FIRST® at Home
Lost at Sea

ACTIVITY SUMMARY

Teamwork challenges are a great way to help your team members learn how to problem solve and work together. They are also a lot of fun! This activity utilizes multiple Core Values by asking the team to choose items that they would want when stranded. They must create a combined list of items and then draw an innovative design for a way to store the items on the lifeboat. This is also a great activity that can be done virtually!

Age Range & Grade Level: *Ages 9+, Grade 4+*

Program Connection: *FIRST*® LEGO® League

Authored By: Tammy Pankey, Manager of Curriculum Development, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Create a list of items that they would want if lost at sea.
2. Work as team to create a combined team list of items.
3. Design a storage space on the lifeboat for the team items.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Ocean currents	3D shapes, Geometry	Communication and Listening	Historical perspectives	Logical Thinking
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

design	prototype	model
engineering design process	drawing	solution

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

Lost at Sea Design Brief, paper, pencil, prototyping materials (optional)

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the *Lost at Sea* Design Brief. Watch the demo video with students or to get inspiration for guiding the students through the activity.	The design brief document is for the students is below. You can adjust the difficulty of the activity by increasing or decreasing the time limit and the number of items they may choose.
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Determine how students will complete the activity, what their length of time will be, how to collaborate virtually and how to share their solutions. Have students work on their solutions.	Solutions can be built and designed using materials around the house or it can be a drawing or computer aided design (CAD).
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their *Core Values Self-Reflection* and review.	*Core Values Self-Reflection* is found in the *Lost at Sea* Design Brief document.

STUDENT OR TEAM ACTIONS

1. Review the *Lost at Sea* Design Brief and problem statement.
2. Research the questions and discuss.
3. Create a list of your own items and share.
4. Work as team to create a combined list of items.
5. Create a storage solution to solve the challenge presented in the problem statement.
6. Share your solution and reflect on your learning.
7. Explore the *Go Further!* opportunities.
8. Complete your *Core Values Self-Reflection*.

GO FURTHER!

Create a prototype of your storage solution along with all the items that would go inside of it. You could create a physical model out of building blocks or modeling clay or design it with computed aided design (CAD).

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution solved the challenge.	Showed how the solution would solve the challenge.	Not clear how the solution would solve the challenge.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
Lost at Sea
Design Brief

PROBLEM STATEMENT

Oh no! Your team is shipwrecked and stranded in a lifeboat. There isn't enough space for everyone's items on the boat. You must use **teamwork** to decide what materials are needed. Be sure to **include** each person's ideas! Can you design an **innovative** way to store all these materials on the boat since space is limited?

If you can't work as a team to determine what materials to keep, your boat might sink! Use the expertise of everyone on your team to determine your material list and design an innovative storage solution. Details of your mission are below.

CRITERIA & CONSTRAINTS

- The items on your material list must realistically fit within or around the lifeboat and with the occupants already instead of it.
- Assume there is no cellphone or satellite service!
- Assume there is not a landmass or island near where your team is stranded.
- This takes place on our earth, where physics and current environmental factors apply.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND

Reflect, research, and answer the questions below.

1. What typically comes in a survival kit?

2. How much space is on a typical multi-passenger lifeboat?

3. Do lifeboats already come equipped with any supplies?

4. What is the history of shipwrecks and lifeboat design?

ACTIVITY STEPS

1. Write down five items you want to have with you on the lifeboat in order of importance. You have 2 minutes to complete the list.

2. Share your list with your team. Explain why you chose the items you did and the order you ranked them in.
3. Circle any items that you have the same as others on the team as they share.
4. Work as a team to narrow down to your list to just 2 unique items per person. You may need to compromise on the items you chose!
5. Use the space below to draw a design for innovative solution to store and hold everyone's items on the boat. Be sure to label all the items from the team.

DRAWING

REFLECTION QUESTIONS

1. How did you narrow your list down to five items? How did you decide the ranking of each item?

2. Did you have disagreements on the final team list? If so, how did you deal with them?

3. How did your storage design differ from teammates? How was it similar?

4. What skills did you use or learn in this activity?

5. What Core Values were used in this activity?

GO FURTHER!

Create a prototype of your storage solution along with all the items that would go inside of it. You could create a physical model out of building blocks or modeling clay or design it with computer aided design (CAD).

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Code Your Escape!

ACTIVITY SUMMARY

Students will create an "Escape Room" in their home then write the pseudocode so that someone could successfully navigate all obstacles in the room to escape!

Age Range & Grade Level: *Ages 9+, Grade 4+*
Program Connection: *FIRST*® LEGO® League: Challenge
Authored By: Tammy Pankey, Manager Curriculum Development**,** *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:
1. Create an Escapee Room in their home.
2. Write a pseudocode for a volunteer (someone in home) to follow to "escape" the room by acting out the written instructions.
3. Provide verbal instructions to volunteer to navigate room until that person has successfully escaped!

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Procedural writing	Spatial Reasoning	Procedural writing		Pseudocode
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing *FIRST* activities.

KEY VOCABULARY

Pseudocode Robot Obstacle Escape Room Programming

Engineering Design Process

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

Code Your Escape Design Brief, assorted materials around home for creating the Escape Room

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the *Code Your Escape!* Design Brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Determine how students will complete the activity, what their length of time will be, how to collaborate or share their solutions. Have students work on their solutions.	Students could share their pseudocode with each other and provide feedback.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their *Core Values Self-Reflection* and review.	*Core Values Self-Reflection* is found in the *Code Your Escape!* Design Brief document.

STUDENT OR TEAM ACTIONS

1. Review the *Code Your Escape!* Design Brief and problem statement.
2. Research the questions and discuss.
3. Create a solution to solve the challenge presented in the problem statement.
4. Share your solution and reflect on your learning.
5. Explore the *Go Further!* opportunities.
6. Complete your *Core Values Self-Reflection*.

GO FURTHER!

Option 1: Take the pseudocode you created for your volunteer and recreate in the coding platform you use with robot or use an online coding platform like Scratch. Even if you don't have a robot at home, you can build your code and share with your team.

Option 2: Trade places! Ask your volunteer to rearrange things in the room then write the pseudocode for you to act out.

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution solved the challenge.	Showed how the solution would solve the challenge.	Not clear how the solution would solve the challenge.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
Code Your Escape!
Design Brief

PROBLEM STATEMENT

You and your team decided to enter an Escape Room to develop your *FIRST*® Core Values. Your team is placed in pairs and only one pair is allowed in at a time. Your partner must put on a blindfold before you both can enter the room! Once you enter the door to the room, you are given this note:

1. You can't walk any further into the room.
2. You must provide give verbal instructions so that your partner can walk across the room to the other door.
3. Be sure to tell your partner every step or movement to take to avoid touching or running into anything.
4. Your partner can't talk or remove the blindfold!

"Your team is counting on you! Using your expertise to help your partner safely avoid all the obstacles in the room so that you both escape! Details of your mission are below."

CRITERIA & CONSTRAINTS

- Your solution must be presented as pseudocode.
- Each step within your pseudocode should only include one action; just like in programming a robot.
- Once your volunteer is acting out your pseudocode, the verbal instructions must be followed exactly.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND

Reflect, research, and answer the questions below.

What is pseudocode?

Why is it beneficial to write pseudocode before programming?

ACTIVITY STEPS

1. Choose a room in your home (preferably one with two doors). Place different objects around the room that could serve as obstacles. Obstacles could include chairs, boxes, tables, pillows, etc. (Be sure your volunteer won't get hurt on the obstacle!)
2. Write out the pseudocode (space provided below) to help the person escape the room you are in. Your instructions should get your volunteer from one door to another or one side of the room to the other side.
3. Find a volunteer to act as your partner in your home. This could be an older sibling, parent, or guardian.
4. Explain the *Problem Statement* and *Escape Room Note* to your volunteer.
5. Read aloud each step of your pseudocode aloud to your volunteer and your volunteer should do EXACTLY what you've written. It is completely OPTIONAL for your volunteer to be blindfolded!
6. Your volunteer should stop once an obstacle is encountered and your steps can no longer be executed.
7. Adjust your pseudocode until your volunteer can safely reach escape the room without touching or running into anything!

PSEUDOCODE

Write out the steps your volunteer should make to safely escape the room.

REFLECTION QUESTIONS

1. What happened when you told your volunteer to walk forward?

2. How does your volunteer know how far to go or when to stop?

3. How specific did your instructions have to be?

4. How does this activity relate to programming a robot to perform actions?

5. What skills did you use or learn in this activity?

6. What Core Values were used in this activity?

GO FURTHER!

Option 1: Take the pseudocode you created for your volunteer and recreate in the coding platform you use with robot or use an online coding platform like Scratch. Even if you don't have a robot at home, you can build your code and share with your team.

Option 2: Trade places! Ask your volunteer to rearrange things in the room then write the pseudocode for you to act out.

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Bridge Design

ACTIVITY SUMMARY

Students create their own bridge design for their favorite place in the world taking into consideration: style, beauty, function, purpose, innovation, structure, form and function.

Age Range & Grade Level: *Ages 9+, Grade 4+*

Program Connection: *FIRST*® LEGO® League Challenge

Authored By: Tammy Pankey, Manager of Curriculum Development**,** *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Brainstorm and sketch ideas for bridge design.
2. Draw, describe, and label important components of bridge design.
3. Optional: Create bridge design using a computer-aided design resource.
4. Share solution with others and reflect on learning.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Forces, function	3D shapes, Trigonometry	Communication and Listening	Historical bridges, Bridge designs	Logical Thinking
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST* activities.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

KEY VOCABULARY

Function Structure Load Material Form

Engineering Design Process

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

design brief, paper, drawing utensils, ruler or computer

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the design brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Determine how students will complete the activity, what their length of time will be, how to collaborate virtually and how to share their solutions. Have students work on their solutions.	Solutions can be drawn or created with CAD.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their *Core Values Self-Reflection* and review.	*Core Values Self-Reflection* is found in the student design brief document.

STUDENT OR TEAM ACTIONS

1. Review the design brief and problem statement.
2. Research the questions and discuss.
3. Brainstorm and sketch ideas.
4. Create a detailed drawing of a bridge design to solve the challenge presented in the problem statement.
5. Optional: Create bridge design using a computer-aided design resource.
6. Share your solution and reflect on your learning.
7. Explore the Go Further! opportunities.
8. Complete your Core Values Self-Reflection.

GO FURTHER!

- Build a model of your bridge design using materials you have at home. These could include paper, spaghetti, wood, toothpicks, straws, or any other supplies.
- Examine what forces act on your bridge by placing different objects of the center of the bridge until it fails.

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution solved the challenge.	Showed how the solution would solve the challenge.	Not clear how the solution would solve the challenge.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
Bridge Design
Design Brief

PROBLEM STATEMENT

Bridges have been around for thousands of years. Today, architects design beautiful and functional bridges with unique features that reflect a city, its culture, and its geography and climate. They have to find a balance between the beauty, form, and function of their designs.

Choose your favorite place in the world! Think about where you could design a bridge in this place. Will it be across water or land? Who will use this bridge? What will be its purpose? What will it look like? How does the local culture influce what the bridge looks like? Create an artistic, unique, and innovative bridge that is also structurally sound.

CRITERIA & CONSTRAINTS

- Bridge design must consider form and function for its intended purpose.
- Bridge should be designed for location's geography, climate, culture and terrain.
- Drawing should include supports and land/ water features on either side of the bridge.
- Drawing should be detailed and contain all relevant information and could be drawn to scale on graph paper.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST® Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND

Reflect, research, and answer the questions below.

1. What are the main parts of a bridge?

2. What are the different types of bridges?

3. How were early bridge structures created and what materials were used?

4. What technological advances have there been in bridge CAD design and simulation?

ACTIVITY STEPS

1. Brainstorm how you will design your bridge structure. Sketch your ideas on a separate sheet of paper.

2. Choose your favorite bridge design. Create a detailed 2-D and/or 3-D drawing of your bridge design on a separate sheet of paper. Label and describe the following on your drawing:
    - Bridge type
    - Bridge place and location
    - Building materials
    - Estimated cost
    - Bridge form and function
    - Bridge style and features

3. Optional: Create your bridge design as a computer-aided design (CAD). Here are some free CAD resources:
    - The Bridge Designer http://bridgedesigner.org/download/
    - SolidWorks Apps for Kids https://beta.swappsforkids.com/#/
    - Autodesk Tinkercad https://www.tinkercad.com/

REFLECTION QUESTIONS

1. Why did you choose your place and location for your bridge?

2. How was your bridge design unique and innovative?

3. How did others in your team/ class design their bridges?

4. How did you ensure bridge design was structurally sound?

5. What skills did you use or learn in this activity?

GO FURTHER!

