STEM Construction Block Activities

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Suggested Grades: 1-3
London Bridge Don’t Fall Down
Grade: 1st

STEM Content Standards

Science:
K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Technology and Engineering:
Standard 1. Students will develop an understanding of the characteristics and scope of technology.
   B. All people use tools and techniques to help them do things.
Standard 2. Students will develop an understanding of the core concepts of technology.
   E. People plan in order to get things done.
Standard 8. Students will develop an understanding of the attributes of design.
   A. Everyone can design solutions to a problem.
   B. Design is a creative process.

Math:

Common Core Math Standards (Number and Operations in base 10)
Extend the counting sequence.
CCSS.MATH.CONTENT.1.NBT.A.1
Count to 120, starting at any number less than 120.

Common Core Math Standards (measurement and data)
Represent and interpret data.
CCSS.MATH.CONTENT.1.MD.C.4
Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.

Big Ideas:
- Planning out and then analyzing how a specific structure can be built sturdily.
- Grasping onto the concept that different tools and techniques accomplish tasks in different ways.
- Understanding how to think creatively and efficiently.
- Applying counting skills in everyday tasks and projects.

Essential Question:
How can you build a bridge that is tall enough to stand over a large amount of water and strong enough to stay up when hit by strong winds?

**Scenario:**

The citizens of London are tired of driving around large bodies of water! They need someone to design and build a tall and sturdy bridge so that people can get from place to place quicker.

**Challenge:**

You will be put into teams and design a bridge that will be made from keva planks. Once the bridge is designed it will be built and tested to see if it can remain standing after being hit by the winds of a hair dryer.

**Limitations:**

- You must only use the materials provided
- You must use at least 20 keva planks
- Your bridge must be at least two inches high
- You must draw out three designs to choose from before building your bridge

**Tools, Materials, and Resources:**

- Keva Planks
- ruler

**Content Information:**

- All people use tools and techniques to help them build.
- People plan in order to get things done.
- Everyone can design creative solutions to a problem.
- Strengths and weaknesses can be analyzed by comparing and contrasting different techniques.
- The number of keva planks in a bridge can and should be organized and counted out.

**Deliverables:**

Engineering Design Journal

**Evaluation:**

Teams will be evaluated on their three designs and the efficiency and thought put into their model bridges.
London Bridge

London Bridge is falling down,
   Falling down, falling down,
London Bridge is falling down,
   My fair lady.
Build it up with wood and clay,
Wood and clay, wood and clay,
Build it up with wood and clay,
   My fair lady.
Wood and clay will wash away,
   Wash away, wash away,
Wood and clay will wash away,
   My fair lady.
London Bridge is falling down,
   Falling down, falling down,
London Bridge is falling down,
   My fair lady.
Build it up with silver and gold,
Silver and gold, silver and gold,
Build it up with silver and gold,
   My fair lady.
Gold and silver I have none,
   I have none, I have none.
Gold and silver I have none,
   My fair lady.
London Bridge is falling down,
   Falling down, falling down,
London Bridge is falling down,
   My fair lady.
Build it up with iron bars,
Iron bars, iron bars,
Build it up with iron bars,
   My fair lady.

(Build it up with keva planks, keva planks, keva planks, build it up with keva planks, my fair lady!)
Bridging Lands

Grade: 2nd

Unit: Building – STEM design

STEM Content Standards:

Science

*Next Generation Science Standards:* 2-PS1-3 - Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.

Technology

*Standards for Technological Literacy:* Standard 11 - Students will develop the abilities to apply the design process.

- B. Build or construct an object using the design process.

Engineering

*Standards for Technological Literacy:* Standard 9. Students will develop an understanding of engineering design.

- B. Expressing ideas to others verbally and through sketches and models is an important part of the design process.

Mathematics

*Common Core State Standards:* Standard 2.MD.A.1 – Measurement & Data: Measure and estimate lengths in standard units.

- 1. Measure the length of an object by selecting and using appropriate tools such as rulers. Yardsticks, meter sticks, and measuring tapes.

Big Ideas:

Construct a large object made up of smaller objects.

Proper use of design process.

Share ideas and collaborate with others.

Use measuring tools to measure.

Presentation of a model.

Essential Question:

How can you build a bridge that is as long as possible?
Scenario:
A terrible earthquake rattles all of San Francisco, and the Golden Gate Bridge suspension rods break and the bridge crumbles to the bottom of the Bay. Luckily, no one was hurt during the earthquake, but a great deal of damage occurred, including the destruction of the bridge. This three mile bridge was essential to life in San Francisco, and now a new one must be built.

Challenge:
Design and build a bridge that is as long as possible.
Work as a team in collaboration.
Complete a sketch of your bridge model.
Final structure must stand on its own, with no human interaction.

Parameters/Constraints:
Bridge must stand on its own.
Only use of materials provided is allowed.
Abutments may be no closer than 3 inches from one another.

Tools:
Measuring tape, or yardstick.

Materials:
300 Keva blocks.

Content Information:
What is bridge design?
The key structural components of bridge construction are: beams, arches, trusses and suspensions.

What are beams?
The simplest structural forms for bridge spans supported by an abutment or pier at each end. No moments are transferred throughout the support, hence their structural type is known as simply supported.
What are arches?

A bridge with abutments at each end shaped as a curved arch. Arch bridges work by transferring the weight of the bridge and its loads partially into a horizontal thrust restrained by the abutments at either side.

What are trusses?

A structure of connected elements forming triangular units. The connected elements (typically straight) may be stressed from tension, compression, or sometimes both in response to dynamic loads.

What are suspensions?

A bridge that has its roadway suspended from two or more cables usually passing over towers and securely anchored at the ends.

What are abutments?

A structure built to support the lateral pressure of an arch or span, e.g., at the ends of a bridge.

Compression and tension are present in all bridges, and they are both capable of damaging part of the bridge as varying load weights and other forces act on the structure. It's the job of the bridge design to handle these forces without buckling or snapping.

What is tension?

The pulling force exerted by a string, cable, chain, or similar solid object on another object.

What is compression?

The application of balanced inward ("pushing") forces to different points on a material or structure, or forces with no net sum or direction.

To deal with these powerful forces one must either dissipate them or transfer them. With dissipation, the design allows the force to be spread out evenly over a greater area, so that no one spot bears the concentrated brunt of it. In transferring force, a design moves stress from an area of weakness to an area of strength.
**Deliverables:**

A sketch of the model and/or written ideas.

Completed measuring sheet, which includes how long and wide the completed bridge is, as well as, and the number of blocks used.

Presentation of final bridge design.

**Evaluation:**

Collaboration with others and teamwork.

Sketch or written pre-building ideas.

Accurate use of measurement tools.

Recorded measurements that are correct.

Creation of a standing bridge.
“It’s almost time to eat Thanksgiving Feast”

Grade: 2nd

Unit: STEM

STEM Content Standards:

Science-
Next Generation Science Standards:

- K-2-ETS.1-1: Engineering Design, Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new and improved object or tool

-Technology & Engineering Standards for Technological Literacy:

- Standard 6. Students will develop an understanding of the role of society in the development and use of technology.
  A. Products are made to meet individual needs and wants

- Standard 11. Students will develop the abilities to apply the design process.
  A. Brainstorm people’s needs and wants and pick some problems that can be solved through the design process
  B. Build or construct an object using the design process.
  C. Investigate how things are made and how they can be improved

-Math-
Common Core State Standards:

- (Measurement & Data) CCSS.MATH.CONTENT.2.MD.A.1. Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.

Big Ideas:

- Using the design loop properly
- Using creativity for problem solving
- Ability to make simple measurements with tools given
- Ability to build a house from Lincoln Logs that can withstand a storm
- Ability to build a house big enough to fit all 12 family members
- Ability to work as a team to complete the task
Essential Question: How will your group design a house that is sufficient enough to withstand a thunderstorm and be big enough to fit a family of 12 people for Thanksgiving Day feast?

Scenario:
Thanksgiving dinner is approaching quickly and there is so much to be done in very little time. A few months ago in the small town of Gobbleville, South Carolina, there was a huge thunderstorm that rattled the whole town. The thunder shook all the houses, the wind whipped all the windows, and the rain pounded on the rooftops. This thunderstorm left the people terrified and the damage had to be fixed before the Thanksgiving feast. However, there was another problem; no one had a big enough house to fit all their family members when they came to town. Each family always has eight extra hungry mouths to feed. So, the town had a meeting and decided it would be best to just rebuild the town from the ground up using new materials. But time was ticking, it was November 1st and there were only a few weeks until the feast. There was no time to waste. The town began clearing out all the houses and after the ground was leveled out and smooth, a truck load of Lincoln Logs was dropped off at each property. Each family was only given one truck load of materials and a few weeks to build their new house. Hopefully by the time Thanksgiving Day arrived each house can withstand any storm that may come, and be able to fit all their family members comfortably.

Challenge:
As a team you will need to design and build a house that meets the requirements of the assignment. Each group will be given one “truck load” (container) of Lincoln Logs and must build a house that is sufficient enough to withstand a thunderstorm, but also be big enough to fit a family of twelve comfortably. Four people live in each house in Gobbleville, then eight more family members come to visit for the holiday. Each group will need to complete the design loop worksheet. Each group will be given some measuring tools to help determine the dimensions of your house. Your group will need to record the proper measurements of your structure, because you will be graded on the height and width of your house and the strength of your structure. Be creative!!! Every twenty-five minutes will count as “one week” for the people in Gobbleville that are building, so this challenge for us will only last one hour so try your best and work as a team! Once all the groups have finished building their structure we will determine who wins the “biggest” house category, then we will test each houses sufficiency. We will create a thunderstorm by creating thunder, wind and rain with tools in our classroom to see which house can withstand the storm the longest. Although each team will be graded on meeting the basic requirements of the project, the team whose house withstands the storm the longest will receive bonus points on the assignment.
Tools, Materials & Resources:

<table>
<thead>
<tr>
<th>Tools: Used to help create design</th>
<th>Materials: What is actually used</th>
<th>Resources: Guides along the way</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) smooth &amp; level building surface</td>
<td>1) container of Lincoln Logs</td>
<td>1) Teammates</td>
</tr>
<tr>
<td>2) rulers, yardsticks, meter sticks &amp; measuring tapes</td>
<td></td>
<td>2) measuring guide handout</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) design loop worksheet</td>
</tr>
</tbody>
</table>

Content Information:

- watch short video introducing Lincoln Logs
  [https://www.youtube.com/watch?v=a4V9dgV-jic](https://www.youtube.com/watch?v=a4V9dgV-jic)
- refer to measuring guide handout
- design loop worksheet

Deliverables:

- any brainstorm sketches of possible Lincoln Log structures
- complete design loop worksheet (1 per group)
- proper measurements of the structure recorded
- completed structure
- presentation of design

Parameters and Constraints:

- only able to use materials, tools & resources given
- you will have only 1 hour to complete the assignment
Evaluation:

1. Understanding of the problem
2. Structure meets requirements
3. Proper measurements are recorded
4. Solution to the problem is creative and unique
5. Ability to work as a team
6. Final project is complete and presented to the class
7. Class discussion and reflection after all projects are presented
Musical Planks
STEM Design Challenge using Keva Planks

Disciplinary Unit: STEM

Grade Level: 3rd Grade

Content Standards:

Next Generation Science Standards:

- LS1.D - Information Processing: Different sense receptors are specialized for particular kinds of information; Animals use their perceptions and memories to guide their actions.

Standards for Technological Literacy:

- Standard 8 - Students will understand the attributes of design:
  - 8.C: The design process is a purposeful method of planning practical solutions to problems.
  - 8.D: Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

- Standard 9 - Students will develop an understanding of engineering design:
  - 9.C: The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
  - 9.D: When designing an object, it is important to be creative and consider all ideas.

