

A Wild Ride! Week 2

Day 4: Challenge Accepted!

Teacher/Parent Background:

When scientists and engineers are faced with a challenging question or problem, they follow steps to best address their task. In engineering fields, engineers use the Engineering Design Process to propose solutions to problems in order to make the world a better place. Engineers start by clearly defining the problem, imagining possible solutions and designing a plan before they create their solutions.

Overview:

In this activity, students will utilize the steps of the Engineering Design Process in order to design a plan for their challenge: *How can we design a roller coaster using force and motion concepts?*

Related Standards:

- Define problems and design solutions pertaining to force and motion.

Key Terms:

- Engineering Design Process: a set of steps engineers use to propose solutions to problems

Materials List:

- Parental/adult supervision
- Internet access
- Journal
- Pen/pencil
- Roller coaster Materials (see [here](#) & [here](#) for additional material ideas/examples)
 - Foam tubing/pool noodles - cut in half lengthwise
 - Masking tape roll
 - Scissors
 - Ruler/measuring tape
 - Paper cups
 - Marbles - various weights
 - Various household objects, such as blocks, boxes, books, etc.
- *Student Resources - Pages 4-6*
 - *Challenge Details*

- *Step 2: Imagine*
- *Step 3: Plan*

Activity Description:

- This week we have learned a lot about how force and motion concepts make a roller coaster work! Let's revisit our whole "Learned" chart to recap our week!
 - Ask students to discuss what they have learned, referencing their "Learned" chart. Significant student learnings should include:
 - A force is a push or a pull.
 - Forces cause motion of objects.
 - Motion is a change of an object's position/its location.
 - The way I push or pull on an object affects its speed.
 - Gravity is a force that pulls objects towards Earth's center.
 - Once a train/cart is pulled up to a high hill using a chain, the force of gravity pulls it down the track.
 - When designing our roller coaster, the first hill should be the tallest. That way, the train/cart can gain a lot of speed to travel through the rest of the track.
- Let's look back at the "Ask" step of our challenge: *How can we design a roller coaster using force and motion concepts?* What do we still need to know?
 - Ask students to revisit the "Ask" step and discuss other "need to knows". Possible student responses may include:
 - I need to know...
 - How many hills can my roller coaster have?
 - Can my roller coaster have loops?
 - What materials do we have to build the roller coaster?
 - How much time will we have to build the roller coaster?
- To answer the remaining "need to knows", review the *Challenge Details* with students. Encourage students to ask clarifying questions about the challenge details.
- Provide time for students to become familiar with the building materials.
 - Prompt them to feel and bend the foam tubing, prop-up the tubing with cups, blocks, boxes, books, etc.
- Then, direct students to revisit their remaining "need to knows". Possible student responses/questions may include:
 - How much time will we have to build the roller coaster?
 - Now that the challenge has been clearly defined and we have accomplished the "Ask" step, you will have today to imagine and plan for your solution. Tomorrow, you will build, test and improve your solution.

- Guide and actively assist students through the “Imagine” step of the Engineering Design Process by reviewing *Step 2: Imagine*. Key details/directions include:
 - Now that the problem has been clearly explained/defined...
 - brainstorm more than one possible solution to the problem.
 - keep in mind the materials/design requirements, as they should be incorporated into your designs.
 - draw and label diagrams of your designs, write-out words/phrases to help you brainstorm!
 - pick your best solution to share with others.
 - **Note:** Depending on the learning environment, the adult/parent may be the only other person in the “class”. Act as a sounding board for the student, allowing him/her to share their best solution ideas.
- Next, guide and actively assist students through the “Plan” step of the Engineering Design Process by reviewing *Step 3: Plan*. Key details/directions include:
 - Work together to decide on one best solution to be built by the whole team. This solution should include ideas from the team; not just one member’s ideas!
 - keep in mind the materials/design requirements, as they should be incorporated into your solution.
 - **Note:** Depending on the learning environment, the adult/parent may be the only other person in the “class”. Act as a design team member by listening to their ideas and sharing additional thoughts/your ideas. You will both work as a team to design a plan.
 - Draw and label a design of your solution and create a materials list with types and amounts of materials needed.
 - **Note:** The amounts of materials will depend on the availability of materials. Limit quantities as you see fit.

Closure:

- Ask students to think about tomorrow’s activities. Engage in a discussion:
 - Thinking about what engineers do, what steps will be taking tomorrow to propose your best solution to the challenge?
 - What are you most looking forward to?

Extensions:

Watch: Crash Course Kids - [Let's Fly! Is One Solution Better Than Another?](#)

Student Resources

Challenge Details

Dear Student,

Arizona Science Center is interested in adding a new exhibit to its *Get Charged Up!* gallery. Since *Get Charged Up!* is all about force and motion, staff members would like to introduce guests to the science behind roller coasters! You have been tasked with designing a roller coaster to be reviewed by Arizona Science Center's Exhibit Technicians for their new exhibit. Please closely follow all details outlined below:

1. Use the steps of the Engineering Design Process to design the best possible roller coaster. This includes:

- a. Imagining possible solutions - there are many possible solutions to this one challenge; think big!
- b. Planning your chosen solution
- c. Creating and testing your solution
- d. Improving your solution to make it even better

2. You may only use the following materials:

- a. Foam tubes - for the roller coaster track
- b. Making tape - to secure parts of the track or to help create roller coaster design features
- c. Scissors - to cut the tape
- d. Marbles - for the roller coaster's train/cart
- e. Paper cups, blocks, boxes, books - to support the roller coaster and to catch rolling marbles
- f. Measuring tape/ruler - to measure the length of the track

3. Your roller coaster must include/stay within the following design requirements:

- a. One hill
 - i. Note: Many guests would enjoy a second hill, if it is possible.
- b. One loop-de-loop
- c. Track length cannot exceed 48 inches or approximately 122 cm.

We eagerly await your design proposals. Best of luck!

Arizona Science Center, Head Exhibit Technician

Step 2: Imagine

Possible Solution #1
(include a diagram with labels)

Possible Solution #2
(include a diagram with labels)

Step 3: Plan

Team Solution (include a diagram with labels)	Materials List (include material types and amounts)