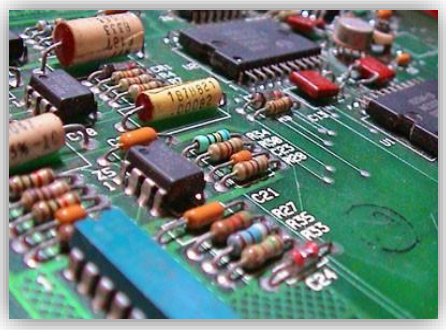
- Build a model of your bridge design using materials you have at home. These could include paper, spaghetti, wood, toothpicks, straws, or any other supplies.
- Examine what forces act on your bridge by placing different objects of the center of the bridge until it fails, pennies or other coins can be used as weights.

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home

Series and Parallel Circuits



ACTIVITY SUMMARY

After reviewing information about series and parallel circuits, students will create simulated circuits online using the Circuit Construction Kit – DC Virtual Lab provided by the University of Colorado at Boulder.

Age Range & Grade Level: *Ages 9+, Grade 5+*

Program Connection: *FIRST*® LEGO® League

Authored By: Randall Hicks, Project Manager**,** *FIRST*® LEGO® League

ACTIVITY OUTCOMES

Participants will:

1. Explore introductory concepts of electricity and electronics like voltage, current and resistance.
2. Create their own series and parallel circuits using an online simulator.
3. Design their own circuits and make predictions about voltage and current.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Conservation of Energy and Energy Transfer	Measurement, Single Step Equations	Research, Content, Reading	Career Connections, Energy in Chemical Processes and Everyday Life	Basic Electronics
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST*® activities.

ENGINEERING DESIGN PROCESS & *FIRST*® CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

KEY VOCABULARY

Conductor	Insulator	Current	Voltage	Resistance	Series Circuit
Electronics	Capacitor	Amp	Ohm	Volt	Parallel Circuit

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

FIRST Series and Parallel Circuits Design Brief, internet connected computer, tablet or smartphone.

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the *FIRST* at Home Activity: **Series and Parallel Circuits Design Brief**	**The student design brief starts on page 4**
Review the problem statement and criteria/constraints with the students.	Remind students they will need to create their circuits like the one's pictured in the activity. While there can be some variation (e.g. the wires may be shorter or longer), they should take care to make sure they have the same components, and the components are connected in the same way.
Background - Have students review the questions and get details to help them understand terms about circuits and electronics. Have students review the Autodesk website	
Have students use the simulator to practice building and measuring different types of circuits. Determine how students will complete the activity, what their length of time will be, how to collaborate, and how to share their solutions. Have students work on their solutions.	It's suggested that adults managing this activity build the virtual circuits before students so that they are familiar with troubleshooting the simulation. Solutions can be sketches or screenshots.
Review *Evidence of Achievement* rubric (on next page) and create additional assessments if needed.	Sample rubric provided.
Explore the Go Further! opportunities	See below.
Wrap up – Have students complete their core values self-assessment and review.	Core Values self-assessment is found in the **Series and Parallel Circuits** student document.

STUDENT OR TEAM ACTIONS

1. Review the activity and complete the building background to get information about electronics and circuits.
2. Use the simulator to explore series and parallel circuits.
3. Complete the challenge using the simulator.
4. Answer the reflection questions, share solutions, and complete the core values self-reflection.
5. Explore the Go Further! opportunities.

GO FURTHER!

Explore some of the other physics and electronics simulators available from the University of Colorado at Boulder

With your parent or guardian's permission, explore some hands-on electronics activities. With online searches, you can find many fun activities to do with items you can find around the house. There are also many inexpensive kits available that will let you continue experimenting with electricity and electronics.

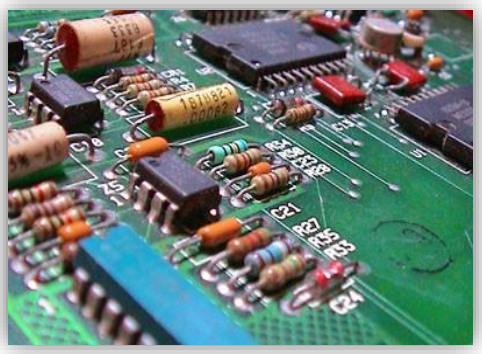
Explore Ohm's Law. Ohm's Law will let you predict exactly how much voltage, current and resistance to expect in any circuit.

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution would help others.	Showed how the solution would help others.	Not clear how the solution would help others.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
Series and Parallel Circuits
Design Brief

PROBLEM STATEMENT



Have you ever wondered what *really* makes robots move? What's inside those motors and circuit boards? They are made up of all types of electronic components, things like resistors, capacitors, integrated circuits and many more. **Electronics** is the study of how we control the movement of electrons – negatively charged sub-atomic particles – through all these components.

Electronics allows us to create the devices that help run the modern world. From robots to computers, from automobiles to airplanes, an **electrical engineer** has had a part in the design of the products that make life easier for all.

CRITERIA & CONSTRAINTS

- You will need an internet connected computer or tablet. (A smartphone should work if that's all you have.)
- You won't need an electronics kit or components: these exercises will use an online circuits simulator. You will do your work in a browser (Chrome, Firefox, Safari, etc.) on your computer or tablet.
- You'll be creating virtual circuits and answering questions.
- Your final task will be to create an original circuit using what you've learned about electronics. Your solution can be saved as a screen capture, or you can draw a diagram of your solution on a sheet of paper.
- You will reflect on your work and how you solved the problem.

ENGINEERING DESIGN PROCESS & *FIRST*® CORE VALUES

FIRST® Engineering Design Process | Explore *FIRST*® Core Values

ACTIVITY STEPS

- Open a browser on your computer or tablet and navigate to the circuit simulator
- Complete the building background section.
- Solve the circuit challenge and share your solution.
- Answer the reflection questions and complete the Core Values Self-Reflection rubric.

BUILDING THE BACKGROUND

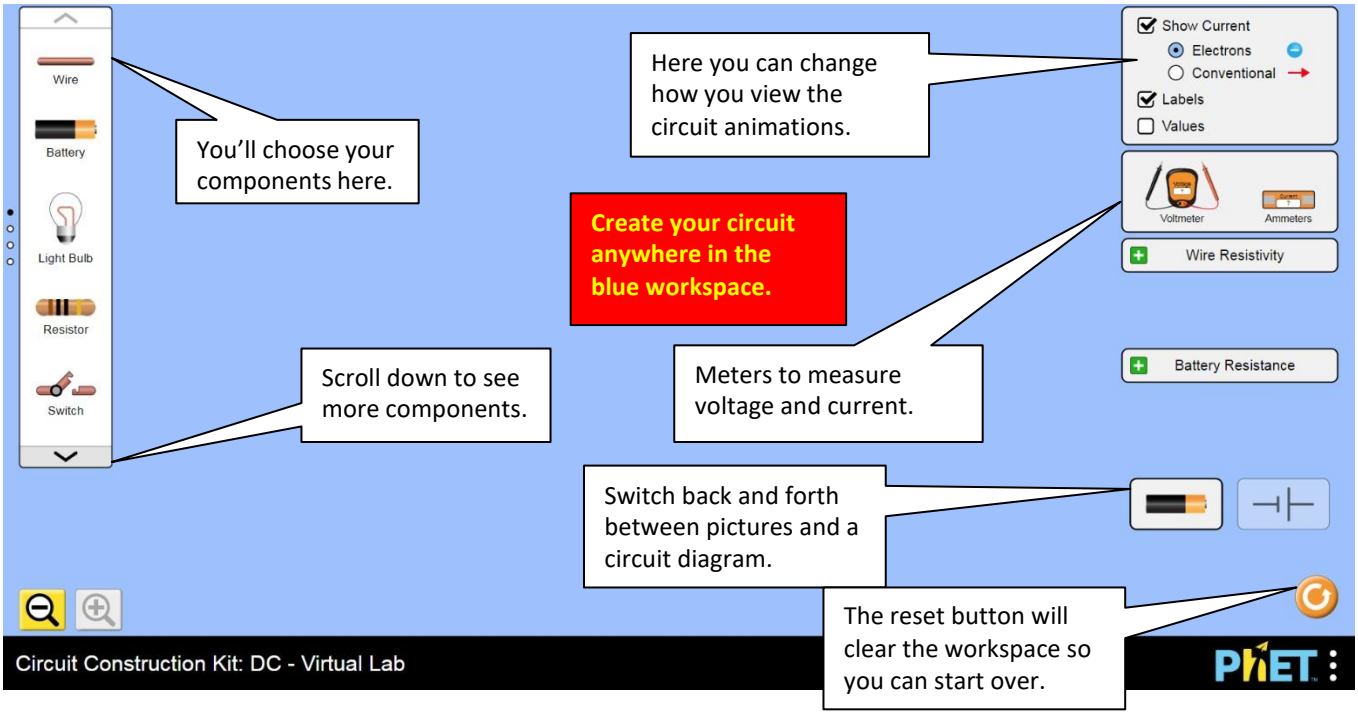
Review the Autodesk website. Use the information on the page to think about the following questions.

1. What are the basic electrical elements that make a circuit work?
2. What properties do materials that use electricity efficiently have?
3. What is the purpose of different types of circuits?
4. What types of electronic devices make up simple circuits?

Series and Parallel Circuits Simulator

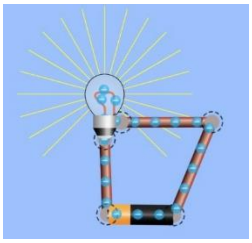
Creating Your First Circuit

a) Open and browser and navigate to the simulator. Your screen should look something like this:



Review the workspace detail above.
Create a circuit that lights the bulb.

What did you notice about making connections in the circuit?



Now let's add another bulb to our circuit. See if you can create the circuit that has 2 light bulbs and 1 battery. Use the image below as an example

What do notice about the brightness of the bulbs in this circuit?

This type of circuit is called a **series circuit**. In a series circuit, all the components – in this case the light bulbs and the wires – share a single path back to the power source, or battery. So, all the electrons have only one route to travel.

In a series circuit, the bulbs must share the voltage from the battery. In the case of this circuit, the default setting is for a 9-volt battery, so we should be able to measure half of that or 4.5 volts at each bulb.

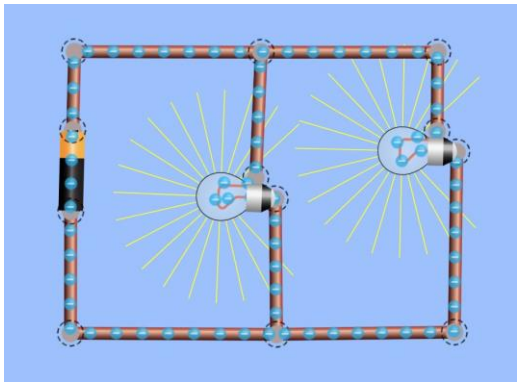
What does your voltmeter read?

What do you think you'll read across the other bulb?

How can measuring the flow of energy (hint – not volts) in this circuit help explain why when you add the additional bulb, they are both less bright?

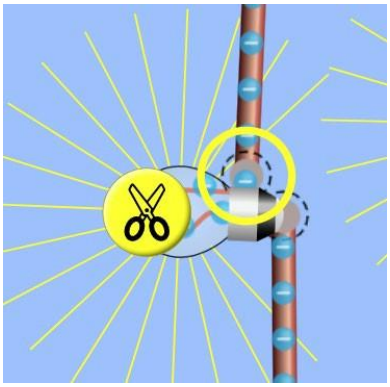
Parallel Circuits

Use the orange reset button  to clear the workspace. Now create the circuit pictured to the right. Make sure each component has its own pathway back to the battery. This may not sound like a big difference, but it really changes everything.



What do you notice about the brightness of the 2 bulbs compared to the series circuit?

What information can you learn using your meter to measure the voltage and amps in the circuit to explain the difference in brightness?