- Standard 11 - Students will develop the abilities to apply the design process.
  - 11.E: The process of designing involves presenting some possible solutions in visual form and then selecting the best solution(s) from many.
  - 11.F: Test and evaluate the solutions for the design problem.

Common Core ELA Standards:

- CCSS.ELA-LITERACY.SL.3.4: Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.
- CCSS.ELA-LITERACY.SL.3.6: Speak in complete sentences when appropriate to task and situation in order to provide requested detail or clarification.

Big Ideas:

- Parameters limit what can be done, but enhance creativity.
- The Design Loop helps to find solutions within the parameters

Essential Question:

How can you build a structure that will make music for the longest time while staying within the parameters?
Scenario:
Students will be split into teams and will be given a certain number and Keva planks and predetermined materials and will be asked to “make music” for the longest amount of time by allowing their marble to move along the structure that they built. They must stay within the parameters of the assignment.

Materials/Resources:
- 200 Keva planks
- 1 square foot area
- Marble
- Stopwatch

Deliverables:
- Activity worksheet with Design Loop (attached)
- Teammate Evaluation

Parameters:
- Must only use required materials
- Must fit inside a square foot area
- Marble must stay within this area
- Must be completed within the time limit
- Must utilize design loop
- Will only be timed while “making music”
- Must work together as a team
### Assessment:

#### Musical Planks Rubric

Name: ________________________  Teammates Names: __________________________

<table>
<thead>
<tr>
<th>Category</th>
<th>Up to 5 pts.</th>
<th>Up to 10 pts.</th>
<th>Up to 15 pts.</th>
<th>Up to 20 pts.</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creativity</td>
<td>Unacceptable Level Performance</td>
<td>Intermediate Level Performance</td>
<td>Accomplished Level Performance</td>
<td>Superior Level Performance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The structure showed no creativity, but it worked.</td>
<td>The structure showed little creativity.</td>
<td>The structure showed moderate creativity.</td>
<td>The structured showed a never before seen solution.</td>
<td></td>
</tr>
<tr>
<td>Parameters</td>
<td>The structure did not follow parameters.</td>
<td>The structure followed few parameters.</td>
<td>The structure stayed within most parameters.</td>
<td>The structure met all parameters.</td>
<td></td>
</tr>
<tr>
<td>Team Performance: (Based on teammate evaluations)</td>
<td>Teammates did not score this teammate high.</td>
<td>Teammates found this teammate a little helpful.</td>
<td>Teammates found this teammate satisfactory.</td>
<td>Teammates found this teammate as a great asset to the team.</td>
<td></td>
</tr>
<tr>
<td>Presentation of Completed Project</td>
<td>Presentation was poor and inadequate.</td>
<td>Presentation was attempted but not in a satisfactory way.</td>
<td>Presentation is adequate but a few presentation skills are lacking.</td>
<td>Presentation explained utilization of design loop; is clear and informative.</td>
<td></td>
</tr>
<tr>
<td>Deliverables</td>
<td>Deliverables not turned in, not answered.</td>
<td>Deliverables turned in with little work.</td>
<td>A few blanks on deliverables.</td>
<td>Deliverables are completely filled out including design loop.</td>
<td></td>
</tr>
</tbody>
</table>

Comments:  
Total Points:
Musical Planks

STEM guidelines and activity sheet for students

Challenge:
When used correctly, KEVA planks and a marble can be used to make music. Your challenge is to make the longest song possible using the given materials and following the given parameters. Goodluck!

Materials:
- 200 KEVA planks
- 1 Marble
- Square foot amount of space

Parameters:
- Must only use the materials provided
- Structure must fit into one square foot area
- Marble must stay inside this area
- Must be completed in allotted time
- Must utilize Design Loop provided
- Must work together as a team
- Timer will only be used while the structure and marble are still making music

Directions:
- Get into groups by pulling KEVA planks out of the cup. Find your partners with the matching planks. This is your team
- Count out 200 KEVA planks
- Measure and tape off a square foot to be your working space.
- Complete the challenge by utilizing the design loop provided and working with your partners.
- Present and time your final product at the end of the given time period.
- Answer follow up questions and complete teammate evaluation.
Musical Planks
Activity Page for Students

Name: ___________________________ Date: __________
Teammates: ____________________________________________

**Design Loop:** Utilize this Design Loop to help you complete the challenge.

**Ask:** What is the Problem at hand? ___________________ 
________________________________________________________________ 
________________________________________________________________ 
________________________________________________________________ 
________________________________________________________________ 

**Brainstorm:** What are at least 3 possible solutions? (Draw at least 3 possible solutions on the back).

**Choose:** Choose the idea that you think will work best.

**Create:** Create that idea with the KEVA blocks!

**Experiment:** Test and time your structure.

**Improve:** Did your structure stay within parameters? If no, how can you make it do so? If so, how can you improve your time? __________ 
________________________________________________________________ 
________________________________________________________________ 
________________________________________________________________ 
________________________________________________________________ 


Follow Up Questions:

1. Were able to improve upon your original design? If so, how? If not, why?

2. What was the hardest part of this challenge?

3. Now that you have seen other group’s designs, can you think of way to improve your own?

4. What did you like most about this challenge? If you did not like it, why not?
Teammate Evaluation:

Teammate 1:

**Team Performance Rubric**

Project or Assignment: __________________________

Name: __________________________  Teammate Name: __________________________

The following rubric is designed to be used to assess student performance when working in teams.

<table>
<thead>
<tr>
<th>Category</th>
<th>Up to 5 pts.</th>
<th>Up to 10 pts.</th>
<th>Up to 15 pts.</th>
<th>Up to 20 pts.</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Responsibility:</strong> My teammate contributed at least 50% of the effort and helped us finish the task.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Contribution:</strong> My teammate contributed to the success of the team, completed his/her share of the work, and offered constructive feedback to complete the tasks.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Team Performance:</strong> My team completed the task or finished a project accurately, on time, &amp; according to specifications because</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**all members contributed.**

| Team Collaboration:  
The team functioned at a high level—with all members carrying out specific roles and contributing equally. |
|---------------------------------------------------------------|

| Communication:  
My teammate contributed to an effective team output, presentation, or communication of effort. |
|---------------------------------------------------------------|

| Comments:  
Total Points: |
|---------------------------------------------------------------|

|          |          |          |          |
Teammate 2:

**Team Performance Rubric**

**Project or Assignment:** ________________________________

**Name:** ___________________ **Teammate Name:** ___________________

The following rubric is designed to be used to assess student performance when working in teams.

<table>
<thead>
<tr>
<th>Category</th>
<th>Up to 5 pts.</th>
<th>Up to 10 pts.</th>
<th>Up to 15 pts.</th>
<th>Up to 20 pts.</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsibility: My teammate contributed at least 50% of the effort and helped us finish the task.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contribution: My teammate contributed to the success of the team, completed his/her share of the work, and offered constructive feedback to complete the tasks.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team Performance: My team completed the task or finished a project accurately, on time, &amp; according to specifications because all members contributed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team Collaboration: The team functioned at a high level—with all members carrying out specific roles and contributing equally.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Communication: My teammate contributed to an effective team output, presentation, or communication of effort. |

| Comments: Total Points: |
Protect Your Clan

Grade: 3rd

Time: 1 hr 30 mins

Discipline Areas: Engineering, Math, Science

Content Standards:

STL Standard 9 Grades 3-5: Students will develop an understanding of engineering design

C. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.

D. When designing an object, it is important to be creative and consider all ideas.

E. Models are used to communicate and test design ideas and processes.

CCSS.Math.content.3.OA.D.9 Identify arithmetic patterns (including patterns in the addition table or multiplication table), and explain them using properties of operations.

NGSS Planning and Carrying Out Investigations:

3-PS2-2 Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

Big Ideas:

* Students will understand that the design loop aids in the process of finding a solution to a given engineering design problem when followed.

* Students will be able to identify arithmetic patterns and explain them using properties of operations.

* Students will know how to observe and take measurements as evidence of their explanation of a design solution.
Scenario and Design Challenge:
As the leader of your clan you are charged with the safety of your people. An enemy clan approaches and you have the task of building a wall to withstand their cannons (a sliding domino). Construct a wall to protect your clan using dominoes, that measures at least 7 inches in length and over 1 inch tall. You will have 24 dominoes to start. You will battle another clan and the conquered clan will join the other giving added resources of 4 dominoes to rebuild. Then challenge another team. Each time the conquered clan will join the other clan and 4 dominoes per added team member will be added to resources. This will go on until we have one winning clan wall.

Essential Question:
How should the dominoes be used to build a wall such that it is the strongest when taking an impact and does not easily get broken through?

Materials:
* Set of dominoes for each student

* Accessory people or town items to go behind the wall.

* Rulers for measuring wall and placement of masking tape.

* Masking tape to mark both starting place of domino and release point of domino to keep this as consistent a variable as possible. Two feet from each wall with five inches for slide action.

* Students will have an engineering journal for this project.

* A slick surface for building and sliding the dominoes on such as large lab tables or tile flooring

Content Information:
1. Have students start in their engineering journals by defining the design problem and its parameters. Next they should generate some possible ideas. Students can name their clan for further motivation. They can make drawing in their journal. They will create a multiplication problem, which includes the number 4 each time, from the 24 dominoes they have. (6 x 4= 24)

2. Once they have selected a wall to build, have them measure out from another clan and mark the tape. Once built they will each send cannons, 1 domino at a time toward the other’s wall.

3. Have students count how many cannons it takes until a hole has been made that goes completely through the wall. If the domino completely misses the wall then have a redo. These numbers should be
noted in their engineering journals. Once there is a winner have them write out an evaluation of what about the wall’s design made it work well.

4. The conquered clan will join the other clan and add 4 more dominoes in resources. Students will create a new multiplication problem for their resources. \((7 \times 4 = 28)\). They will generate wall ideas together coming up with a better build, with the goal of lasting through more cannons. Then they will measure out from a new clan and prepare for battle. Record the number of cannons. Again write down what about the wall’s design made it work well.

5. These clans will combine and again 4 dominoes will be added per person joining, 8 this time, to the resources. Students will create a new multiplication problem for this. \((8 \times 4 = 32)\). A new wall will be built. This will continue until there is one winning clan wall. The teacher can proclaim that we are all now one clan: (teacher’s name) 3rd grade class!

6. Students will now look at the data they have collected and determine what aspects in evaluation of the design build made for a stronger structure. Were more dominoes helpful? Was there a placement that was particularly affective? How were the dominoes staged? Did collaboration with others promote a better build? Did each design get better as you went, taking more cannons to break through?

