIKE Essential carnival games

1:45 - 2:30	Daily Debrief, Clean Up, and Wrap Up	45 min	• Student projects • LEGO® Education SPIKE™ Essential sets • Devices with LEGO® Education SPIKE™ App • Certificates of Completion • Student journals • Sticky notes

Welcome and Team Building Activity
Time: 20 minutes
Materials:

- Student journals
- SPIKE Essential sets
- Chart paper
- Sticky notes
- Markers

Welcome students back. On a piece of chart paper, draw a very large light bulb. Inside your drawing, have students write positive discoveries they've made about themselves during the week.

Then ask:

> *Have you ever been bored waiting for something to start or finish, like in a waiting room or on a long car drive? What would be fun to play with at these times?*

Using the bricks in their SPIKE Essential sets, have students build something fun to pass the time when waiting or bored. They can build anything they like and should be ready to share and explain how it solves their problem.

Allow 5–10 minutes Then lead sharing, inviting presenters to say their name, share their design solution, and explain how it solves the defined problem.

Review group rules and expectations
Time: 5 minutes
Materials: Group Rules chart

Quickly review the group rules and expectations. Highlight positive moments from Day 4 (times when students helped each other, asked great questions, showed teamwork, helped to clean up…)

Students will share the cool carnival game that they create. If appropriate, introduce that the class will welcome guests today.

Team Briefing 1
Time: 5 min
Materials: None

Share this Big Question to frame the day: *How do people create new ideas and present them to others?*

Say:

> *Finding solutions to design problems is the same whether the problem is going places, exploring the environment, or making a fun game. We often need to explain solutions and persuade listeners why they solve the problem.*
>
> *Today you'll have one last challenge that leads to our final project. You'll help Sofie modify a junior pinball game to make it more fun or challenging.*

Facilitate a quick discussion about energy transfer and problem solving. Ask:

- *How is energy transferred in the pinball game, such as between the bumpers and flippers?*
- *What would happen if you changed the flippers or bumpers in some way, like to a different shape? How could you change the way the flippers moved?*

Challenge 1: Junior Pinball
Time: 50 minutes
Materials:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Junior Pinball lesson (Crazy Carnival Games unit)
- Building instructions for Junior Pinball
- Student journals

In the app, show students the introductory story about Sofie wanting a fun and challenging pinball game to play. Explain that they will build the game and then use their engineering skills to improve the design so that it's more fun and/or challenging.

Ask students to:

- Build the Junior Pinball model through lesson Step 4.
- Program, improve, and test the game in lesson Steps 5–9.
- Record solutions, observations, and test results in their journal.
- Reflect on whether their current design and program will solve Sofie's problem of making the game more fun and/or challenging

As students work, ask questions like:

- *What happens when your first improvement idea doesn't work? How can you adjust it to be successful?*
- *Why is it important to test a program to make sure it works?*

- *What happens if more than one design solution works? How do you decide which solution is best?*
- *How does your change make the pinball game more fun for Sofie and her friends?*

Break
Time: 5 minutes

Workplace Wellness: Physical Fitness
Time: 15 minutes
Materials:
- May vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas include simple exercises like jumping jacks or running in place. Many companies encourage physical activity during the workday.

Team Briefing 2
Time: 5 minutes
Materials: None

Say:

We've used our engineering skills to solve many problems this week, from moving things to new places (Taxi! Taxi!) to exploring nature (Swamp Boat) and protecting the environment (Trash Monster Machine). We also improved two carnival games (Avoid the Edge and Junior Pinball.) Now it's your turn to create your own carnival game to have at school. You will create the build, the rules, and the scoring, and then write directions on how to play, using all your learning from the week to make a game you think will be super fun.

Then you'll present your work in a showcase as we all play your newly created carnival game.

Showcase Discussion, Planning, and Building
Time: 40 minutes
Materials:
- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Creative Carnival Games lesson (Crazy Carnival Games unit)
- Student journals
- Craft materials, including construction paper

Say:
Now it's time to design, build, and program your Crazy Carnival game. Here are the criteria:
- *You must name the game.*
- *You must write or share directions on the object of the game, how to play, and how to score points.*
- *Your game must use two components (motor, light, or sensor).*

- *Players must be able to win the game.*
- *The game must be fun to play.*
- *There must be a way to make the game challenging.*
- *You must present your solution to classmates.*
- *You must show me a plan for your game before you start building/programming.*

Elicit and answer students' questions, posting the criteria for reference if you wish. Encourage them to use craft materials to share information with game players.

As needed, facilitate a brainstorming session to generate possible game ideas. You can also refer students to the Crazy Carnival Games unit in the SPIKE app, especially the Creative Carnival Games lesson.

Allow planning time. (Allow LEGO® brick use if you wish, or limit students to ideas only.) Circulate to discuss each plan with pairs to confirm that it's feasible in the available time and to identify ways to support students as they build and program.

Once you have approved a pair's plan, encourage them to build and program.

Lunch
Time: 30 minutes

Showcase Preparation
Time: 60 minutes
Materials:
- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Crazy Carnival Games unit
- Creative Carnival Games lesson (for support)
- Student journals
- Pencils
- Construction paper or other craft materials
- Tape

Allow additional building and programming time, supporting students in creating models that can be completed in the allotted time. You may need to help them scale back their plans.

Encourage students to:
- Test their game more than once to confirm that it plays as intended.
- Make modifications as needed to improve the directions, the scoring, the build, the program, and other criteria based on design testing.
- Make sure their players will have all the information needed to play and have fun.

Explain that after 45 minutes, students will present their game to explain their solutions for a fun and challenging game. Allow time for students to set up their games and create the required written explanations.

Break
Time: 5 minutes

Workplace Wellness: Physical Fitness
Time: 10 minutes
Materials:

- May vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas could include simple exercises like jumping jacks or running in place. Many companies encourage physical activity during the workday.

Showcase
Time: 30 minutes
Materials:

- LEGO® Education SPIKE™ Essential sets
- Devices with LEGO® Education SPIKE™ App
- Student projects—SPIKE Essential carnival games
- Student journals

Students should be set up and ready when the showcase begins, especially if you will welcome outside guests.

Have groups take turns presenting their game solutions. Then, students (and any guests) will play all the games or assign one team member to try each game. Have students write:

- The name of each game they played
- The mechanisms involved in the games
- Something they liked or disliked about it
- If they had fun
- How challenging the game was

Tell students they will need this information later.

Daily Debrief, Clean Up, and Wrap Up
Time: 45 minutes
Materials:

- Student projects
- SPIKE Essential sets
- Devices with SPIKE App
- Student journals
- Sticky notes
- Certificates of Completion

Have students disassemble their games and replace the elements in the correct locations.

Confirm that the sets are in good order and contain the hub, motors, light, and sensors. Make sure devices are powered off and stored. Conduct complete inventories, assigning a location for extra pieces and noting sets with pieces that are missing.

Have students clean up any additional materials from the showcase.

Distribute 3 sticky notes per student. Using their journal writing and notes from the showcase, ask students to share, draw, or write:

- The name of the game that was the most fun and why
- The name of the game that was the most challenging and why
- The name of their team's game and what they liked best about it

Collect notes or verbal sharing and organize by game name. Have a member of each team collect their notes.

Briefly discuss games many players found:

- Fun and why.
- Challenging and why.

Ask students what games they would create if they could do this challenge again.

Celebrate all the students and their games and all they have learned.
You can present each student with a Certificate of Completion.
Students may take home their journals.