Use the scissors tool to break the wire in front of one of the bulbs.

What happens to the bulbs?

Use the meter and observe the measurement. *How have your readings changed that explain what you observe with the bulbs?*

Final Challenge

Using what you've learned so far, create a parallel circuit with **3 bulbs.**

Observe what happens to the brightness of the bulbs and take measurements to prove your observations.

SKETCH OR PASTE YOUR CIRCUIT SOLUTION

Sketch the circuit you created to solve the final challenge. This should be a circuit with 3 light bulbs in parallel. Be sure to draw all the values you recorded with the voltmeter and the ammeters. You may also take a screen capture of your solution and paste it here if you are saving your work to a file.

REFLECTION QUESTIONS

1. Think about the lights and wiring in your home or apartment. Do you think these devices use mostly series or parallel circuits? Explain your answer.

2. What would be the advantage of a series or parallel circuit?

3. As an electrical engineer what other components might you need to use to build more complex circuits?

GO FURTHER!

Explore some of the other physics and electronics simulators available from the University of Colorado at Boulder

With your parent or guardian's permission, explore some hands-on electronics activities. With online searches, you can find many fun activities to do with items you can find around the house. There are also many inexpensive kits available that will let you continue experimenting with electricity and electronics.

Explore Ohm's Law. Ohm's Law will let you predict exactly how much voltage, current and resistance to expect in any circuit.

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Bridge Engineering

ACTIVITY SUMMARY

Students use the engineering design process to create a bridge solution using limited materials.

Age Range & Grade Level: *Ages 9+, Grade 4+*

Program Connection: *FIRST*® LEGO® League

Authored By: Tammy Pankey, Manager of Curriculum Development, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Brainstorm and sketch ideas for bridge design.
2. Build and create a bridge solution to solve the challenge.
3. Share solution with others and reflect on learning.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Forces, Materials	3D shapes, Trigonometry	Communication and Listening	World bridges, Technology changes	Logical Thinking
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Forces	Structure	Span	Load
Engineering Design Process	Solution		

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

Bridge Engineering Design Brief, envelope, masking tape, rubber bands

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the *Bridge Engineering* Design Brief.	You can adjust the difficulty of the activity by adjusting the materials the students use and time provided to complete activity.
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Determine how students will complete the activity, what their length of time will be, how to collaborate virtually and how to share their solutions. Have students work on their solutions.	Solutions can be built and designed using materials around the house. Students could submit pictures or videos of their designs.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their *Core Values Self-Reflection* and review.	*Core Values Self-Reflection* is found in the student Design Brief document.

STUDENT OR TEAM ACTIONS

1. Review the Bridge Engineering Design Brief and problem statement.
2. Research the questions and discuss.
3. Brainstorm and sketch ideas.
4. Create a bridge solution to solve the challenge presented in the problem statement.
   (If students are completing at home, they could recruit a sibling, parent or guardian to do activity with them.)
5. Measure or estimate the span of your bridge solution.
6. Share your solution and reflect on your learning.
7. Explore the Go Further! opportunities.
8. Complete your Core Values Self-Reflection.

GO FURTHER!

- Use additional materials to strengthen your bridge and secure it to the chairs.
- See what load your bridge can hold by placing different objects on top of the center of the bridge until it fails.

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution solved the challenge.	Showed how the solution would solve the challenge.	Not clear how the solution would solve the challenge.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home Bridge Engineering Design Brief

PROBLEM STATEMENT

There are many architectural wonders around the world. Bridge engineers have to consider costs, location, and materials when designing these spanning wonders. You are part of the engineering team that has to create a new bridge in a rural, mountainous area that will provide a way for people to cross the river that isn't safe to cross when there are heavy rains. With this new bridge, two rural communities will now have access to each other even during heavy rains. Build a bridge using your limited materials.

CRITERIA & CONSTRAINTS

- You can only use these materials: an envelope or other paper, 3 inches of masking tape, and 5 rubber bands.
- Your bridge should span across two chairs or other objects.
- You can't use any of the materials (or yourself!) to secure the bridge to the chairs. The bridge can only rest on top of the chairs.
- Create your solution within the time allotted by your teacher or coach.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND

Reflect, research, and answer the questions below.

1. What forces act on a bridge?

2. What different materials are used in bridge building?

3. What technological advances have there been in bridge engineering and testing?

4. Name some innovative bridge engineering examples across the world.

ACTIVITY STEPS

1. Brainstorm how you will design your bridge structure. Sketch your ideas.

2. Create the solution you think is best.

3. Record or estimate the distance that your bridge spans between the chairs.

REFLECTION QUESTIONS

1. How did you decide where to start?

2. How did you decide what to do with the materials?

3. Did everyone feel like their ideas were heard and considered?

4. What did you learn by doing this activity?

5. What would you do differently if you did it again?

GO FURTHER!

- Use additional materials to strengthen your bridge and secure it to the chairs.
- See what load your bridge can hold by placing different objects on top of the center of the bridge until it fails.

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Marble Roller Coaster

ACTIVITY SUMMARY

Students use the engineering design process to create a roller coaster using the given materials that will safely transport the marble from start to finish.

Age Range & Grade Level: *Ages 9+, Grade 4+*

Program Connection: *FIRST*® LEGO® League Challenge

Authored By: Tammy Pankey, Manager of Curriculum Development, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Design a roller coaster that will have loops, hills and drops.
2. Build a roller coaster that will safely transport the marble from start to finish.
3. Analyze the results to see if their design would fit the given problem.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Forces and motion, energy	Estimation and problem solving	Writing and sentence usage	Historical perspectives	Logical Thinking
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Forces	Motion	Design
Engineering design process	Engineer	Solution

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

Marble Roller Coaster Design Brief, (for constructing the track - paper, cardstock, insulation tubing cut in half), tape, rulers, marble, chairs or other objects to support the structure.

GUIDANCE & SET-UP

Description – Action – Guidance	Notes
Provide students with the design brief	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Determine how students will complete the activity, what their length of time will be, how to collaborate virtually and how to share their solutions. Have students work on their solutions.	Solutions can be built and designed using materials around the house. Students could submit pictures or videos of their designs.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their *Core Values Self-Reflection* and review.	*Core Values Self-Reflection* is found in the student design brief document.

STUDENT OR TEAM ACTIONS

1. Review the Marble Roller Coaster Design Brief and problem statement.
2. Research the questions and discuss.
3. Brainstorm ideas.
4. Generate a rough sketch of your marble roller coaster.
5. Create a marble roller coaster solution to solve the challenge presented in the problem statement.
   (If students are completing at home, they could recruit a sibling, parent or guardian to do activity with them.)
6. Determine your testing and observation methods. Analyze your results after testing.
7. Iterate on your design and make improvements. Test again.
8. Generate a sketch that shows the final roller coaster that you created.
9. Share your solution and reflect on your learning.
10. Explore the Go Further! opportunities.
11. Complete your Core Values Self-Reflection.

GO FURTHER!

- Go online to https://www.learner.org/series/interactive-amusement-park-physics/. Build a roller coaster and evaluate your design. Click “Your Safety Inspection” to analyze your design.
  - Why did your design work? Why did it fail? Describe below how each step was successful or a failure.

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution solved the challenge.	Showed how the solution would solve the challenge.	Not clear how the solution would solve the challenge.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
Marble Roller Coaster
Design Brief

PROBLEM STATEMENT

You are president of an engineering firm that designs and builds roller coasters. Six Flags has just commissioned you and your team of highly trained and specialized engineers to design their new roller coaster. This is to be the premier roller coaster in the world. It is to be faster and more thrilling than any other coaster that exists today.

CRITERIA & CONSTRAINTS

- The roller coaster must change levels at least 7 times.
- The roller coaster must have a minimum of two loops.
- A marble will be used as the vehicle for your marble roller coaster.
- The marble will begin at the top of the coaster and end at the bottom level of the coaster.
- The Marble does not have to return to the starting point.
- After you assemble your roller coaster, test it and record your observations, analyze the results.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND

Reflect, research, and answer the questions below.

What forces act on a roller coaster?

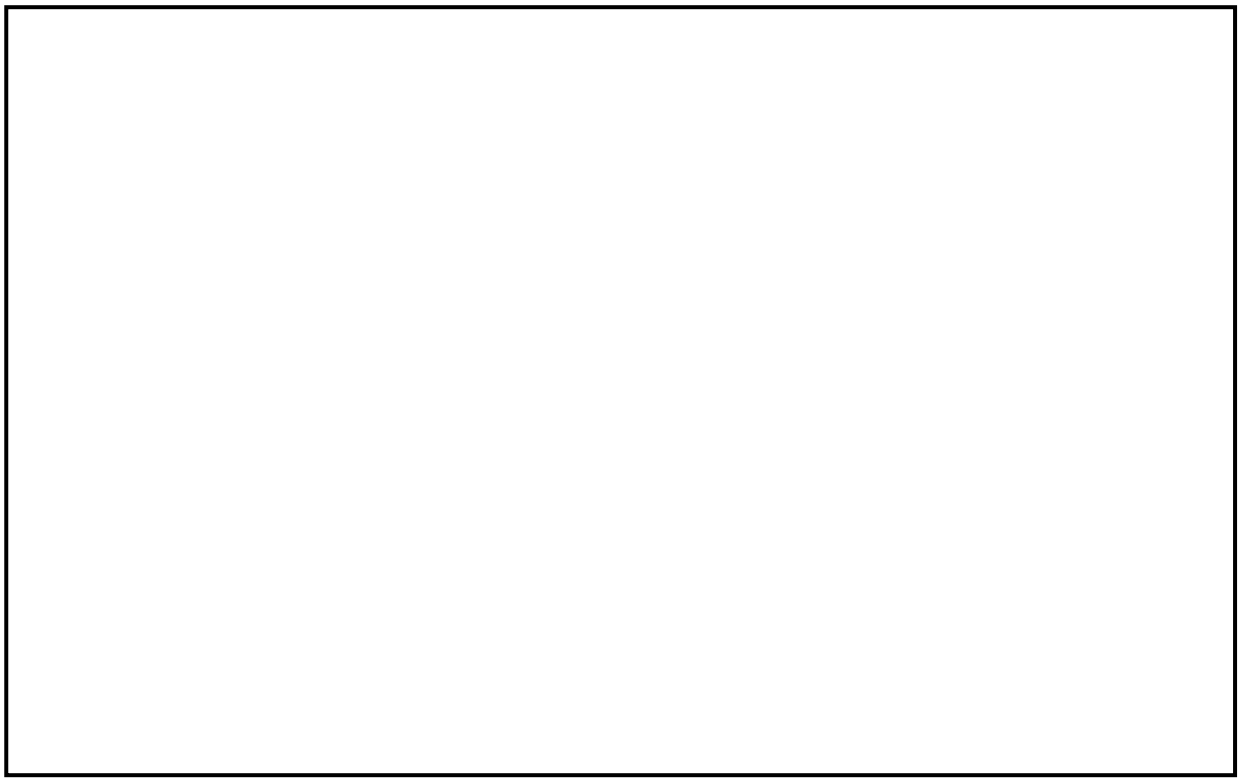
What different materials are used to build roller coasters?

What technological advances and innovative designs have there been in roller coasters?