7. Finally, students will look at the multiplication problems they have made using the number four and identify the pattern that they see. (Every time four is multiplied by another number the resulting number is even. Have them explain why 4 times a number can be decomposed into two equal addends.)
<table>
<thead>
<tr>
<th>Assessment Rubric: Protect Your Clan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Design problem and generated ideas</strong></td>
</tr>
<tr>
<td>Correctly stated the design problem and knew the parameters. Showed that you were generating ideas before you started building.</td>
</tr>
</tbody>
</table>

| **Data and testing** | All data for each build has been successfully recorded. Wrote down reasoning for why the design build was successful. | Most of the data has been recorded. Gave some answers for reasoning of design build success. | Did not include enough data. Reasoning for good design builds was not evident in writing. |

| **Collaboration with team** | Worked well with team members and gave insightful ideas and help to build a good design. | Worked ok with team members and gave some ideas to help with the design build. | Did not work well with team members. Did not help give ideas to aid in the design build. |

| **Summary of results** | Collected data is used for evaluation after each build, this is used to determine important aspects of a strong design build. | Some data was used for an evaluation. Summary had some aspects of why the design build worked. | Data was not used to give an evaluation of the design. Summary could not tell why the design build was successful. |

| **Math Explanation** | Included a multiplication problem with 4 for each build that was correct. Understood pattern and gave a good explanation. | Included most multiplication problems. Some understanding of pattern and attempted explanation. | Did not give enough multiplication problems with 4. Did not show understanding of pattern or give an explanation. |
Protect Your Clan

Scenario and Design Challenge:

As the leader of your clan you are charged with the safety of your people. An enemy clan approaches and you have the task of building a wall to withstand their cannons (a sliding domino). Construct a wall to protect your clan using dominoes, that measures at least 7 inches in length and over 1 inch tall. You will have 24 dominoes to start. You will battle another clan and the conquered clan will join the other giving added resources of 4 dominoes to rebuild. Then challenge another team. Each time the conquered clan will join the other clan and 4 dominoes per added team member will be added to resources. This will go on until we have one winning clan wall.

What is the design problem?

What are your parameters?

Generate some ideas, this space can be used to draw or write in (back of paper too), but show your brainstorming process. Give your town a name.
Materials:
Ruler 25 Dominoes (one is the cannon) Masking tape

You will have 24 dominoes for your first build. Make a multiplication problem from this using the number 4.

Step 1. When you have decided on a design build for your first wall measure out two feet from building spot and place masking tape. Measure out five inches and place another piece of masking tape. Then measure out another two feet and here your first opponent will set up their wall.

Step 2. When your walls are built you will use a single domino to slide as a cannon at the other wall. Start at the back masking tape and release at the second. If you miss the wall entirely then take a redo. The battle is won by breaking a hole all the way through the wall.

How many cannons for first trial of your base? What is the height and length?

How many cannons for first trial of opponent’s base? What is the height and length?

Evaluate the winning design, what led to its success?

One of you has now been conquered, your clans will combine forces to build a better wall. Your resources have increased by 4 dominoes. Create a new multiplication problem for the number of dominoes using the number 4.

Generate some ideas, this space can be used to draw or write in (back of paper too), but show your brainstorming process. Give your new town a name.

The tape is already laid out so all you have to do now is repeat Step 2.
How many cannons for your base? What is the height and length?

How many cannons for opponent’s base? What is the height and length?

Evaluate the winning design, what led to its success?

One of you has now been conquered, your clans will combine forces to build a better wall. Your resources have increased by 8 dominoes. Create a new multiplication problem for the number of dominoes using the number 4.

Remember it is important to work collaboratively with your team, it will be part of your grade. Generate some ideas, this space can be used to draw or write in (back of paper too), but show your brainstorming process. Give your new town a name.

The tape is already laid out so all you have to do now is repeat Step 2.
How many cannons for your base? What is the height and length?

How many cannons for opponent’s base? What is the height and length?

Evaluate the winning design, what led to its success?

One of you has now been conquered, your clans will combine forces to build a better wall. Your resources have increased by 16 dominoes. Create a new multiplication problem for the number of dominoes using the number 4.

Remember it is important to work collaboratively with your team, it will be part of your grade.
Generate some ideas, this space can be used to draw or write in (back of paper too), but show your brainstorming process. Give your new town a name.

This should by your final round. The winning clan here will have to have a very solid sturdy wall for their town’s protection. Repeat Step 2 one last time.
How many cannons for your base? What is the height and length?

How many cannons for opponent’s base? What is the height and length?
Now that we are all one big happy clan again look at the data that you have collected and determine what aspects in evaluation of the design build made for a stronger structure. Possible questions to answer are: Were more dominoes helpful? Was there a placement that was particularly affective? How were the dominoes staged? How did height and length effect the outcome? Did collaboration with others promote a better build? Did each design get better as you went, taking more cannons to break through? What made the final wall standing so great?

Look at the multiplication problems that you have made using the number four and identify the pattern that you see.

Explain why 4 times a number can be decomposed into two equal addends.
Falling Bridge

Grade: 3rd

STEM Content Standards:

Science:

- Next Generation Science Standards: 3-ESS3-1, Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard. [Clarification Statement: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lighting rods.]
- Next Generation Science Standards: Ps3.C. When objects collide, contact forces transfer energy so as to change the objects’ motions.

Technology and Engineering:

- Standards for Technological literacy: Standard 6: Students will develop an understanding of the role of society in the development and use of technology.
  - A. Products are made to meet individual needs and wants.
- Standards for Technological Literacy: Standard 8: students will develop and understanding of the attributes of design.
  - c. the design process is a purposeful method of planning practical solutions to the problem.
  - d. requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

Math:

- Common Core Math Standards (Measurement and Data): CCSS.Math.Content.2.MD.A.1 Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.

Big Ideas:

- Effects of severe weather
- Multiple solutions for a problem
- Measurement of height, length and with
- Understanding the Engineering Design loop

Essential Question:

- How can you use your creativity to design a bridge using the keva blocks that will hold your car and not collapse during severe winds?
Scenario:

- You are trying to make it home before the terrible rain storm hits your town. Winds are picking up and it is starting to rain. You just have to cross a bridge before you are home but winds are getting stronger and stronger. How can you design a bridge that will not crumble during the storm and that one that will keep your car safe?

Challenge:

- Design and construct a bridge that will keep your car from falling into the river below during the storm or collapsing
- Your structure must meet parameters and constraints of the design challenge.
- You must provide sketches and all brainstorm when turning in final worksheets.
- Your group may test your bridge one time and make any needed changes or revisions for the final test

Tools, Materials, and Resources:

- Keva Blocks (200 per group)
- Writing materials
- Worksheet (attached)
- Ruler
- Small toy car
- Hair dryer or leaf blower (use leaf blower from a further distance)
- Working space

Content information:

- Explain how to use and handle keva blocks
- Revisit any former assignments using keva blocks
- Discuss how bridges are a form of technology (how they help make peoples’ lives easier in means of transportation.)
- Optional: Show video of Tacoma bridge swaying and collapsing because of wind (can show whole video or just parts) [https://www.youtube.com/watch?v=j-zczJSxnw](https://www.youtube.com/watch?v=j-zczJSxnw)

Deliverables:

- Design loop worksheet (individual)
- Any other scratch work to be turned in
**Parameters or constraints:**

- You may only use the Keva blocks given to your group (no borrowing from other groups)
- You will only be able to test your product one time before the final test
- Your bridge must be able to support your toy car on its own
- You must build your bridge on the table assigned to your group

**Evaluation: Students will be evaluated on…**

- Understand the effects of severe weather
- Ability to work as a team in an assigned group
- To understand the task
- Complete the worksheet individually
- Follow any parameters and constraints
- Use only materials provided
- Evaluate their own work during the pre-test and make any needed changes.
Falling Bridge Worksheet

1. What is the problem and what information do you need to solve it?

2. Brainstorm a solution on your own. Then collaborate with your group and choose which design you will build with your teammates.

3. Sketch the design you will build as a team.

4. List the steps you will use in constructing your final product. What is your individual role and what are the roles of your team?
5. Pre-test your idea. What worked and what didn’t? Why and why not?

6. Did you make any changes? What were they?

7. List the measurements of your design. Height, Length and Width.

8. Did your final design work? Why or why not?

9. Reflect on yourself as a team player. How well did you work with your group?

10. What were some of your strengths with this assignment? What were some weaknesses?
Hitting the Slopes

Grade: 3rd

Disciplinary Area: STEM

Standards:

- NGSS: The effect of unbalanced forces on an object results in a change of motion. Patterns of motion can be used to predict future motion. Some forces act through contact, some forces act even when the objects are not in contact. The gravitational force of Earth acting on an object near Earth’s surface pulls that object toward the planet’s center.
- Math: [CCSS.MATH.CONTENT.3.MD.B.4](https://www.corestandards.org/Math/Content/3/MD/B/4): Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units— whole numbers, halves, or quarters.
- Technology: Standard 2. Students will develop an understanding of the core concepts of technology. H. Resources are the things needed to get a job done, such as tools and machines, materials, information, energy, people, capital, and time.
- ELA: [CCSS.ELA-LITERACY.W.3.3](https://www.corestandards.org/ELA-Literacy/W/3/3): Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.

STEM Content:

- Gravitational potential energy
- How potential energy affects motion and kinetic energy
- How measurement is used in real world scenarios

Big Ideas: Slopes, ramps, measurement, energy, force, and distance.

Essential Question: How can different combinations of gravitational potential energy and heights of ramps affect how far an object goes?

Materials: K’nex, rulers, and bouncy balls.

Scenario: Jack and Annie (Magic Tree House) find themselves in a ski lodge in the Rocky Mountains. It is their first time skiing and they want to jump as far as they can off slopes, but they don’t know which jumps to take. Build a slope that will allow the ball to go as far as possible so you can tell Jack and Annie what kinds of slopes to look for.

Parameters:

- 30 minutes to build
- Limited number of K’nex

Steps:

- In partners, the students will have 30 minutes and a number of K’nex to build a slope and their ball down
- To do this, they will follow the steps of design loop and the accompanying questions to turn in.
After building, they will each demonstrate their idea to the class and mark how far their ball went.

After this is complete, they will measure how far it went to the ¼ or 1/8 of an inch.

With the help of the teacher, the class will set up 2 graphs with titles, axes labels, and numbering. One graph will be based on how tall their initial starting point was and the other by how tall their ramp was.

Each group will then mark their distance on graphs on the board. These charts are also in the student’s packets and they will mark the spots on their graphs as it is drawn on the board.

Using these graphs, have the students decide what factors affect the distance of the ball (potential energy from starting point).

They will then complete the reflection questions on the worksheet and fill out a partner assessment and turn those in.

To provide closure: I would discuss the role of potential energy and then talk about how ski slopes are made by men and not nature and how we manipulate them to increase distance, height, etc.
<table>
<thead>
<tr>
<th>Category</th>
<th>0-10 pts.</th>
<th>11-15 pts.</th>
<th>16-20 pts.</th>
<th>21-25 pts.</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unacceptable Level Performance</td>
<td>Intermediate Level Performance</td>
<td>Accomplished Level Performance</td>
<td>Superior Level Performance</td>
<td></td>
</tr>
<tr>
<td>Applying Concepts</td>
<td>Structure does not solve the problem</td>
<td>Structure solves the problem but does not meet all of the parameters</td>
<td>Structure solves the problem in a basic way</td>
<td>Structure solves the problem in a creative and new way</td>
<td></td>
</tr>
<tr>
<td>Creativity</td>
<td>Little to no creativity evident</td>
<td>Project shows limited effort</td>
<td>Project shows a decent amount of thought and effort</td>
<td>Project is a well thought out idea that meets the requirements in a neat way</td>
<td></td>
</tr>
<tr>
<td>Following the Design Loop</td>
<td>The loop was not followed</td>
<td>Some steps of the loop were used, but it was not completed</td>
<td>One or two of the steps were skipped</td>
<td>The loop was used in its entirety to plan and build the project</td>
<td></td>
</tr>
<tr>
<td>Reflection</td>
<td>Little to no explanation or demonstration of application of how ideas changed</td>
<td>Limited amount of explanation of their ideas’ changes</td>
<td>Explanation shows growth, but does not use correct terminology</td>
<td>Student uses scientific terminology learned to explain how their ideas changed through the process</td>
<td></td>
</tr>
</tbody>
</table>

Comments:
Total Points:
Hitting the Slopes

Jack and Annie went into the Tree House find themselves in a ski lodge in the Rocky Mountains. It is their first time skiing and they want to jump as far as they can off slopes, but they don’t know how to do that. You will have 30 minutes to build and test slope made of K’nex that will allow the ball to go as far as possible so that you can tell Jack and Annie what they should do.