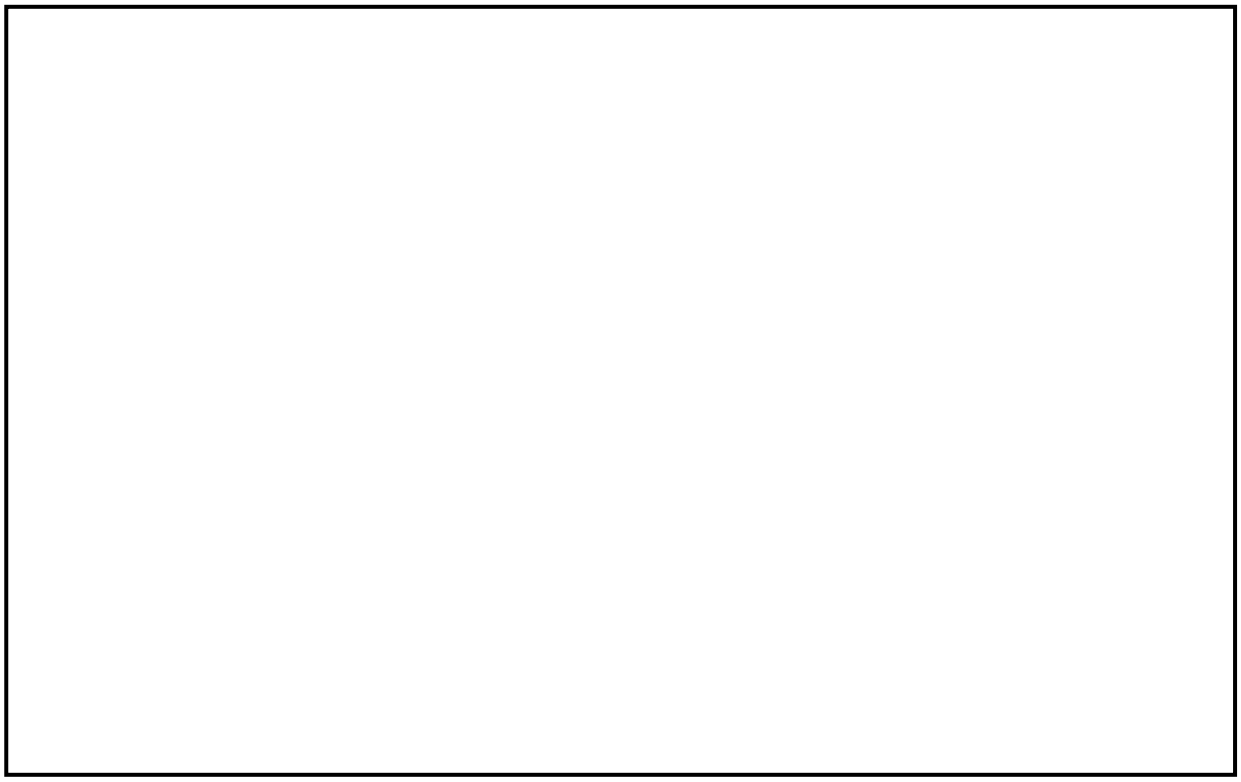
What is the history of roller coasters?

ACTIVITY STEPS

1. Brainstorm your ideas for your marble roller coaster solution.
2. Generate a rough sketch of your marble roller coaster. Include how the device will look, approximate dimensions (size), materials used and other important information about the design.



3. Create your solution.
4. Determine your testing and observation methods. Analyze your results after testing.
5. Iterate on your design and make improvements. Test again.
6. Generate a sketch that shows the final roller coaster that you created.



REFLECTION QUESTIONS

1. How does the starting position of the marble affect the speed of the marble at the end of the first hill?

2. What happens to the marble's energy as it goes up a hill and slows down?

3. Would a marble ever be able to get over a hill higher than its initial starting height? Why?

4. How would using a different sized marble affect its initial potential energy?

5. If a life-sized version of your roller coaster was built would you ride it? Why?

GO FURTHER!

- Go online to https://www.learner.org/series/interactive-amusement-park-physics/. Build a roller coaster and evaluate your design. Click “Your Safety Inspection” to analyze your design.
    - Why did your design work? Why did it fail? Describe below how each step was successful or a failure.

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
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Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Remote Communication

ACTIVITY SUMMARY

Students work in pairs to remotely communicate their vehicle model designs using only verbal communication. One student will create the vehicle model then has to verbally communicate instructions to the other student in a different location on how to build the model.

Age Range & Grade Level: *Ages 9+, Grade 4+*

Program Connection: *FIRST*® LEGO® League Challenge

Authored By: Tammy Pankey, Manager of Curriculum Development, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:
1. Design a vehicle model.
2. Draw and write out a plan to communicate this design to their partner without pictures or video.
3. Remotely communicate design build instructions verbally to partner.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Simple machines	Estimation and problem solving	Writing and sentence usage	Communications	Logical Thinking
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Remote
Communication
Design
Engineering Design Process
Engineer
Solution

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

Remote Communication Design Brief, LEGO elements or any materials at home that could be used to construct a vehicle like cardboard, paper, cups, recycled materials, etc.

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the design brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Determine how students will complete the activity, what their length of time will be, how to collaborate virtually and how to share their solutions. Have students work on their solutions.	Solutions can be built and designed using materials around the house. Students could submit pictures or videos of their designs.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their *Core Values Self-Reflection* and review.	*Core Values Self-Reflection* is found in the student design brief document.

STUDENT OR TEAM ACTIONS

1. Review the *Remote Communication* Design Brief and problem statement.
2. Research the questions and discuss.
3. Brainstorm your ideas for your vehicle model. Think about the materials that you and your partner both have available.
4. Create a sketch of your vehicle design. Include your design specifications.
5. Create your vehicle model that solves the challenge presented in the problem statement.
   (Be sure to pair students with a partner on the team or in the class. Or this could be done with a sibling or someone at home in a separate room.)
6. Write out your plan for how to communicate to your partner how to build the vehicle model that you have designed.
7. Communicate to your partner how to build your vehicle model.
8. Compare your vehicle model to your partner's vehicle model after this activity is complete.
9. Share your solution and reflect on your learning.
10. Explore the Go Further! opportunities.
11. Complete your Core Values Self-Reflection.

GO FURTHER!

- Trade roles! You will listen to your partner's design now and create it!
- Iterate on your design! Get feedback from your partner. What improvements can you make? Work together to make an even better design. Make it functional and test it out.

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution solved the challenge.	Showed how the solution would solve the challenge.	Not clear how the solution would solve the challenge.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home Remote Communication Design Brief

PROBLEM STATEMENT

Imagine that you are an engineer collaborating with another engineer in a completely different location. You are in Location A and your partner is in a remote location (Location B), out of sight, and out of range to meet with or talk to, face-to-face.

You have been asked to make a simple vehicle model. You will be designing the model at your location (Location A), but the final product will need to be reproduced by your colleague at a different location (Location B).

Your colleague, in Location B, has the required components, but does not have the design specifications for the model. They will need recreate the model you've designed, based on communication from you in Location A.

CRITERIA & CONSTRAINTS

- You may not take a picture of the design or show the individual (in Location B) a photo of the model you have developed.
- The materials you use to make your vehicle model must be the same ones available to your partner at their location.
- Your model can't be bigger than 12" x 12" x 12" (L x W x H).

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND

Reflect, research, and answer the questions below.

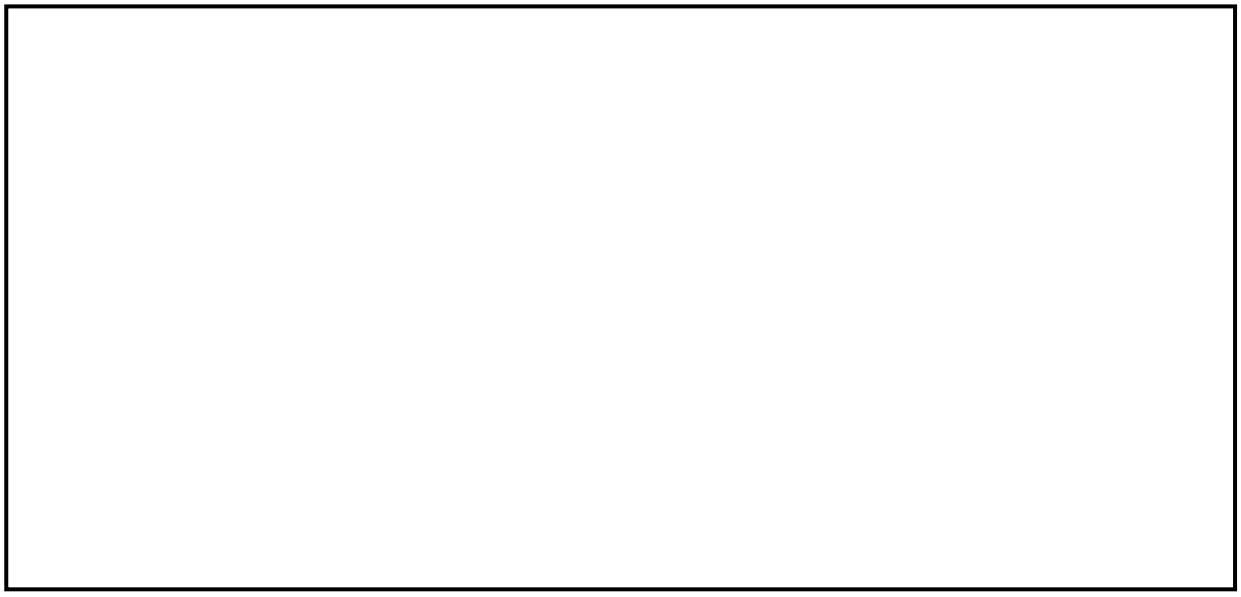
1. What are design specifications?

2. What do engineers include in their model drawings?

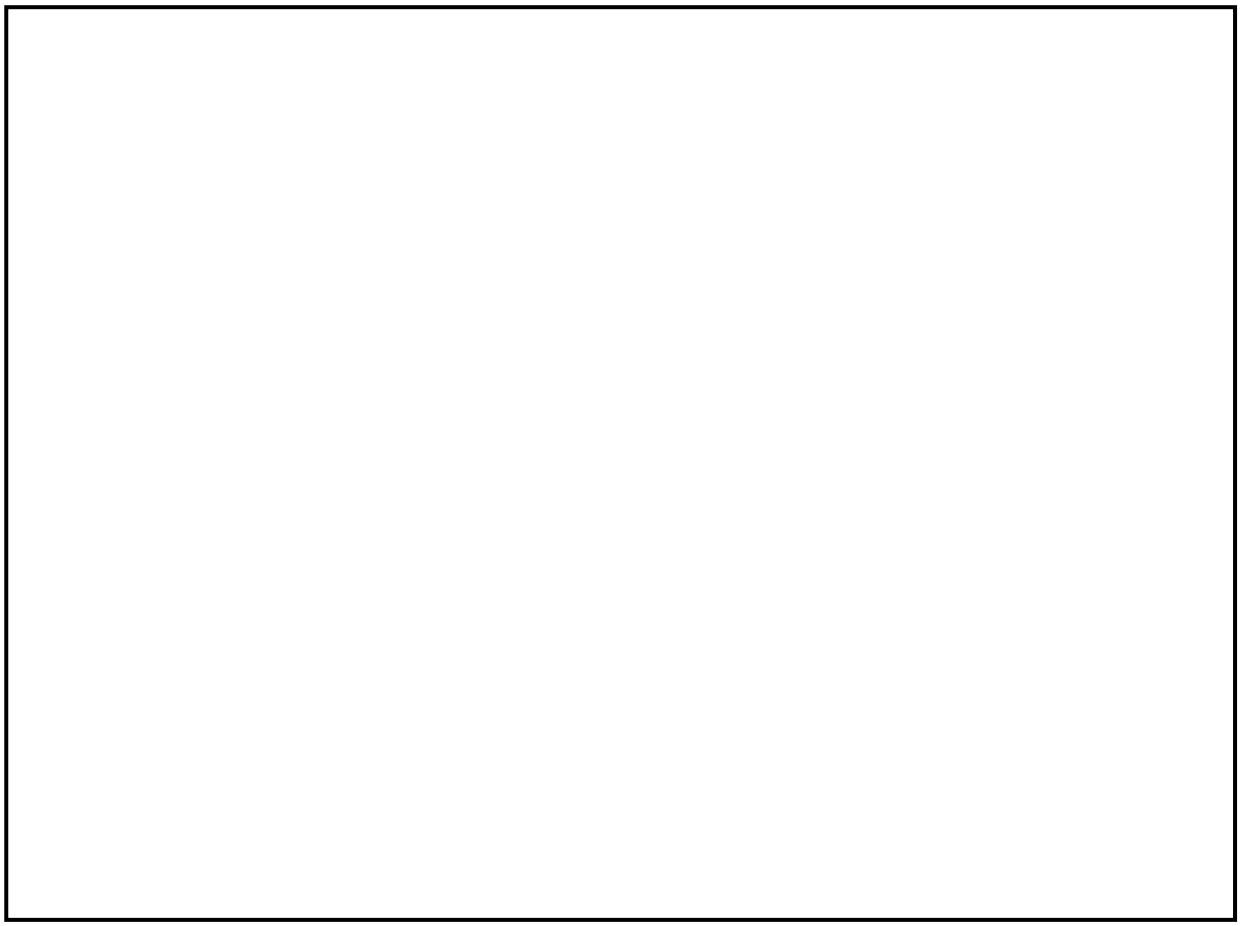
3. What technological advances and innovative designs have there been in roller coasters?

ACTIVITY STEPS

1. Brainstorm your ideas for your vehicle model. Think about the materials that you and your partner both have available.
2. Create a sketch of your vehicle design. Include your design specifications.



3. Create your vehicle model.
4. Write out your plan for how to communicate to your partner how to build the vehicle model that you have designed.



5. Communicate to your partner how to build your vehicle model.
6. Compare your vehicle model to your partner's vehicle model after this activity is complete.

REFLECTION QUESTIONS

1. What did you **DISCOVER** about yourself and your partner when completing this activity?

2. How did you both use **TEAMWORK** to create your vehicle models?

3. What is the importance of communication in the *FIRST* Core Values?

4. In what ways was **INNOVATION** used during this activity?

5. What challenges did you face by having to do this activity remotely? How does this demonstrate **INCLUSION**?

GO FURTHER!

- Trade roles! You will listen to your partner's design now and create it!
- Iterate on your design! Get feedback from your partner. What improvements can you make? Work together to make an even better design. Make it functional and test it out.

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Python 101

ACTIVITY SUMMARY

After reviewing some basic computer science terms, students will be guided through introductory-level coding tasks that explore math operators and program structures. Students will then copy and view a program that manipulates and graphics "sprite," and iterate on this program to solve a final challenge.

Age Range & Grade Level: *Ages 9+, Grade 4+*

Program Connection: *FIRST*® LEGO® League Challenge

Authored By: Randal Hicks, Project Manager, *FIRST*® LEGO® League

ACTIVITY OUTCOMES

Participants will:

1. Explore the basic structure of the Python programming language including math operators, variables and strings.
2. Create and iterate coding samples using an online Python coding platform (codesters.com).
3. Problem-solve and design their own programs using a "sprite" graphics module.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Building models and simulations, planning and carrying out investigations	Analyzing data, math functions	Research, content reading	Career connections	Programming languages
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Computer	Program	String	Hardware
Code	Variable	Operation	Loop

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

Python for Beginners design brief, Internet-connected computer or tablet or smartphone

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the *FIRST* Python 101 design brief.	
Review the problem statement and criteria/constraints with the students.	Remind students they will need to copy the code samples and programs *exactly* as they are pictured in the lesson. Also, students will need to delete or clear the previous code or programs before using the Python editor for each new task. See the callouts that describe what to do if students get a syntax error.
Background	Have students review (or type/write) the definitions to the key vocabulary.
Determine how students will complete the activity, what their length of time will be, how to collaborate and how to share their solutions. Have students work on their solutions.	It's suggested that adults managing this activity work-through the coding activities before students so that they are familiar with troubleshooting problems. Solutions can be saved text files of code or screenshots.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their core values self-assessment and review.	Core Values self-assessment is found in the Python for Beginners student lesson.

STUDENT OR TEAM ACTIONS

1. Review the definitions to the key vocabulary using https://k12cs.org/glossary/
2. Work through the activities and the final challenge of the "Python 101" design brief.
3. Write, save or copy/paste solutions to the final challenge in the space provided.
4. Answer the Reflection Questions and share solutions.
5. Explore the Go Further! opportunities.
6. Complete the *FIRST* Core Values self-assessment.

GO FURTHER!

Explore more programming and coding activities here: https://hourofcode.com/us/beyond#student- section

Download the Python Integrated Development Environment (IDE) so you can write and save your own programs. Instructions can be found here: https://www.python.org/about/gettingstarted/

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution would help others.	Showed how the solution would help others.	Not clear how the solution would help others.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
Python 101
Design Brief

PROBLEM STATEMENT

Computer programmers design software solutions that drive the modern world. From the time you get up in the morning and use a microwave oven, to when you check your social media accounts at night before you go to bed, you've probably been interacting with computer programs all day long. If you've ever played with a robot, you've probably even created your own program to make the robot move and sense its environment. Are you ready to take your programming to the next level? This lesson will introduce you to a free text-based programming language "Python." Python is used by computer programmers around the world to create apps and websites.

CRITERIA & CONSTRAINTS

1. You need an internet connected computer or tablet or smartphone.
2. Use the provided link to the online version of Python.
3. You will do your work in a browser (Chrome, Firefox, Safari, etc.) on your device.
4. At first, you'll be copying code samples until you learn some Python basics.
5. Your final task will be to solve a problem using what you've learned about Python.
6. Save your solution as a screen capture, or you can write your solution on a sheet of paper.
7. Complete the reflection about your work and how you solved the problem.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

BUILDING BACKGROUND

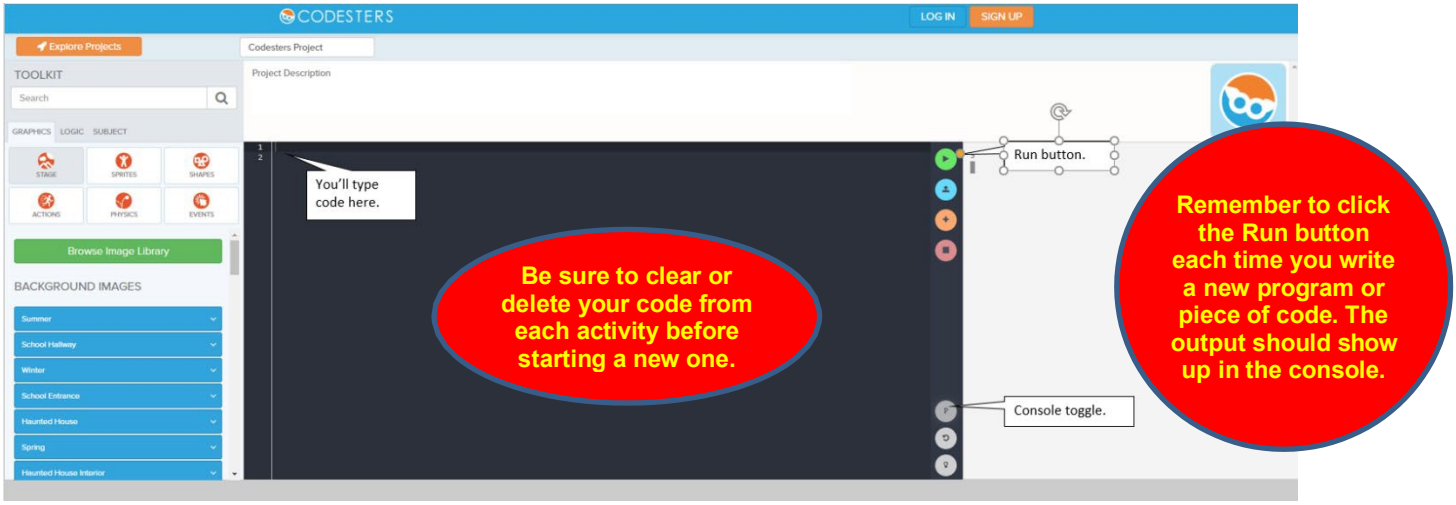
Review the definitions to the following computer science terms. You might want to use the online glossary found here: https://k12cs.org/glossary/

Computer	Program	String
Hardware	Code	Operation
Software	Variable	Loop

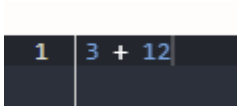
PYTHON CODING AND PROGRAMMING ACTIVITIES

Part 1 – The Basics

a) Open a web browser and navigate to https://www.codesters.com/project/ . Your screen should look something like this:



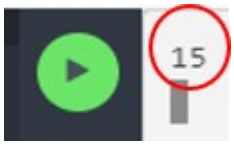
b) First, we'll try typing in some code into the black box and then clicking on the green Run button.

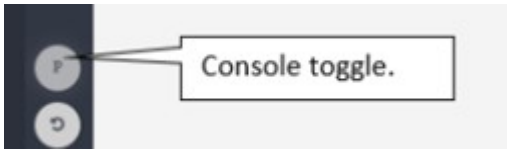


That didn't seem to do much, so let's try it a different way:

```
1  print 3 + 12
```

After you type the command Print and click the Run button, you should see the number 15 appear in the console screen next just next to the Run button. If you don't see any output, try clicking the Console toggle button.





c) Now let's try a few other things. Edit your print statement to read **Print 12 - 3**. Remember to click the Run button again to see the results.

Next let's see how Python handles math order of operations with parentheses.

Try out some more addition and subtraction own!

```
1  print (12 - 3 - 12 - 11)
```

```
1  print (12 - 3) - (12 - 11)
```

```
1  print (12 - 3) - (12 - 11) - 8
```

d) Next, let's see how Python deals with multiplication and division. You will use the asterisk * for multiplication and the forward slash / for division. Use parentheses to help with order of operations.

PYTHON CODING AND PROGRAMMING ACTIVITIES (continued…)

Try the following lines of code. Remember to hit the Run button after you type each line.

```
print 50 - 5 * 6
```

```
print (50 - 5) * 6
```

```
print (50 - 5 * 6) / 4
```

So far, you've learned what the Print command does, how to add, subtract, divide and multiply, and how to control order of operations with parentheses.

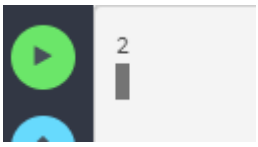
Part 2 – Next-Level Math

a) Now let's look at some types of math operations you may not have seen before. We'll also introduce how variables – or a symbolic name that is used to keep track of a value that can change while a program is running. In computer science, when you want to show the remainder in a division operation as a decimal, it's called "float" division. In the piece of code below we'll declare a variable called **my_var** by give it an initial value of 7.0 / 3.0. We're telling the computer we want to do float division by using decimals with the 7.0 and the 3.0. The result shows the answer to 11 decimal places.

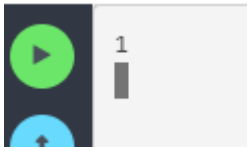
```
my_var = 7.0 / 3.0
print my_var
```

b) Next let's look at a couple of other types of division. Floor division just returns the integer part of the answer, so there is no remainder or decimal. Remainder, or "modulus" division, returns, as you might guess, *just* the remainder. Two forward slashes **//** is the operator for floor division, and the percent sign **%** is the operator for modulus division. Try the following samples of code:

```
my_var = 7// 3
print my_var
```




```
my_var = 7 % 3
print my_var
```

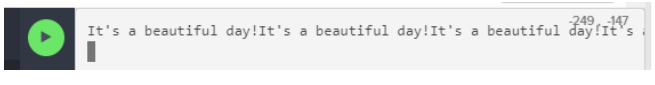


Part 3 – Strings

In computer programming, a **string** is a sequence of letters, numbers or other symbols that are not typically used for math operations. Strings might represent things like names and addresses, and they can be stored in variables just like numbers. In the following code, we'll assign a variable called my_string to hold the string "It's a beautiful day." Then we'll show how we can use math to print multiple copies of this string.

```
my_string = "It's a beautiful day!"
print my_string
```


```
my_string = "It's a beautiful day!"
print my_string * 5
```



Part 4 – Graphics and Sprites

Python has some fun ways for you to start learning about coding and programming. One of them is a sprite – a very simple animation that you can move around and interact with.

PYTHON CODING AND PROGRAMMING ACTIVITIES (continued…)

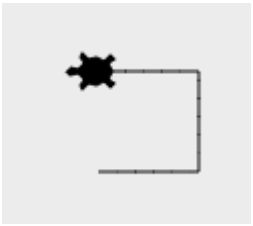
a) The following program will place the Tina the Turtle sprite on the console screen and move her from left to right *and back* after a 1 second pause. Copy the program *exactly* as you see it here.

```
1  import turtle
2  tina = turtle.Turtle()
3  tina.shape('turtle')
4  tina.penup()
5  tina.forward(20)
6  my_string = "Why, hello there!"
7  tina.write(my_string)
8  stage.wait(1)
9  tina.backward(20)
```

Do you see how we've used the **my_string** variable? How could you make Tina say something different? How do you think you could make Tina wait 2 seconds before moving back to the left? *Give it a try!*

b) The following program will make Tina draw ¾ of a square.

```
1  import turtle
2  tina = turtle.Turtle()
3  tina.shape("turtle")
4  tina.forward(50)
5  tina.left(90)
6  tina.forward(50)
7  tina.left(90)
8  tina.forward(50)
9
```



What lines of code do you need to add to make Tina complete the square? *Try it out and see if you're right!*

c) Let's see if we can make Tina draw some more interesting shapes. To do this, we'll create a structure called a **list**, and fill it with numbers. In order to make Tina do something over and over, we'll use something called a **loop**. With a list and a loop, we can get Tina to move over and over in a predictable way.