**STEP 1: State the problem**

What is the goal? _________________________________________________________

What are the limitations? _________________________________________________________

What do you already know that could help make the ball go further?

_________________________________________________________

_________________________________________________________

**STEP 2: Draw potential solutions**

**STEP 3: Chose & build a solution**

Which one did you chose? _________________________________________________________

How tall is your starting point? _________________________________________________________

How tall is your ramp? _________________________________________________________

**STEP 4: Test your solution**

How far did the ball go? _________________________________________________________

**STEP 5: Evaluation your solution**

Label the graphs’ axes and number appropriately along the side. Fill out as we plot points.
Which group’s ball went the furthest? ____________________________________________________

Did groups with higher starting points or ramps have more distance?
____________________________________________________________________________________
What role does potential energy play?

In the space provided write about how you and your partner decided how to build your ramp. What did you already know? How did this experience increase your knowledge of energy and gravity’s role in the world?
The following rubric is designed to be used to assess student performance when working in teams.

<table>
<thead>
<tr>
<th>Category</th>
<th>Up to 5 pts.</th>
<th>Up to 10 pts.</th>
<th>Up to 15 pts.</th>
<th>Up to 20 pts.</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Responsibility:</strong> My teammate contributed at least 50% of the effort and helped us finish the task.</td>
<td>Unacceptable Level Performance</td>
<td>Intermediate Level Performance</td>
<td>Accomplished Level Performance</td>
<td>Superior Level Performance</td>
<td>Both teammates contributed equal amounts of effort</td>
</tr>
<tr>
<td>Team member did not contribute effort</td>
<td>Team member contributed a little effort</td>
<td>Team member contributed some effort but other member clearly did more work</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Contribution:</strong> My teammate contributed to the success of the team, completed his/her share of the work, and offered constructive feedback to complete the tasks.</td>
<td>Team members worked independently and did not complete their share of work</td>
<td>Team members worked together a little but did not look over each other’s work</td>
<td>Team members completed all of the work and offered limited feedback to each other</td>
<td>Team members completed tasks and looked over and edited final product together</td>
<td></td>
</tr>
<tr>
<td>The task was not finished</td>
<td>The task was almost complete but was missing one or two specifications</td>
<td>The task was completed but was sloppy and last minute</td>
<td>The task was complete, neat, and on time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Team Collaboration:
The team functioned at a high level—with all members carrying out specific roles and contributing equally.

<table>
<thead>
<tr>
<th></th>
<th>One member did all of the work</th>
<th>Members split work but one did not complete or did little actual work</th>
<th>Members split work but one did an unequal amount of work</th>
<th>Members split work and completed equal roles</th>
</tr>
</thead>
</table>

### Communication:
My teammate contributed to an effective team output, presentation, or communication of effort.

<table>
<thead>
<tr>
<th></th>
<th>The team members fought or refused to share information</th>
<th>Team members demonstrated limited communication</th>
<th>Team members had some communication but some parts seemed unorganized</th>
<th>Team members worked together well and clear planning was shown in the presentation</th>
</tr>
</thead>
</table>

Comments:
Total Points:
Keva Structures Challenge

Grade: 3rd

STEM Content Standards:

Science:
3-5-ETS1-1.

Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-3.

Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Technology and Engineering:

STL Standards

Standard 10. Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Math:

CCSS.Math.Content.3.MD.B.4

Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters.

Big Ideas:

- Sturdiness and balance
- Experimentation and problem solving
- Teamwork

Essential Question:

Can you design a Keva structure in 1 hour that allows more than 50 pounds to be placed on top of it?

Scenario:

Using the given materials construct a 9-inch or shorter structure, and no more than 4.5-inches wide, that allows barbell weights to be placed on top of the structure until the structure collapses.
Challenge/Parameters:
You will have 1 hour to complete this challenge.

Working in pairs you will design a Keva structure that is able to withstand over 50 pounds of weight. The structure will not be taller than 9 inches, and the length/width will not exceed 4.5 inches. Each Keva block is 4.5 inches in length, so this should not be an issue. Use glue to put the Keva blocks together. If you need to make a Keva block shorter, cut carefully with a razorblade. If something is just slightly longer than it should be or you need to balance your structure, use the sand paper to smooth the surface.

If at any time during the challenge you want to test your structure, bring it to the testing center to place weights on it. (Remember: If it breaks, you start over) You will use experimentation and problem solving to make a structure to hold as much weight as possible.

Once you feel your structure is complete, or time expires, bring it to the testing station to be tested.

Tools, Materials, and Resources:
Keva blocks, wood glue, razor blade, ruler, and sand paper.

Content information:
Stable Structures
Triangles are the strongest shape because any added force is evenly spread through all three sides. Look closely at a pyramid – it's made of triangles! Squares or cubes can be strengthened by adding a diagonal piece across the middle, making it two triangles linked together.

Balance
An even distribution of weight enabling someone or something to remain upright and steady.

Structural Load
Structural loads or actions are forces, deformations, or accelerations applied to a structure or its components. Loads cause stresses, deformations, and displacements in structures. Assessment of their effects is carried out by the methods of structural analysis.

http://dictionary.reference.com/browse/balance
**Deliverables:**

Pairs of students will come up with at least 3 design possibilities and document them on the provided worksheet. Students are allowed 1 hour for the construction of their structure using only the materials provided. At the end of 1 hour, the pairs will test their structure at the testing center. Pairs will record, on the provided worksheet, how much weight is placed on top of their structure before it finally collapses.

Turn in provided worksheet with at least 3 design possibilities. Mark which of these 3 design possibilities was the final product. Also on the worksheet will be how much weight is placed on the structure. Structure will be presented to class, and then tested.

**Evaluation:**

From the worksheet deliverable that the students turn in, assess their three designs checking for an understanding of development and experimentation in problem solving. Also, did they correctly add the weight placed on their structure?

From the structure deliverable, you will keep anecdotal records and a checklist to make sure the student followed all parameters of the challenge. Before the structure is to be tested, make sure the structure is 9 inches or shorter, and no more than 4.5 inches wide. Lastly, did the pair finish their final product in less than an hour?

**What the teacher needs to know about testing:**

Testing center will consist of 4 blocks of 4X4 pieces of wood that are two, four, six, and eight inches tall depending how tall the student’s structure is. Then have a 16X16 board that is 2 inches thick. Have a pole coming down the direct center. (See picture below)

When testing, slide structure over pole and down to the floor. Then place the testing board on top of the structure. Then weights can be placed on top of the board in an even manor. When the structure breaks, it will only fall a couple of inches max because of the 4 blocks on each corner.
Our Town

Unit: Stem Transportation Technologies

Grade: 3rd

STEM Standards:

Technology and Engineering:

Standard 8: Students will develop an understanding of the attributes of design.

Benchmark-

C. The design process is a purposeful method of planning practical solutions to problems.

d. Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

Science:

2-PS1-3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.

2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

Math:

CCSS.MATH.CONTENT.3.MD.A.2

Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). 1 Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.

CCSS.MATH.CONTENT.3.G.A.1

Understand that shapes in different categories (e.g., rhombuses, rectangles, and others) may share attributes (e.g., having four sides), and that the shared attributes can define a larger category (e.g., quadrilaterals). Recognize rhombuses, rectangles, and squares as examples of quadrilaterals, and draw examples of quadrilaterals that do not belong to any of these subcategories.

Big Ideas:

- Understand how to work in groups.
- Use the design loop to come up with a solution for the design challenge.
- Understand how to come up with a solution using construction blocks to solve a design challenge.

Essential Questions:

How can you build a structure that withholds different weight limits?
Scenario: Your group is going to be given a time limit of 15 minutes to construct your design for your town and then an additional 45 minutes to build a small town with three buildings. The main building uses 150 Keva building blocks that can withstand a 20 pound weight. One structure that will withstand a 15 pound weight that only uses 75 Keva blocks and the last structure that uses 25 blocks that is able to withstand 12 pounds. After all three buildings have been built, place all the weights on the different buildings at the same time and time the structures to see if the buildings can withstand the weights.

Challenge: Build a town with three buildings that can withstand three different weight limits for at least a minute.

Tools and Materials:
- Keva Blocks
- Stop watch or app
- 15 pound weight
- 25 pound weight
- 12 pound weight

Content Information: Introduce mass to students and explain how different masses have an affect on structures. Then show them that in order for different structures to be able to hold different masses they have to be built a certain way, which involves balance and stability. To demonstrate the stability get four Keva blocks and then put a book on top of them. This allows the students to see that the keva blocks are stable and will hold different weight limits if placed in the correct way. Discuss with the students the different shapes that students might see in their structures after they have finished building their town. Divide students into groups of four to five and pass out the Keva Blocks.

Vocabulary:
- Balance
- Stability
- Masses
- Obtuse Triangle
- Acute Triangle
- Right Triangle
- Rectangle
- Octogon

Preparation: To prepare for this lesson, the teacher will need to have enough Keva blocks for at least five different groups and designate different areas in the room for the groups.
**Student Handout**

**Scenario:** Your group is going to be given a time limit of 45 minutes to build a small town with three buildings. The main building uses 150 Keva building blocks that can withstand a 20 pound weight. One structure that will withstand a 15 pound weight that only uses 75 Keva blocks and the last structure that uses 25 blocks that is able to withstand 10 pounds. After all three buildings have been built, place all the weights on the different buildings at the same time and time the structures to see if the buildings can withstand the weights.

**Instructions:**

- Work through the design loop to come up with the design plan you and your team is going to use for the challenge.
- After choosing the design your group will use, complete the Blueprint for Our Town page. This worksheet should show where you will place the weights for each building in your town.
- Collect the materials below and begin building your town.
- Once all three of your buildings are built, examine the structures and look for the different shapes.
- When your group is ready to test the buildings, designate three team members as the weight placers, one member as the timer, and one member that writes down the test results.
- Complete the reflection page.

**Tools and Materials:**

- Keva Blocks
- Stop watch or app
- 15 pound weight
- 25 pound weight
- 12 pound weight
Reflection Page:

1. Who was in your group?

2. Did each member contribute equally?

3. Which shapes did you notice in your buildings?

4. Did your buildings withstand the different weights?

5. What could you have done differently?

6. How did the weights affect the structures?
<table>
<thead>
<tr>
<th>Our Town</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Poor</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>Did the town have three different structures?</td>
<td>The group only had one structure.</td>
<td>The group had two structures.</td>
<td>The group successfully built three different buildings</td>
</tr>
<tr>
<td>Testing the Buildings</td>
<td>Only one building was able to withstand the weights.</td>
<td>Two buildings were able to withstand the weights to the time limit.</td>
<td>All three buildings withstood the weights to the time limit.</td>
</tr>
<tr>
<td>How well do the students understand that masses affect the structures?</td>
<td>Student are able to give a brief description of how masses affect the structures.</td>
<td>Student gave an in depth description of how masses affect the structure.</td>
<td>Student gave an in depth description of how masses affected the structure by using examples that they experienced with the design project.</td>
</tr>
</tbody>
</table>
From Small to Large

Grade Level: 3rd Grade

STEM Content Standards:

K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Big Ideas: The big ideas of this lesson involve physics, engineering, and design. Students will learn about balance, counterbalance, gravity, and center of gravity.

Essential Question: Is it possible for a large structure to have stability with a small base?

Scenario: Show students pictures of different structures that have been built using the concept of counterbalance and weight distribution. For example, my apartment complex features these concepts with the way the balconies are built and how each level is larger than the one before it. Ask students how this is possible, and then pose the challenge to them.