The numbers in the list control how many times Tina turns.

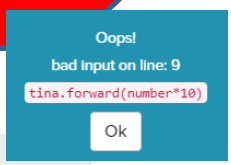
This number makes Tina move forward a little further after each turn.

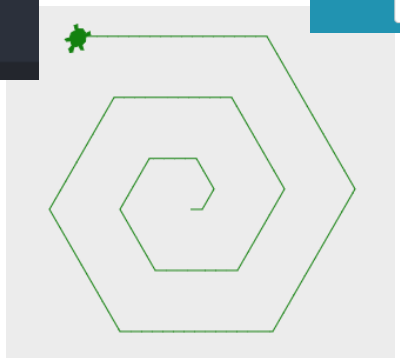
```
1  import turtle
2  tina = turtle.Turtle()
3  tina.shape('turtle')
4
5  number_list = [1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16]
6
7  tina.color("green")
8  for number in number_list:
9      tina.forward(number*10)
10     tina.left(60)
11
```

Be sure to indent the loop

This number controls the angle of the turn.

If you get an error when you run your program, it means you've probably typed something in wrong. Be sure to check your work carefully!



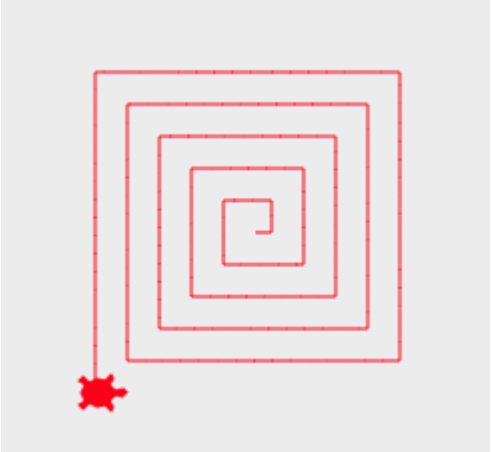


PYTHON CODING AND PROGRAMMING ACTIVITIES (continued…)

Try adjusting the values in the number list, the multiplier that makes Tina move a little further each time, and the number that controls the angle of the turn. See what new shapes you can make. Remember to click Play each time you change some of these numbers.

Part 5 – Final Challenge

Using what you've learned so far, write a program that will make the following shape:



Hint: You should be able to use the program in section C of Part 4 above to make this shape. You will need to change the values in the number list, the multiplier, and the number that controls the angle of the turn. Also, you will need to find the part of the program that sets Tina's color. Think back to how you made the square shape in section B of Part 4.

Once you've created your solution, be sure to write it down (or type and save it) so you can share your program. You can also take a screen capture of your program and your output and save it to a file. Finally, be sure to complete the Core Values Self-Reflection below.

Most of all, *have fun!* And if you like this activity, see the Go Further! section above and try some new coding and programming activities.

WRITE OR PASTE YOUR PROGRAM SOLUTION

Write the code you created to solve the final challenge in the box below. You may also take a screen capture of your program and the program output and save it to a file.

REFLECTION QUESTIONS

2. Explain what the following terms mean and how you might use each in a computer program: a) float division, b) floor division and c) modulus division.

3. What was the hardest part of this activity?

4. What skills did you use or learn in this activity?

5. How did math help you solve this programming challenge?

GO FURTHER!

- Explore more programming and coding activities here: https://hourofcode.com/us/beyond#student-section
- Download the Python Integrated Development Environment (IDE) so you can write and save your own programs. Instructions can be found here: https://www.python.org/about/gettingstarted/

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Soda Can Design

ACTIVITY SUMMARY

Students create a soda can design (2-D drawing, 3-D design, physical model) and pitch their design in a sales presentation.

Age Range & Grade Level: *Ages 9+, Grade 4+*

Program Connection: *FIRST*® LEGO® League Challenge

Authored By: Tammy Pankey, Manager of Curriculum Development, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Design an appealing soda can.
2. Give an oral presentation to the class about the soda can.
3. Build a model of the newly designed soda can.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Nature of Technology	Geometric Shapes	Persuasive writing, Presentation		Computed Aided Design
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Computer Aided Design	Model	Design	Sales Pitch
2-D and 3-D	Presentation		

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

Soda Can Design Brief, blank paper, empty soda can, art supplies, tape or glue (Optional – computer with internet access, Microsoft Paint or other design program i.e. Tinkercad or SketchUp)

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the design brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Determine how students will complete the activity, what their length of time will be, how to collaborate virtually and how to share their solutions. Have students work on their solutions.	Provide the resources you want the team to use for their 2-D and 3-D design creations. • SolidWorks Apps for Kids https://beta.swappsforkids.com/#/ • Autodesk Tinkercad https://www.tinkercad.com/ • SketchUp
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their *Core Values Self-Reflection* and review.	*Core Values Self-Reflection* is found in the student design brief document.

STUDENT OR TEAM ACTIONS

1. Review the *Soda Can* Design Brief and problem statement.
2. Research the questions and discuss.
3. Think of an exciting name for your new soft drink.
4. Sketch three possible "eye-catching" designs. Remember visual impact (how attractive and appealing your design looks) will influence first time buyers.
5. Select the best soda can design and create a 2-D drawing of it in a paint program or full-size colored drawing on a sheet of paper.
6. (Optional) Create a 3-D model of your design using a computer-aided design (CAD) software. Remember to follow the design criteria and constraints!
7. Create a physical model of your soda can design that contains all the design elements.
8. Write a sales slogan for your soda.
9. Prepare a one-minute oral presentation of your product. Explain what shapes and colors seem to be the most eye catching. Explain how and why you choose this design for your soda. Share your sales slogan. Show your 2-D and 3-D designs and your physical model.
10. Explore the Go Further! opportunities.
11. Complete your Core Values Self-Reflection.

GO FURTHER!

- Create a presentation of your sales and marketing strategy for your new soda can.
- Create the packaging for the box that will hold the soda cans. This design also needs to have visual impact and appeal to buyers. Repeat the steps in this activity.

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution solved the challenge.	Showed how the solution would solve the challenge.	Not clear how the solution would solve the challenge.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home

Soda Can Design
Design Brief

PROBLEM STATEMENT

The board of directors of your soft drink company has just listened to the projected sales report from the marketing department—and it's not good. Your two main competitors have been outselling you over the last seven months. Something has to be done and soon! The task of coming up with a new soft drink has been turned over to your Research and Development (R&D) department. The new drink is ready for production and distribution; all you need is an exciting name and design for the soda can.

CRITERIA & CONSTRAINTS

- The design, must include all the following
  - Name of drink
  - Ingredients
  - Bar code
  - Catchy design
- You must use only the materials provided to you.
- Include a 2-D and 3-D design of your soda can.
- Finished design should be taped around an empty soda can.
- You must create a sales presentation of soda can design.

ENGINEERING DESIGN PROCESS & *FIRST* CORE VALUES

FIRST Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND

Reflect, research, and answer the questions below.

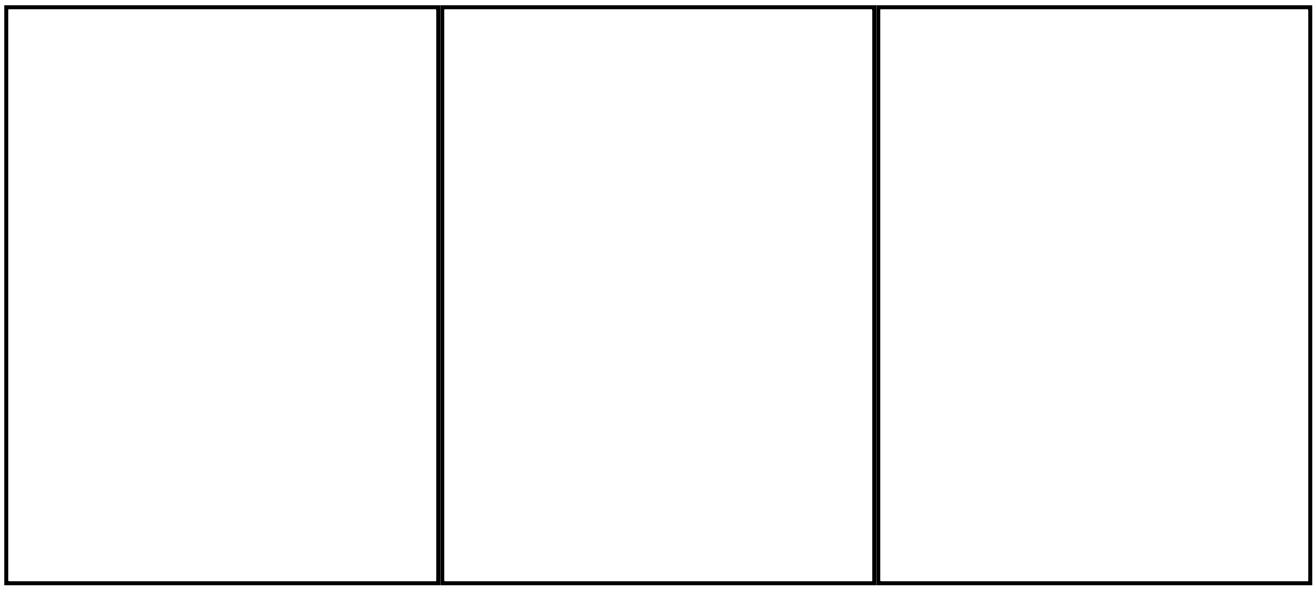
1. What are strategies that designers use to convince customers to buy their products?

2. What design elements are important when creating a product?

3. How have soda can designs changed over time?

ACTIVITY STEPS

1. Think of an exciting name for your new soft drink.
2. Sketch three possible "eye-catching" designs. Remember visual impact (how attractive and appealing your design looks) will influence first time buyers.



3. Select the best soda can design and create a 2-D drawing of it in a paint program or full-size colored drawing on a sheet of paper.
4. Create a 3-D model of your design using a computer-aided design (CAD) software. Remember to follow the design criteria and constraints! Here are some free CAD resources:
   - SolidWorks Apps for Kids
   - Autodesk Tinkercad
   - SketchUp
5. Create a physical model of your soda can design that contains all the design elements.
6. Write a sales slogan for your soda.

7. Prepare a one-minute oral presentation of your product. Explain what shapes and colors seem to be the most eye catching. Explain how and why you choose this design for your soda. Share your sales slogan. Show your 2-D and 3-D designs and your physical model.

REFLECTION QUESTIONS

1. How was your bridge design unique and innovative?

2. How did you ensure your design had visual impact?

3. How did you have to change your design idea when you went from a 2-D drawing to a 3-D drawing to a physical model?

4. What skills did you use or learn in this activity?

5. What would you do differently if you did it again?

GO FURTHER!

- Create a presentation of your sales and marketing strategy for your new soda can.
- Create the packaging for the box that will hold the soda cans. This design also needs to have visual impact and appeal to buyers. Repeat the steps in this activity.

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Robot Arm

ACTIVITY SUMMARY

Using the engineering design process to solve a problem, students will build and test a prototype for a robotic arm.

Age Range & Grade Level: *Ages 9+, Grade 4+*

Program Connection: *FIRST*® LEGO® League Challenge

Authored By: Libby Simpson, Director of Education, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Research potential occupational hazards and ergonomic design for humans.
2. Create a design for a robotic arm that humans can use in a manufacturing environment.
3. Build a prototype and test the solution.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Engineering & Design Thinking
Scientific Method and Engineering Design Process	Measurement, Shapes, Force and Motion	Persuasive writing, Presentation		Human Centered Design
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Manufacturing	Occupational	Ergonomics	Prototype
Engineering Design Process	Hazard	Human Centered Design	

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

Robot Arm Design Brief, cardboard, glue, rulers, scissors, other assorted materials for building, string or yarn.

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the design brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students. Show the video for inspiration.
Review the problem statement and explore new vocabulary with students.	
Determine how students will complete the activity, what their length of time will be, how to collaborate virtually and how to share their solutions. Have students work on their solutions.	Suggest the materials or provide materials for students to use.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* opportunities	See below
Wrap up – Have students complete their *Core Values Self-Reflection* and review.	*Core Values Self-Reflection* is found in the student design brief document.

STUDENT OR TEAM ACTIONS

1. Review the *Robot Arm* Design Brief and problem statement.
2. Research the questions and discuss.
3. Analyze your materials and create a design sketch.
4. Build and test your solution.
5. Explore the Go Further! opportunities.
6. Complete your Core Values Self-Reflection.

GO FURTHER!

- Create a presentation pitch for the board meeting and plan out how you would show that your device works.

- Create a design and determine the materials that would be used to build a full working model of your prototype.

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution solved the challenge.	Showed how the solution would solve the challenge.	Not clear how the solution would solve the challenge.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home

Robot Arm Design Brief

PROBLEM STATEMENT

The manufacturing department of your soda can production company needs you to find a solution to creating a safer working environment for the employees. One of the tasks that has created many injuries is removing hot soda cans from one point to another. Use your knowledge of mechanics and robotics to create a solution that will keep the workers safe while doing this task. Prepare a working prototype to demonstrate your idea at the next safety board meeting.

CRITERIA & CONSTRAINTS

- Your device must work using human hands.
- Create a solution that is easily put on and removed.
- Your solution must be low cost.
- Your solution should be a working prototype that demonstrates how the device works.

ENGINEERING DESIGN PROCESS & *FIRST*® CORE VALUES

FIRST® Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND

Reflect, research, and answer the questions below.

Watch this video for inspiration.

1. What are occupational hazards in soda can manufacturing environments?

2. What measurements do you need to think about before designing and building a solution?

3. What materials that you have access to, will work best to build a solution for a prototype?

4. How does a prototype differ from a design?

SKETCH YOUR DESIGN

Be sure to include any measurements you need to create your prototype.

BUILD THE DESIGN

Collect your materials and build your prototype. Be sure to follow all safety instructions or rules.

TEST THE PROTOTYPE

Determine how to test your robot arm to see if it works.

REFLECTION QUESTIONS

1. How is your solution similar or different from other types of robots used in manufacturing?
2. How did you test if your design worked?
3. How did ergonomics play an impact in your solution?
4. How would you describe the types of tasks your device can help humans do?
5. What skills did you use or learn in this activity?
6. What would you do differently if you did it again?

GO FURTHER!

- Create a presentation pitch for the board meeting and plan out how you would show that your device works.
- Create a design and determine the materials that would be used to build a full working model of your prototype.

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Gravity Car

ACTIVITY SUMMARY

Students design, build, and test a vehicle powered by the force of gravity.

Age Range & Grade Level: *Ages 9+, Grade 4+*

Program Connection: *FIRST*® LEGO® League Challenge

Authored By: Tammy Pankey, Manager of Curriculum Development, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Design and build a car powered by gravity.
2. Conduct tests of the gravity car on a gravity ramp.
3. Make observations and determine the average distance traveled.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science/Design Thinking
Forces and Motion	Measurement Distance	Research	Environmental issues	Engineering Design Process, Testing, Iteration
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Force	Distance	Design	Gravity
Modification	Average		

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

Gravity Track Design Brief, materials to build gravity car (LEGO® set or materials around home), materials to build gravity track (wooden board, 10 boards or materials around home)

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the design brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Determine how students will complete the activity, what their length of time will be, how to collaborate virtually and how to share their solutions. Have students work on their solutions.	Make sure students record the track distance. As an option, students could create their gravity car designs in a CAD program online.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* Opportunities	See below.
Wrap up – Have students complete their *Core Values Self-Reflection* and review.	*Core Values Self-Reflection* is found in the student design brief document.

STUDENT OR TEAM ACTIONS

1. Review the *Gravity Car* Design Brief and problem statement.
2. Research the questions and discuss.
3. Generate a rough sketch of your Gravity Car design.
4. Create your Gravity Car following the criteria and constraints.
5. Set up your gravity track.
6. Record your distance after each run. Determine the average distance.
7. Explore the Go Further! opportunities.
8. Complete your Core Values Self-Reflection.

GO FURTHER!

- I feel the need for speed! Calculate the speed traveled by your gravity car. Add different masses to your car and determine how the extra mass affects its speed.
- Iterate and Improve! Now that you have tested your gravity car, make improvements to it. Can you get it to travel farther? Can you get it to travel faster? Can it do both or only one of these?

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution solved the challenge.	Showed how the solution would solve the challenge.	Not clear how the solution would solve the challenge.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
Gravity Car
Design Brief

PROBLEM STATEMENT

Design, build, and test a vehicle powered by the force of gravity.

CRITERIA & CONSTRAINTS

- The car must between 3 and 6 inches long.
- The car must travel the longest distance from the end of the Gravity Ramp Track.
- You must have at least two wheels and no more than six wheels on your car.
- You will have only three runs on the track.
- Use the materials specified by the teacher or adult facilitating this activity.

ENGINEERING DESIGN PROCESS & *FIRST*® CORE VALUES

FIRST® Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND

Reflect, research, and answer the questions below.

1. What are Newton's laws of motion?

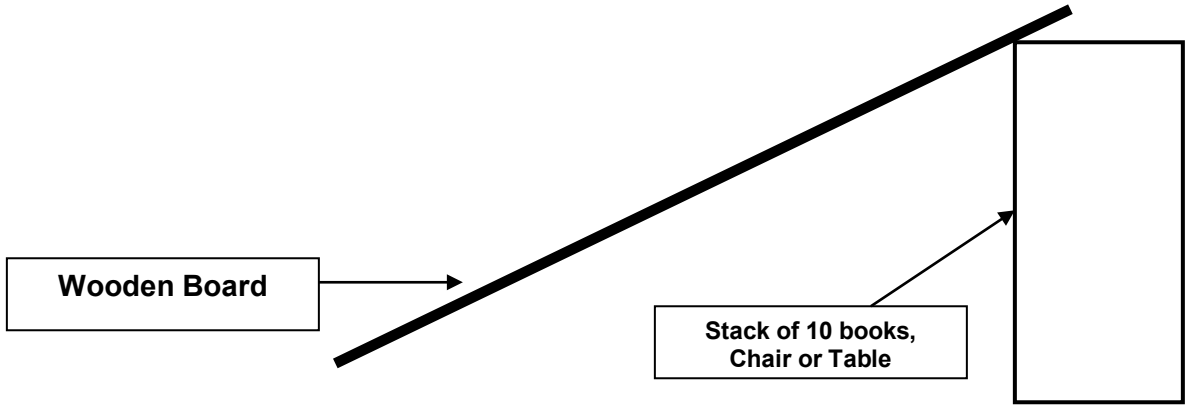
2. What forces act on an object in motion?

3. What is the relationship between distance, speed, and time?

ACTIVITY STEPS

1. Generate a rough sketch of your Gravity Car design.

2. Create your Gravity Car based on your design. Be sure you follow the criteria and constraints!
3. Set up your gravity track using this diagram as a reference. Use alternative materials as needed from around your home to make your gravity track.



4. Record your distance after each run in the chart below. Determine the average distance.

Gravity Track Run Results

Run	Distance (ft or in)
1.	_____
2	_____
3.	_____
Average	_____

REFLECTION QUESTIONS

1. What are the limitations of the model you created?

2. Was your coaster well designed? Explain your answer.

3. Predict what would happen if you added additional mass to the gravity car.

4. What skills did you use or learn in this activity?

5. What would you do differently if you did it again?

GO FURTHER!

- I feel the need for speed! Calculate the speed traveled by your gravity car. Add different masses to your car and determine how the extra mass affects its speed.
- Iterate and Improve! Now that you have tested your gravity car, make improvements to it. Can you get it to travel farther? Can you get it to travel faster? Can it do both or only one of these?

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.

FIRST® at Home
Mechanical Device

ACTIVITY SUMMARY

Students use the engineering design process to create a mechanical device.

Age Range & Grade Level: *Ages 9+, Grade 4+*

Program Connection: *FIRST*® LEGO® League Challenge

Authored By: Tammy Pankey, Manager of Curriculum Development, *FIRST*® Education

ACTIVITY OUTCOMES

Participants will:

1. Produce a design solution to a unique mechanical problem.
2. Build a functional mechanical device, which will solve a unique real-world problem.
3. Modify a mechanical device to improve the design solution.

RELEVANCE MATRIX – Subject Area Crosswalks and Core Values Addressed

Science	Math	Literacy	Social Studies	Computer Science
Simple machines	Interpret data	Sentence usage	Cause and effect relationships	Pseudocode
Discovery	Innovation	Impact	Inclusion	Teamwork

FUN! Our last Core Value should always be used when doing any *FIRST* activities.

KEY VOCABULARY

Simple Machines	Problem Solving	Brainstorming
Engineering Design Process	Complex Machines	Solution

MATERIALS & SUPPLIES NEEDED FOR THIS ACTIVITY

Mechanical Device Design Brief, materials to build gravity car (LEGO® set or materials around home)

GUIDANCE SET-UP

Description – Action – Guidance	Notes
Provide students with the design brief.	
Review the problem statement and criteria/constraints with the students. Remind students they will be using the engineering design process to work towards a solution.	Review the age appropriate engineering design process with your students.
Determine how students will complete the activity, what their length of time will be, how to collaborate virtually and how to share their solutions. Have students work on their solutions.	Solutions can be built and designed using LEGO elements or materials around the house. Students could submit pictures or videos of their designs.
Review *Evidence of Achievement* rubric (on next page) and create assessments if needed.	Sample rubric provided.
Explore the *Go Further!* Opportunities	See below
Wrap up – Have students complete their *Core Values Self-Reflection* and review.	*Core Values Self-Reflection* is found in the student design brief document.

STUDENT OR TEAM ACTIONS

1. Review the *Mechanical Device* Design Brief and problem statement.
2. Research the questions and discuss.
3. Brainstorm ideas.
4. Generate a rough sketch of your mechanical device.
5. Create a mechanical device solution to solve the challenge presented in the problem statement.
   (If students are completing at home, they could recruit a sibling, parent or guardian to do activity with them.)
6. Determine your testing and observation methods. Analyze your results after testing.
7. Iterate on your design and make improvements. Test again.
8. Generate a sketch that shows the mechanical device that you created.
9. Share your solution and reflect on your learning.
10. Explore the Go Further! opportunities.
11. Complete your Core Values Self-Reflection.

GO FURTHER!

Career Connections: Choose a career from the list below, research the career and complete the following questions.

What types of activities do people in this career do in their job?
What education or training is needed to be eligible for this career?
What are the STEM connections to this type of career?
What is the average yearly salary for this type of job?
Where do people who do this job work (companies)?

Welder	Machinist	Mechanical Engineer	Quality Control Inspector
Material Scientist	Electrical Engineer	Architect	Biotechnology Engineer

EVIDENCE OF ACHIEVEMENT

Evaluation Rubric			
Category	**3 points**	**2 points**	**1 point**
Requirements	All requirements on the design brief were met.	Some of the requirements on the design brief were met.	Only a few requirements on the design brief were met.
Design	Clearly showed how the solution solved the challenge.	Showed how the solution would solve the challenge.	Not clear how the solution would solve the challenge.
Collaboration	Demonstrated collaboration by sharing information or working with team members.	Shared some information or with team members.	Respect and inclusion being developed.
Knowledge Gained	All the questions are answered completely.	All the questions are answered but could have more detail.	The questions are not answered.

FIRST® at Home
Mechanical Device Design Brief

PROBLEM STATEMENT

Design, build, and test a mechanical device.

CRITERIA & CONSTRAINTS

- The mechanical device must solve one of the problems on the **Unique Problem List**.
- You must have your Unique Problem approved by your teacher.
- After you assemble your mechanical device, test it and record your observations if the devices solve the problem.
- Revise your mechanical device to improve the solution to the problem.
- Use the materials specified by the teacher or adult facilitating this activity.

ENGINEERING DESIGN PROCESS & *FIRST*® CORE VALUES

FIRST® Engineering Design Process | Explore *FIRST* Core Values

BUILDING THE BACKGROUND

Reflect, research, and answer the questions below.