Tools, Materials, and Resources: Materials needed are Keva blocks (150-200 per pair group), pencils, worksheets for each student, and a designated work space for each team.

Content Information: Students will need background knowledge of gravity, and balanced and unbalanced weight. You might research how other large structures are built and do some research on physics concepts.

Deliverables: Students must deliver a completed partner rubric, worksheet, and design loop as well as a completed structure and short presentation.

Challenge: In pairs, start with a small base. Build a structure that is larger than the base it is build on.

Parameters or Constraints: The structure must be at least 5 inches tall and 5 inches wide but may be as large as students can make it. Students may use only the Keva blocks given and stay within the boundaries of their work space. You might use taped off sections of the floor or one single desk top.

Evaluation: Students will be evaluated based on their completed design loop, worksheet, and presentation as well as a partner scored rubric and teacher scored rubric.
From Small to Large

Take a look at the buildings above. Have you ever looked at a building or structure and thought to yourself, “How is that built? How is that stable?” In the photos above the structures both have something in common. It appears that the higher and wider the levels are, the larger they are than the levels before them. Each of these massive structures sits on a much smaller base level than the rest of the building. How is this so? You are going to find out how these structures can exist by building one of your own.

In pairs, build a small base. Build a structure on top of it that is larger than the base it is built on. The structure must be at least 5 inches wide and 5 inches tall. It may be as large as you can make it, and you should aim to do so. You may use only the Keva blocks given and stay within the boundaries of your work space.

You will be graded by:

- Worksheet
- Design Loop
- Completed Structure
- Partner Assessment
- Short demonstration of what you did/what you learned.
- Scoring rubric
Student Worksheet

Sketch your final design in the middle!

What is the question asking? What are the parameters?

What can be improved and shared?

How did the design work?

Describe the best idea.
The Design Loop

1. **Identify** – What is the problem?

2. **Brainstorm** – Think of possible solutions for the problem at hand.

3. **Test** – Test solutions for accuracy, durability, reliability, etc…

4. **Evaluate** – Think about the solutions, make any needed changes, and make the best one.

5. **Present** – Present the solution to peers and those with the same problem.
<table>
<thead>
<tr>
<th></th>
<th>Smiley</th>
<th>Neutral</th>
<th>Sad</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Work</strong></td>
<td>😊</td>
<td>😐</td>
<td>😞</td>
</tr>
<tr>
<td>My partner finished their part of the work and tried their best.</td>
<td>😊</td>
<td>😐</td>
<td>😞</td>
</tr>
<tr>
<td>My partner finished their part of the work, but it was not their best.</td>
<td>😐</td>
<td>😐</td>
<td>😞</td>
</tr>
<tr>
<td>My partner did not finish their part of the work.</td>
<td>😞</td>
<td>😐</td>
<td>😞</td>
</tr>
<tr>
<td><strong>Collaboration</strong></td>
<td>😊</td>
<td>😐</td>
<td>😞</td>
</tr>
<tr>
<td>My partner worked and talked with me the entire time.</td>
<td>😊</td>
<td>😐</td>
<td>😞</td>
</tr>
<tr>
<td>My partner worked and talked with me most of the time.</td>
<td>😐</td>
<td>😐</td>
<td>😞</td>
</tr>
<tr>
<td>My partner did not work with or talk to me.</td>
<td>😞</td>
<td>😐</td>
<td>😞</td>
</tr>
<tr>
<td><strong>Effort</strong></td>
<td>😊</td>
<td>😐</td>
<td>😞</td>
</tr>
<tr>
<td>My partner tried their best and was on task the whole time.</td>
<td>😊</td>
<td>😐</td>
<td>😞</td>
</tr>
<tr>
<td>My partner tried hard, but was not on task the entire time.</td>
<td>😐</td>
<td>😐</td>
<td>😞</td>
</tr>
<tr>
<td>My partner did not try their best and was not on task.</td>
<td>😞</td>
<td>😐</td>
<td>😞</td>
</tr>
</tbody>
</table>
**Rubric for STEM Design Challenge**

Rubric can be altered (made more specific, challenge based, etc.) based on STEM Design Challenge. The rubric I have created is a basic rubric that can be used for all the following Design Challenges.*

<table>
<thead>
<tr>
<th>Criteria</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration</td>
<td>Students did not work collaboratively with others.</td>
<td>Students worked, at times, collaboratively within others.</td>
<td>Students consistently worked collaboratively with others.</td>
</tr>
<tr>
<td>Design Process</td>
<td>Students are missing 3 or more steps from their design challenge process.</td>
<td>Students are missing 1-2 steps from their design challenge process.</td>
<td>Students completed all steps to their design challenge process.</td>
</tr>
<tr>
<td>Written Conclusion</td>
<td>Students do not have a written conclusion.</td>
<td>Students have a partial written conclusion with some details.</td>
<td>Students have a well written conclusion with details.</td>
</tr>
<tr>
<td>Models</td>
<td>Students did not build a model.</td>
<td>Students built a model that needed some adjusting.</td>
<td>Students built a model that was successful at the task.</td>
</tr>
<tr>
<td>Data</td>
<td>Students collected little to no data.</td>
<td>Students collected some data.</td>
<td>Students collected all necessary data.</td>
</tr>
</tbody>
</table>
Build a bridge and get over it!

Grade: 3rd-4th

STEM Content Standards:

Science: 5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down. [Clarification Statement: “Down” is a local description of the direction that points toward the center of the spherical Earth.] [Assessment Boundary: Assessment does not include mathematical representation of gravitational force.

Technology and Engineering: 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, cost.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Math: CCSS.Math.Content.5.MD.C.4 Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units.

Big Ideas: Measurements, proper use of the design loop, problem-solving through creativity, understanding weight and strength, understanding shapes and structures.

Essential Question: How can you build a bridge that is structurally sound enough to carry the weight of a car?

Scenario: You and your family are trying to get home from vacation, you took a wrong turn somewhere and now you are faced with crossing the river, there are no bridges to be seen and if you turn back, you might run out of gas. Now you must build a bridge using the trees from the forest around you (Keva Planks). You only have a few hours before night time, so you must hurry!

Challenge: You must build a bridge strong enough to hold the weight of a hot wheels car driving through over it, only using the materials provided.

Tools, Materials, and Resources: Keva planks, a level, and a hot wheels car.

Content information: An important thing to remember is that the shape of the base of the bridge is crucial to its stability.

Deliverables: Student will turn in a design journal with their ideas on how to build the best bridge. They will also demonstrate the stability of their final product.

Parameters or constraints: Use only the materials provided.

Evaluation: Students need to demonstrate that their bridge is, in fact, strong enough to withstand the weight of the car by pushing it over the bridge. Students will also present all brainstorming ideas from their design journal.
Suggested Grades: 4-5
Mini Golf Masters

Grade: 4th

Next Generation Science Standards:

PS3.C Relationship between energy and forces

When objects collide, contact forces transfer energy so as to change the objects’ motions.

Standards for Technological Literacy:

Standard 8: Students will develop an understanding of the attributes of design.

Benchmark C: The design process is a purposeful method of planning practical solutions to problems

Benchmark D: Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

Common Core Mathematics Standards:

CCSS.MATH.CONTENT.4.G.A.1

Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.

Common Core English Language Arts Standards:

CCSS.ELA-LITERACY.SL.4.1

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on other’s ideas and expressing their own clearly.

Big Ideas:

- Design
- Angles

Essential Question: How can you use at least one right, acute, and obtuse angle and at least 2 other geometrical shapes to build a mini golf hole?

Scenario + Challenge: You and your two partners have been chosen to design a mini golf hole for the Professional Mini Golf Association (PMGA) that is hosting a tournament in your town. Using the materials they give you, you must design a challenging hole with bunkers and other obstacles. You will use the design process to come up with two different designs and then build your best design. The hole must include at least two angles the ball will create, and 2 other shapes as obstacles such as rectangles, squares, diamonds, etc. In your two designs, you must draw out the desired route of the golf ball, showing the two angles (at least) it will travel. You must measure the angles and label them on your designs. Once the whole class builds their holes, the class will have a PMGA Tournament on the course.
Tools, Materials, and Resources:

- KEVA Maple 400
- GeoBlocks set of 330
- Design journal
- Protractors
- Ping Pong balls (or golf balls)

Deliverables:

- Design loop handout with 2 designs
- Example paper

Parameters or constraints:

- Use the materials provided
- The ball must travel and form at least 2 angles
- Must include at least 2 shapes as “obstacles” in the hole
- Must have 2 designs on paper before building one
- 2 hours to design and build (over the span of 2 days)

Evaluation:

- Final product
- Design loop handout with 2 designs
- Rate Your Teammate
Mini Golf Masters

Grade: 4th

Essential Question: How can use at least one right, acute, and obtuse angle and at least 2 other geometrical shapes to build a mini golf hole?

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- Must include at least 2 shapes as “obstacles” in the hole
- Must have 2 designs on paper before building one
- 2 hours to design and build (over the span of 2 days)

Evaluation:

- Final product
- Design loop handout with 2 designs
- Rate Your Teammate handout
Rate your teammate

Did your teammate do what he or she was supposed to?

Give them a 5 if they were a very good teammate.  
Give them a 3 if they were an average teammate.  
Give them a 1 if they were a poor teammate.

My name is: ____________________________

My teammate was: ____________________________

<p>| | |</p>
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<tbody>
<tr>
<td>Did they actively</td>
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<tr>
<td>participate?</td>
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<td></td>
<td></td>
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<tr>
<td>Did they listen to your</td>
<td></td>
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<tr>
<td>ideas?</td>
<td></td>
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<tr>
<td></td>
<td></td>
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<tr>
<td>Did they contribute their</td>
<td></td>
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<tr>
<td>own ideas?</td>
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<td></td>
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<tr>
<td>Did they work hard?</td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Did they follow directions?</td>
<td></td>
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</tbody>
</table>
The team successfully followed the design loop.

The team demonstrated creativity and problem solving skills.

The team was able to design a product under the given constraints.

The team collaborated, discussed solutions, and worked well together.

The team designed and built a mini golf hole

Team Member Names:

Total: 70/50
Make the Track to Win the Race

Grade level: 4th Grade

Disciplinary area: STEM- Basic engineering

Units: Structure, design, speed

STEM Content Standards:

- **Technological Literacy**: Science for Technological Literacy Standard 2: Students will develop an understanding of the core concepts of technology.
  - Benchmark I: Tools are used to design, make, use, and assess technology.
  - Benchmark K: Tools and machines extend human capabilities, such as holding, lifting, carrying, fastening, separating, and computing.
- **Science**: Next Generation Science Standards: Physical Science Progression: PS3: Moving objects contain energy. The faster the object moves, the more energy it has. Energy can be moved from place to place by moving objects, or through sound, light, or electrical currents. Energy can be converted from one form to another form.

Big ideas:
- Construction design
- Teamwork
- Brainstorming ideas and possible solutions
- Understanding factors involved in making something of good structure
- Measuring angles with a protractor
- Relating angle measurement to speed
- Relating speed to energy
- Measuring length with a ruler
- Drawing an angle from measuring it with a protractor

Essential questions:
- How can you and your team build a race car track out of Tegu blocks that will make the race car go faster than any other team's race car track?
- How do angle amounts effect the speed of the race car using the tracks made?
- How does the speed the race car effect the energy amount of the race car?

Scenario: You are a non-motor powered race car driver. The cars you race and compete do not have a motor, so you rely on tracks with slopes formed by angles to give your car energy, which you get from going a faster speed. You, along with every other competitor in the next race, get the opportunity to design the race track they will be driving on individually for the next race. Design a race car track that will make your car have the most energy and the most speed out of all your race car driver competitors who are building a track they will race in the next race.
Materials/resources:
- Protractor
- Ruler
- Race car (provided by the teacher to use when testing the speed)
- A collection of 10 24-piece sets of Tegu blocks (240 total Tegu blocks)

STEM Content Information: Cars, just like all objects, have to have energy in order to be able to move. The more energy an object has, the faster the object is able to move. Race car drivers want the fastest speed out of all the drivers they are competing against so that they can win the race. Slopes are very helpful in creating energy and speed of race cars. Angles create slopes, and are measured in degrees, which are found by using protractors.

Deliverables: After the teacher reviews how to use a protractor with the class, each student will work in groups of four total students to build a race car track 50 inches in length from end to end using up to the 240 Tegu blocks given to them. Each group will have one hour to work together brainstorming with the design loop how they will build their race car track with the Tegu blocks and have one slope and angle in their race car track. After the hour is over, each group will present their race car track with the rest of the class, starting by measuring the angle that makes up their slope (monitored by the teacher) and sharing it with the class. After measuring the angle, they will start a timer and let the race car provided by the teacher go on their track. All students in the class will fill out a chart individually that they are provided with each group's track slope angle and time. They will then fill out some follow-up questions from a worksheet provided.

Parameters: Each race track must:
- Be 50 inches in length from the start end to the finish end
- Be made using ideas your group thought out on your design loop worksheet
- Have one angle less than 180 degrees
- Be made of only the Tegu blocks provided
- Be made and sit on a table

Assessment: Each student will complete a design loop worksheet with their group members before they start creating their race track. During and after all groups present their race tracks, students will complete a worksheet with assignment observations and follow-up questions on it. The teacher will look over and grade these two worksheets, as well as make sure they measured their angle right when they were presenting their race track.
Name: ______________________________

Group number: ______

<table>
<thead>
<tr>
<th>Group number</th>
<th>Slope angle on the race track (measured in degrees)</th>
<th>Time it took for the car to finish the race (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Which group’s race car went the fastest? __________
2. What was the angle degree of the slope on their race track? __________
3. Which group’s race car went the slowest? __________
4. What was the angle degree of the slope on their race track? __________
5. Which group’s race car had the most energy? __________
6. Which group’s race car had the most energy? __________
7. What do you think is key when making a race track so that your race car can go fast and have a lot of energy? Why? ________________________________________________________________

_________________________________________________________________________________
Batman Races the Joker

Disciplinary Area: STEM

Unit: Kinetic Energy, Speed, Mass,

Suggested Grade Level: 4th or 5th

STEM Content Standards:

Next Generation Science Standards

MS.PS3.1—Construct and interpret displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

MS.PS2.4—Construct and present arguments using evidence to support the claim that gravitational interactions depend on the masses of interacting objects.

Technology and Engineering

STL Standards and Benchmarks

Standard 2: Students will develop an understanding of the core concepts of technology

L. Requirements are the limits to designing or making a product or system.

Standard 8: Students will develop an understanding of the attributes of design.

C. The design process is a purposeful method of planning practical solutions to problems.

Mathematics Common Core State Standards:

CCSS.Math.Content.5.MD.A.1: Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.

Big Idea:

- Technical Procedural Directions
- Interactions of Mass, Speed, Time, and Distance
- Conversion of measurements

Essential Question: How can you design a BatCar that will go the furthest distance with the fastest time and redesign it to be able to stop at a certain distance?

Scenario: The Joker has escaped from the police and it is up to you to build your non-motorized BatCar or BatMotorcycle to get to the end of the city where Joker is at within the fastest time. Can you help the good guys out?

Challenge: Using the materials provided build a rubber racer car that has enough speed that can go the furthest without stopping.
Vocabulary:

**Mass:** refers to how much an object weighs.

**Elastic Potential Energy:** Energy stored within an elastic object, such as a rubber band.

**Friction:** A force that resists motion between two bodies in contact.

**Kinetic Energy:** The energy that can be seen; the energy of an object in motion.

**Potential Energy:** Stored energy; derived from condition or position rather than motion.

**Speed:** The rate of motion. Distance travelled divided by time of travel.

**Spring Constant:** The stiffness or ability to stretch.

**Velocity:** The speed of an object moving in a specific direction.

**Work:** Total applied force multiplied by the total distance travelled.

Materials and Resources Provided:

<table>
<thead>
<tr>
<th>Materials Needed</th>
<th>Recourses Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Dowels</td>
<td>Cutter</td>
</tr>
<tr>
<td>4 Wheel Hubs</td>
<td>Hammer</td>
</tr>
<tr>
<td>2 Hole Plates</td>
<td>Wax. Soap, or Crayon</td>
</tr>
<tr>
<td>1-2 Stop Clip</td>
<td>Reamer</td>
</tr>
<tr>
<td>10 #16 Rubber bands</td>
<td>Graphing Paper</td>
</tr>
<tr>
<td>2 Stretch Tires</td>
<td>Safety Glasses</td>
</tr>
<tr>
<td>16 inches of string</td>
<td></td>
</tr>
<tr>
<td>2 Connector Strips</td>
<td></td>
</tr>
</tbody>
</table>

Content Information:

What is potential energy?

- The energy possessed by a body by virtue of its position relative to others, stresses within itself, electric charge, and other factors.

What is distance?

- An amount of space between two things or people.

What is velocity?

- The speed of something in a given direction.

What the teacher needs to know:

There will need to be several desks set up with room for the students to work around. Also, there will need to be a ‘finish line’ for the students to reach whenever they are done with putting their cars together. A timer will be needed for the teacher to record how fast the cars go and for how long. A meter stick will be needed for the teacher to measure exactly how far the cars go.
Deliverables:

- “How To” worksheet
- Completion of the test for results worksheet
- Directions for the races
- Questionnaire worksheet. (Asking how far their car went, for how long the car went… etc.)

Parameters and Constraints:

- Only use the given resources and tools.
HOW TO BUILD A RUBBER BAND RACER

1. Start with the frame. Cut four 100mm (4in) dowels. Insert them into two hole plates. Tip: Wax the dowel ends
2. The Wheels come next. Cut two 125mm (5in) dowels. They will become axles. Insert them into two wheels.
3. Adding more wheels- Place the wheel & axles from step 2 through the frame (where you think they will function best). They can be moved later. Press the two remaining wheels onto the axles. Tip: Wheels should not be tight against the frame.
4. Let it roll (test it out). Roll your racer across the floor or down a ramp. Reduce friction, allowing it to roll the furthest possible distance.
5. Add traction. Rubber tires can be stretched around your wheels to provide traction. Tip: Applying glue to the outside of the wheel will help the stretch tire stay on (after it dries).
6. Clips and Bands. Attach two #16 rubber bands and one stop clip. Place the stop clip on the wheel axle with the stretch tires. Attach the stop clip so the “hook” is facing away from the racer when up.
7. Secure the clip. The stop clip may slip (rotate on the axle) when pulled by a rubber band. This can be prevented with a drop of glue. You may invent your own way to hook the rubber band.
8. Wind up and let it go. Wind-up your rubber band racer: a) Hook the rubber band around the clip. b) Wind the rubber band around the axle by pulling the racer backwards with wheels on the ground, or by holding the racer and turning the wheels backward with your hands. c) Let it go!!!
Teacher expectations:

- Make sure that every student participates.
- Creativity is key in the assignment.
- The students can either create a car or a tricycle.
- If the students cars don’t work, see if they understand why they don’t work and have them write their finding down and see if they can make modifications.
- The main goal is to see how far their cars will go. There will be a starting point that everyone will have and their goal is to get to ‘The Joker’.
Shake it up or shake it down

Grade: 4th

STEM Content Standards:

Science: PS.6.4.1 Investigate the relationship between force and direction
NS.1.4.11 Generate conclusions based on evidence

Technology and Engineering: Standard 8. Students will develop an understanding of the attributes of design. In order to realize the attributes of design, students should learn that: The design process is a purposeful method of planning practical solutions to problems

Math: [CCSS.MATH.CONTENT.4.MD.A.3](https://www.corestandards.org/Math/Content/4/MD)
Apply the area and perimeter formulas for rectangles in real world and mathematical problems. For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor.

Big Ideas:

- Force
- Gravity
- Measurement

Essential Question: How can I build a building that will withstand the simulated earthquake, and how can I build a building that will not?

Scenario: There has been a series of earthquakes occurring in a city. In a neighborhood there was an apartment building (building A) that was able to withstand the effects of the earthquake, unfortunately the apartment building (building B) next to building A did not make it.

Challenge: Working in pairs, make a model of the two apartment buildings on the earthquake grid simulator. Building A must be taller than building B and building A must be able to withstand the earthquake.

Tools, Materials, and Resources:

- LEGO bricks
- Large, flat LEGO baseplate
- Metric ruler
- Two flat pieces of thin wood
- Four small rubber balls
- Two rubber bands

Content information:

- Place the boards on top of one another and "rubber band" them together by stretching a rubber band around each end, about 2.5 centimeters from the edge of the boards.
- Insert the rubber balls between the boards at each corner, placing them about five centimeters in from the edges.
- Attach a large, flat LEGO plate to the top by slipping the plate underneath the rubber bands. Your "shake table" is now ready
Earthquakes are the shaking, rolling or sudden shock of the earth’s surface. They are the Earth's natural means of releasing stress. The West Coast is most at risk of having an earthquake, but earthquakes can happen in the Midwest and along the East Coast. Earthquakes can be felt over large areas although they usually last less than one minute. Earthquakes cannot be predicted.

**Deliverables:**

**Parameters or constraints:**

- Building A must be taller than Building B
- Lego buildings must be at least six inches tall
- Legos are the only building material that can be used

**Evaluation:**

Students will be evaluated on if they are successful at getting one building to stay up and one to fall day. Students must also be able to explain why their buildings fall or stand while using the terms force, gravity, and movement.
Let’s Make A Bridge!

Grade: 5th

Stem Content Standards:

**Next Generation Science Standards (NGSS)**

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

**Standards for Technological Literacy – STL Benchmarks**

Standard 1. Students will develop an understanding of the characteristics and scope of Technology.

- Grade level 3-5 D. Tools, materials, and skills are used to make things and carry out tasks.

**Common Core Mathematics Standards**

Generate and analyze patterns.

CCSS.MATH.CONTENT.4.OA.C.5

Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself.

Big Ideas:

- Being able to be a useful member in an engineering design group.
- Being able to use the Keva Blocks to plan and solve an engineering design problem.
- Being able to understand the development and characteristics of the design.
- Being able to weigh and tell the measurements of the toy cars with a scale.

Essential Question

What would be the best method to design a bridge that can withstand a certain amount of weight by using the Keva Blocks?

Scenario

A Fayetteville Engineering Company needs to build bridge. It needs to be able to hold the weight of several cars at one time. It's up to you to help them figure out the best method to design a bridge that can meet their requirements.

Challenge

Working as a member of a 4-5 person engineering group, use the Keva Blocks to design and build a bridge that will be able to support the weight of as many toy cars as it can without falling down.
Tools, Materials, and Resources

Materials:
- 400 Keva Blocks
- Several Toy Cars

Tools:
- Measuring Scale

Content Information

Important Vocabulary Words
- An inclined plane, also known as a ramp, is a flat supporting surface tilted at an angle, with one end higher than the other, used as an aid for raising or lowering a load.
- Support: To hold up or to brace the weight of something.
- Weight: A body's relative mass or the quantity of matter contained by it, giving rise to a downward force; the heaviness of a person or thing.

Deliverables
- Drawing of the bridge design.
- Finished engineering design product of the bridge
- Calculation of the total weight of the toy cars on the bridge.