1. What forces act on a roller coaster?

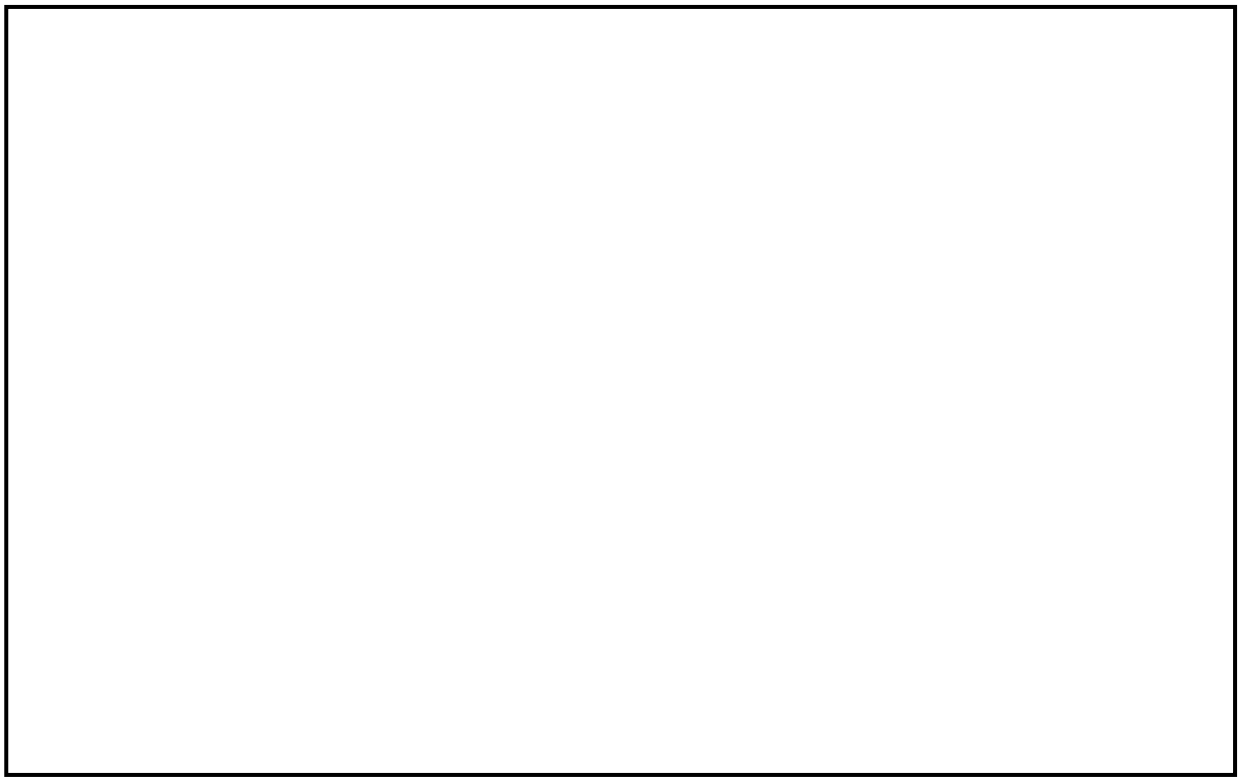
2. What different materials are used to build roller coasters?

3. What technological advances and innovative designs have there been in roller coasters?

4. What is the history of roller coasters?

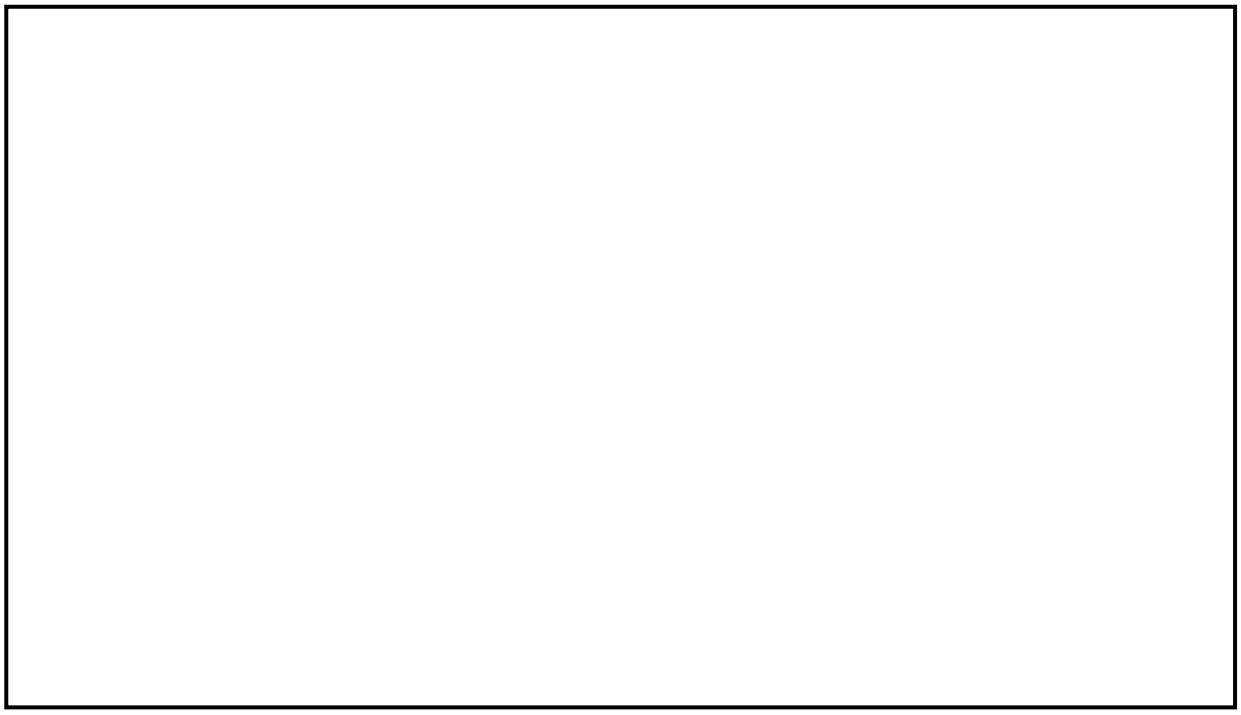
ACTIVITY STEPS

1. Choose your *Unique Problem* to create your mechanical device solution for. Check with your teacher or adult on your selection.
2. Brainstorm your ideas for your mechanical device solution.
3. Generate a rough sketch of your mechanical device. Include how the device will look, approximate dimensions (size), materials used and other important information about the design.

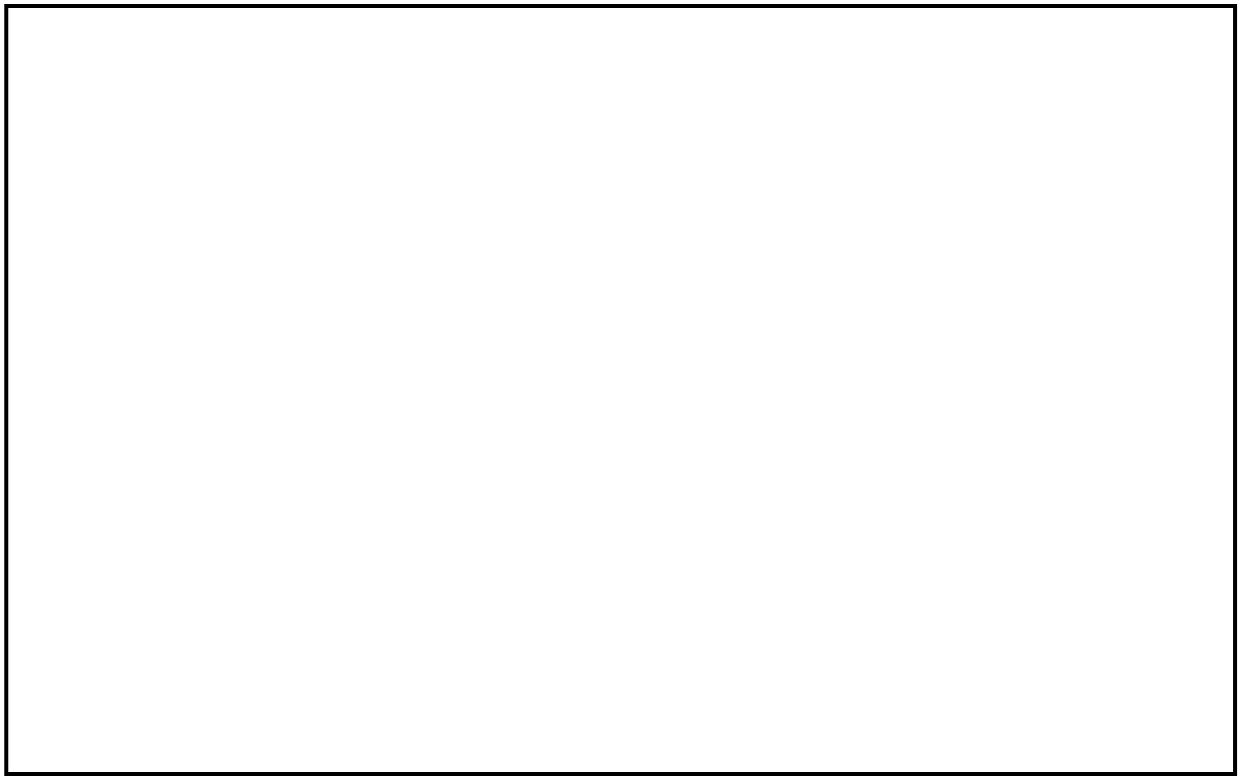


4. Create a 3-D model of your design using a computer-aided design (CAD) software. Remember to follow the design criteria and constraints! Here are some free CAD resources:
    - SolidWorks Apps for Kids https://beta.swappsforkids.com/#/
    - Autodesk Tinkercad https://www.tinkercad.com/
5. Pseudocode
6. Create your solution.
7. Code
8. Determine your testing and observation methods. Analyze your results after testing.
9. Iterate on your design and make improvements. Test again.

10. Generate another sketch with the modifications you made to your mechanical device.



11. Create a business pitch of your solution. Explain how and why you choose your design for your mechanical device. Explain how you went through the engineering design process. Show your drawing, 3-D design, pseudocode or code, and your solution. Use the space to write notes for what to cover in your pitch.



Engineering A Problem – Unique Problem List

Unique Problem 1 You must design a bridge that will span a river. The traffic on the river requires that the bridge must lift up to allow the shipping traffic to move through. It must use the strength of the riverbank but is may not have supports on the river.	**Unique Problem 2** On a construction site materials are often difficult to move. Build a mechanical device, which can lift materials from one location and place it in another location. Only the mechanical device may be used to hold or move the object.
Unique Problem 3 Elevators have enabled handicapped people to easily move up and down floors of a building without any assistance. Design a tall tower with an elevator capable of lifting from the bottom vertically up to the top.	**Unique Problem 4** In an assembly line products do not always move in a straight line. Design a device, which is capable of moving the an object in one-direction and then 90 degrees to the first direction. The device must not drop or allow the object to get stuck.
Unique Problem 5 Build a mechanical device, which can open a garage door. The garage door must open wide enough for the car to enter. The car will be simulated by toy car or scale model.	**Unique Problem 6** Cooks in the kitchen often have to mix a variety of ingredients together. Build a mechanical device, which will automatically mix the ingredients without human assistance.
Unique Problem 7 People in hospital beds often need to have there head or feet elevated. Build a mechanical device, which will raise the head up by just pushing a button.	**Unique Problem 8** Design an amusement park ride which is capable of moving people in a continuous motion…stop and move in the opposite direction.

REFLECTION QUESTIONS

1. How did the engineering design process help you solve this problem?

2. What were the benefits of sketching and brainstorming before creating the 3D model of your design?

3. What unique problem did you choose to solve and why?

4. How did using coding make your device more efficient or user friendly?

5. How did your business pitch reflect the design of your device?

GO FURTHER!

Career Connections: Choose a career from the list below, research the career and complete the following questions.

1. What types of activities do people in this career do in their job?
2. What education or training is needed to be eligible for this career?
3. What are the STEM connections to this type of career?
4. What is the average yearly salary for this type of job?
5. Where do people who do this job work (companies)?

Welder	Machinist	Mechanical Engineer	Quality Control Inspector
Material Scientist	Electrical Engineer	Architect	Biotechnology Engineer

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.