Parameters or Constraints
- Gather information of what you know about the construction of a bridge.
- Sketch out possible solutions and decide on the best method.
- Experiment with your blocks by constructing different ideas before beginning the actual bridge.
- The complete bridge must:
  - Be completed and tested in one hour.
  - Built on one table in the classroom.
  - Able to hold at least one toy car but more than one if possible.
  - Stay intact after the toy cars have been placed.

Evaluation
- Once every group has completed their construction of the bridge, they will be asked to place one toy car on their bridge.
- Then each group whose bridge is still standing will keep placing cars on their bridge until one group’s bridge has the most toy cars.
- Each group will then calculate the weight that their bridge was able to hold.
**Construction Block Activity**

**Grade Level: 5th grade**

**Standards:**

**Math**

CCSS.MATH.CONTENT.5.MD.A.1
Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.

**Technology:**

Standard 8:
Benchmark C: The design process is a purposeful method of planning practical solutions to problems.
Benchmark D: Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

Standard 11:
F: Test and evaluate the solutions for the design problem
Benchmark G: Improve the design solutions

**Big Ideas:**

- Convert measurements to different units
- Use the design loop to solve the problem
- Build a unique structure that is stable with a narrow base

**Essential question:** How can you create a structure that is narrow at the base and wider at the top?

**Scenario:** A city has run out of space for new buildings except for narrow pieces of land. Think of a way to create a structure that is narrow at the base and wide at the top so you can maximize the space given.

**Challenge:** Construct a building that is two Keva blocks wide and three Keva blocks high at the base. Then, build a structure that is wider than the base having 200 Keva blocks to use. Use as many Keva blocks as possible.

**Content Information:** Students will be able to research during the design period to look up actual buildings that are made this way.
**Deliverables:** The students will need to show how they built the structures on their engineering journal. The students need to be able to know why this would be beneficial to the city, since they don’t have a lot of ground space. They need to be able to show their different design ideas through their engineering journal. The final design should maximize the amount of keva blocks used. The groups need to measure the width and height of their structure and then convert the unit measurements.

**Materials:**

- 200 keva blocks
- 2 meter sticks
- ruler

**Parameters:** The students will be given one hour to complete their building. The building that is created must be wider than the base that is given to them. Use as many blocks as possible to create this structure. The structure may not be put together using any type of adhesive. Only Keva blocks are allowed to create the structure. The students are allowed to rebuild the structure if it falls, but at the end of the hour whatever is built is what the students will have to present and measure to make sure it is wider than the base.
Assessment:

<table>
<thead>
<tr>
<th></th>
<th>Excellent (25-20)</th>
<th>Good (19-15)</th>
<th>Okay (14-10)</th>
<th>Insufficient (9-0)</th>
<th>Total Points:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creativity</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Top is wider than the base</td>
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<tr>
<td>Engineering Journal</td>
<td></td>
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</tr>
</tbody>
</table>

Comments:
Scenario: A city has run out of space for new buildings except for narrow pieces of land. Think of a way to create a structure that is narrow at the base and wide at the top so you can maximize the space given. You and a partner follow the design loop and engineering design journal. You and your partner have one hour to complete a design that meets the parameters. You may re-design the structure if it falls down, but once the hour is up you must use whatever is standing as your final product.

Materials:

- 200 keva blocks
- two meter sticks
- ruler
Engineering Journal:

Problem:
____________________________________________________________________________________
_________________________________________________________________________________

Imagine Possible Solutions:

<table>
<thead>
<tr>
<th>Design 1:</th>
<th>Design 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design 3:</th>
<th>Design 4:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

**Plan:** Explain the final design and draw what it will look like

____________________________________________________________________________________
Create: Write down the process of what is being built and the strategies you are using to complete this design.

________________________________________________________________________________________________________________________________________
________________________________________________________________________________________________________________________________________
________________________________________________________________________________________________________________________________________
________________________________________________________________________________________________________________________________________
________________________________________________________________________________________________________________________________________

Final Product:

Dimensions:

Length: mm cm m

Width: mm cm m
Lego Sculpture Challenge

STEM Disciplinary Area: engineering

Grade Level: 5th

Unit: Construction blocks

STEM Content Standards:

- Standards for Technological Literacy:
  - STL 8C: The design process is a purposeful method of planning practical solutions to problems.
  - STL 8D: Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

- NGSS 3-5-ETS1 Engineering Design:
  - 3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
  - 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

- Common Core Mathematics:
  - CCSS.MATH.CONTENT.5.G.B.3: Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.
  - CCSS.MATH.CONTENT.5.G.B.4: Classify two-dimensional figures in a hierarchy based on properties.

Big Ideas:

- Being able to use the design loop effectively.
- Being able to creatively use Lego blocks.
- Work together with other students effectively.
- Being able to understand how small pieces can make up one large project.

Essential Question: How can you create a sculpture that mimics the creativity and engineering practices of the large Lego sculptures presented in the PowerPoint?

Scenario: A millionaire just gave you a commission to create a large Lego sculpture for a park in your town. He wants an original creation, but it must fit the dimensions of the space. He also wants the sculpture to be lifelike, and not abstract. It must look like something (an animal, person, character, etc.). Are you up for the challenge of Lego creation?

Materials/Resources:

- Lego sets (enough for each student group to have enough for the parameters set)
- 15” x 15” cardboard squares (for sculptures to sit on)
- Rulers
- Lego Sculpture PowerPoint (for teacher to introduce lesson)
- Engineering Design Loop Handout
- Student Instructions Handout
STEM Content Information:

- Students need to know how to respectfully interact and trade with other students.
- Students need to know how to measure using a ruler.
- Students need to know how to do basic addition, subtraction, multiplication, and division.
- What are the steps in the engineering design loop?
  - 1) Identify the problem
  - 2) Brainstorm how the problem can be solved
  - 3) Choose a solution
  - 4) Test the solution
  - 5) Evaluate the solution
  - 6) Improve on the solution
  - 7) Share with others

Deliverables: At the end of the lesson, students will need to submit two items for evaluation: These items are:

- Finished Lego sculpture (group project)
- Design Loop Handout (completed individually)

Parameters or Constraints: Students may only design sculptures that stay within the 15” x 15” cardboard square they are given. They may build as tall as they wish, but only within the project’s allotted time. They must budget their time and resources wisely. Each group will be given the same number of Legos, but each group’s bag will have different shapes, sizes, and colors. The groups are allowed to trade with one another if Legos are needed across groups. The sculpture must also be made to look like something in particular. The group must have an idea in mind.

Evaluation: Students will be evaluated in three separate ways during this project: a checklist for the sculpture project, the graded design loop handout, and a teamwork evaluation for the group members to fill out on their teammates as a check.
Name: _______________________________________________________

Lego Sculpture Checklist

Understanding of the Task
______/10  Student knows what is expected of him/her.
______/10  Student works well with teammates.
Comments:

Meets Parameters
______/10  Group design meets the parameters.
______/10  Group project does not go outside the 15” x 15” cardboard square.
Comments:

Creativity
______/10  Group sculpture is creative. It looks like what it is supposed to look like in the design brief.
______/10  Group attempted to make sculpture creative.
______/10  Sculpture is aesthetically pleasing.
Comments:

Engineering Design Loop
______/10  Student completed the design loop thoroughly.
______/10  Student used the design loop in coming up with a legitimate solution for the sculpture project.
Comments:
Overall Effort

_____/10  Student put in the work necessary to complete a creative Lego sculpture.

Comments:

Overall: ___________/100 points

Overall Comments:
Lego Sculpture Challenge

A millionaire just gave you a commission to create a large Lego sculpture for a park in your town. He wants an original creation, but it must fit the dimensions of the space. He also wants the sculpture to be lifelike, and not abstract. It must look like something of your choice (an animal, person, character, etc.). Are you up for the challenge of Lego creation?

**Design** and **create** a Lego sculpture that fits within a 15-inch by 15-inch cardboard square. The sculpture may not go outside the perimeter of the square. It may, however, be as tall as you wish. Legos are provided. Each group will be given a bag of the same number of Legos. The Legos will be different sizes and colors. You ARE allowed to trade other groups for their Legos. No stealing or cheating is allowed! Rulers are also provided. Use the engineering design loop throughout the entire process.

Time to get to working on your Lego masterpiece!
# Engineering Design Loop

<table>
<thead>
<tr>
<th>Step 1: Identify the Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 2: Brainstorm how the Problem can be Solved</td>
</tr>
<tr>
<td>Step 3: Choose a Solution</td>
</tr>
<tr>
<td>Step 4: Test the Solution</td>
</tr>
<tr>
<td>Step 5: Evaluate the Solution</td>
</tr>
<tr>
<td>Step 6: Improve on the Solution</td>
</tr>
<tr>
<td>Step 7: Share with Others</td>
</tr>
</tbody>
</table>
Teamwork Evaluation

Your name: ___________________________________________

Teammates’ Names:
____________________________________________________________________________________
________________________________________ ________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

Rate your teamwork on a scale of 1-5. 1 being “I really disagree,” and 5 being “I really agree.”

I tried my best to work with my team. 1 2 3 4 5

My team and I worked well together. 1 2 3 4 5

When a teammate and I disagreed on something, we talked it out. 1 2 3 4 5

One team member did not do all the work. We all worked on the project equally. 1 2 3 4 5

My team came up with a project that was both creative and fit the parameters. 1 2 3 4 5

I contributed something unique and wholly original to my team. 1 2 3 4 5

Overall, my experience on my team was great! 1 2 3 4 5
I have something else to add:

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

________________________________________

____________________________________________

_________________________________________________________________

Your signature: X

____________________________________________________________________________

*By signing your name on this teammate evaluation, you understand that everything on this is true. You did not alter the evaluation to hurt anyone or anyone’s grade.
Volcano Toothpicks
Grade Level: 5th
Disciplinary: STEM
Unit: 4. Earth's Systems: Processes that Shape the Earth

Content Standards:

Science:

- *Next Generation Science Standards:* 4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on human.
- *Next Generation Science Standards:* 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.

Technology and Engineering:

- *Standards for Technological Literacy:* Standard 8. Students will develop an understanding of the attributes of design.
  
  C. The design process is a purposeful method of planning practical solutions to problems.

- *Standards for Technology Literacy:* Standard 9. Students will develop an understanding of engineering design.
  
  C. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.

- *Standards for Technology Literacy:* Standard 10. Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
  
  C-E.

- *Standards for Technology Literacy:* Standard 11. Students will develop the abilities to apply the design process.
  
  D. Identify and collect information about everyday problems that can be solved by technology, and generate ideas and requirements for solving a problem.
Mathematics:

- **CCSS. Math.Content.3.MD.B.2.** Represent and interpret data.

**Big Ideas:**

- Understanding parts of volcanoes and concept of how they work
- Understanding why certain materials withstand lava
- Understanding that the cereal, marshmallow, and sugar cube dissolve in warm water
- Using the design loop correctly
- Recording and graphing
- Using creativity to solve problems

**Essential Question:** How can you design a structure out of toothpicks that withstands the “lava” flowing from the volcano?

**Scenario:** You and your family have decided to move to Hawaii, which is known for its volcanoes. Your family lives not far from the volcano’s path, so you and your family decide to build a structure that can withstand the volcano’s lava. Keep in mind you only have a limited amount of supplies so use what you can to build the strongest and safest structure to withstand the lava.

**Challenge:** Working with your STEM group, decide which materials you think will make your structure withstand the lava and then plan how you want to build your structure. You will only get 20 connectors so choose carefully. Use the design loop worksheet to plan out your structure and then begin on your project. After you have built your structure, test how well it withstands the “lava.” You will have 10 minutes to observe and record your answers on the Volcano Picks worksheet. You may change one thing about your project and test your new structure. Compare your results and then graph and present your results to the class.

**Tools and Materials:**

- Each team is provided with 40 colored Toothpicks, 20 Connectors of choice (cereal pieces, marshmallows, or sugar cubes), a stopwatch, and a small plastic person.
Resources:

- Design Loop Worksheet
- Results Worksheet

Content Information:

What are the characteristics of magma and lava?

- **Magma** is molten (melted) rock. When magma reaches the earth’s surface it mixes in with steam and gas that is around it and it turns into lava. **Lava** is slightly cooler than magma, glows a different color, and it is made up of different substances.

Why does sugar dissolve? Why does it dissolve faster in hot water?

- Like all materials, sugar and water are both made of very small particles. When you add sugar to water, the water particles are attracted to the sugar particles. Sugar particles are then surrounded by lots of water particles. Each sugar particle is spread out and separated from the other sugar particles, so the white crystals of sugar appear to disappear. We say that the sugar is **soluble** in water and so has **dissolved** in the water. The sugar (the **solute**) has dissolved in the water (the **solvent**) to form a **solution**. If the water is hot, the particles spread faster because they have more energy to move. The marshmallows, sugar cubes, and cereal all contain lots of sugar. When hot water flows to the base of their structure, it breaks apart and dissolves, ruining the structure. This is similar to volcano lava and houses. The lava is hot enough to catch the house on fire. Students are to discover that like in real life, most structures or objects do not withstand against volcano’s lava except certain types of metals such as iron, which have a melting point above 2,800 degrees Fahrenheit. Students would research these and devise the best course of action to take after project is completed knowing this information.
Students can use sugar cubes as a stackable base, or however they find fit. Structure can be made a variety of ways. “Lava” should be made with warm water, orange food coloring, and dirt/rocks. Other connectors that could be used: cheese cubes, different types of marshmallows, and harder candies to illustrate how some materials are stronger than others.

Deliverables:

- Completion of Design Loop Worksheet
- Completion of Volcano Picks Worksheet
- Presentation of final design and results, including graph
Parameters or Constraints:

- Use only the given materials
- Build and observe your structure for 10 minutes
- Results must explain how volcanoes work, how objects dissolve, and why certain metals can withstand lava
- Use a stopwatch to time how many seconds the structure holds together
- Structures must sit in the pan/bowl given by teacher
- Structure must be tested with teacher’s “lava” (mixture of warm water, red/orange food coloring, rocks)
- Structure must hold a small plastic person, keeping them safe from the volcano’s lava

Evaluation:

- Students will be evaluated using a rubric on the work they did on their worksheets, understanding of concepts, if their project met parameters, and their final presentation and creativity. Students will evaluate members in their group with the peer evaluation rubric. This is their chance to explain to me any problems they feel might have taken place.

Expected Outcome:

- After this experiment, students will understand parts of a volcano, where volcanoes are located, how people can reduce the impacts of volcanoes on humans, and what materials can withstand lava, understanding of melting points. Students will also understand what a solute and solvent is and what happens when something dissolves.
Student Copy

Essential Question: How can you design a structure out of toothpicks that withstands the “lava” flowing from the volcano?

Scenario: You and your family have decided to move to Hawaii, which is known for its volcanoes. Your family lives not far from the volcano’s path, so you and your family decide to build a structure that can withstand the volcano’s lava. Keep in mind you only have a limited amount of supplies so use what you can to build the strongest and safest structure to withstand the lava.

Challenge: Working with your STEM group, decide which materials you think will make your structure withstand the lava and then plan how you want to build your structure. You will only get 20 connectors so choose carefully. Use the design loop worksheet to plan out your structure and then begin on your project. After you have built your structure, test how well it withstands the “lava.” You will have 10 minutes to observe and record your answers on the Volcano Picks worksheet. You may change one thing about your project and test your new structure. Compare your results and then graph and present your results to the class.

Tools and Materials:
- Each team is provided with 40 colored Toothpicks, 20 Connectors of choice (cereal pieces, marshmallows, or sugar cubes), a stopwatch, and a small plastic person.

Resources:
- Design Loop Worksheet
- Results Worksheet

Make sure to:
- Use only the given materials
- Build and observe your structure for 10 minutes
- Results must explain how volcanoes work, how objects dissolve, and why certain metals can withstand lava
- Use a stopwatch to time how many seconds the structure holds together
- Structures must sit in the pan/bowl given by teacher
- Structure must be tested with teacher’s “lava” (mixture of warm water, red/orange food coloring, rocks)
- Structure must hold a small plastic person, keeping them safe from the volcano’s lava
Turn in:

- Completion of Design Loop Worksheet
- Completion of Volcano Picks Worksheet
- Presentation of final design and results, including graph

How you will be graded:

- Rubric graded by teacher
- Student evaluation your teammates will fill out on you
How many seconds did it take for the structure to collapse?

How well did your design work?

How did your connectors react to the “lava”? Did they dissolve?

Materials of choice:

The best connectors are:
Volcano Picks

1. Which connectors did you decide to use?  
2. Why did you decide to use these materials?

3. Write down some observations during your experiment. What did you see after 10 minutes? Did your connectors hold? How many seconds did they hold?

4. If your connectors held your structure together, why do you think this is? If they fell apart, why do you think this is?

5. What does this tell you about the connector’s ability to dissolve in water?

6. How do you think you could change your structure to withstand the lava better? Why?

7. Change ONE thing about your structure and test this experiment again. Make observations during this time.

8. Compared to your first structure, did this one hold for a longer or shorter time? Why?

9. Do you think certain materials could withstand lava in real life? Why or why not?
10. Label parts of the volcano below.

11. As a group decide which connector worked best and record results on class graph.
Team Performance Rubric

Project or Assignment: ________________________________

Name: ____________________        Teammate Name: ____________________

Check box if task was completed by individual teammate. Get brief explanation in box if teammate did not complete required task. This is your chance to explain to me how your partners worked as a group.

<table>
<thead>
<tr>
<th>Category</th>
<th>Teammate #1:</th>
<th>Teammate #2:</th>
<th>Teammate #3:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsibility:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My teammate contributed at least 25% of the effort and helped us finish the task.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contribution:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My teammate contributed to the success of the team, completed his/her share of the work, and offered constructive feedback to complete the tasks.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Team Performance:</td>
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<td></td>
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</tr>
<tr>
<td>My team completed the task or finished a project accurately, on time, &amp; according to specifications because all members contributed.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Team Collaboration:</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>The team functioned at a high level—with all members carrying out specific roles and contributing equally.</td>
<td></td>
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<tr>
<td>Communication:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My teammate contributed to an effective team output, presentation, or communication of effort.</td>
<td></td>
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</tbody>
</table>


Volcano Toothpicks Rubric

<table>
<thead>
<tr>
<th>Category</th>
<th>0-6 Poor Level Performance</th>
<th>7-13 Good Level Performance</th>
<th>14-20 Excellent Level Performance</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proper use of the Design Loop</td>
<td>Does not use the design loop worksheet or demonstrate understanding of volcano structure design</td>
<td>Uses worksheet to brainstorm one solution, but fails to use content understanding in designing structure</td>
<td>Uses worksheet to brainstorm multiple solutions and uses content knowledge in volcano design</td>
<td></td>
</tr>
<tr>
<td>Completion of Volcano Picks Worksheet</td>
<td>Does not complete worksheet or provides minimal results</td>
<td>Only records some data or answers a few questions</td>
<td>Records data accurately and explains all answers in detail</td>
<td></td>
</tr>
<tr>
<td>Did it meet the parameters?</td>
<td>Uses other materials not given</td>
<td>Uses given materials, but results do not explain concepts</td>
<td>Uses only given materials and results explain understanding of content knowledge</td>
<td></td>
</tr>
<tr>
<td>Understanding of volcanoes, concept of how objects dissolve, and structures that withstand volcanoes</td>
<td>Does not demonstrate understanding of concepts</td>
<td>Demonstrates understanding of one or two concepts briefly</td>
<td>Demonstrates good understanding of all concepts</td>
<td></td>
</tr>
<tr>
<td>Presentation and Creativity</td>
<td>Design shows no creativity or no explanation of reasoning</td>
<td>Design is lacking some creativity and students give brief explanation of solution</td>
<td>Design is original and thoroughly describes solution</td>
<td></td>
</tr>
</tbody>
</table>

Comments:  

Total Points: /100
Help Jack and Jill Go Up the Hill

Rubber band Racers

Grade: 5th

STEM Content Standards

Science

Next Generation Science Standards: PS.6.5.1- Classify simple machines.

Next Generation Science Standards: PS.6.5.6- Conduct investigations using potential energy and kinetic energy.

Technology

Standards for Technological Literacy: Standard 6, Students will develop an understanding of the role of society in the development and use of technology.

- B. Because people’s needs and wants change, new technologies are developed, and old ones are improved to meet those changes.

Engineering

Standards for Technological Literacy: Standard 9, Students will develop an understanding of the attributes of design.

- C. The design process is a purposeful method of planning practical solutions to problems.

Math

Common Core State Standards: Standard 5. MDA.1- Convert like measurement units within a given measurement system.

BIG Ideas

Energy  Simple Machines  Friction  Wheel and Axle  Potential Energy  Kinetic Energy  Ramps and Angles

Essential Question

How can you alter the propulsion means of a rubber band racer to make it up the hill (ramp) in order to get Jack and Jill back to the well to fetch a pail of water?

Scenario

We all know that Jack and Jill went up the hill to fetch a pail of water. But no one ever seems to realize that Jack and Jill spilled their pail of water on their tumble down the hill, which means they are still thirsty! You must help Jack and Jill get up to the hill in a rubber band racer.
Challenge

Work in groups of a three in order to follow the directions on how to build a rubber band racer. Once you complete the final product, think about what you need to alter in order to make yours different from others. Create a part of the rubber band racer that you can shoot a rubber band from in order to make it move forward. You may only use the given materials. Your vehicle should be tested to see if it has enough energy to make it up a 3in x 3in ramp (the hill that Jack and Jill need to get to the top of). The rubber band racer that makes it safely to the top of the ramp and back down the other side will be most suitable for Jack and Jill.

Tools, Materials, and Resources

You may only use the materials given in the rubber band racer packet along with tools found in the STEM lab. You may use also use five rubber bands, 1 foot of string, and 4 stop clips in addition to your rubber band racer packet.

Content Materials

Refer to your rubber band racer packet to create your racer. You will find tidbits of useful information that can help you to create an awesome racer that can help Jack and Jill!

Deliverables

Design Journal

Rubber band Racer

Parameters

Students must not stray far from the original designs of the rubber band racers. The racer must look like the intended design

Evaluation

Students will share their designs by presenting their racers to the class and showing them how their racers make it to the top of the ramp and back down the other side. Students will teach others about the changes they made and how those changes affected their overall racer. (I.e. help students to realize “Wow! I can’t believe what a big difference changing the ____________ made in the entire process!”)

Design Journals:

Students will answer questions in a design journal given by the teacher about how they accomplished their final goal, what did and did not work, if they altered their rubber band racer, what mathematical skills they used to get Jack and Jill up the hill, and how they used they potential and kinetic energy within the rubber band racer to get them there.
Suggested Grades: 6-12
Measuring with KEVA - TEACHER COPY

Grade: 5th or 6th

Discipline Area: STEM

Unit: Measuring using improvised units and Ratios

STEM Content Standards:

Mathematics:

CCSS.MATH.CONTENT.6.RP.A.1
Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

CCSS.MATH.CONTENT.6.RP.A.3.D
Use ratio reasoning to convert measurement units; manipulate and transform units appropriately

OBJECTIVE: Students will use the length-to-width ratios of KEVA planks to determine the heights of their towers.

MATERIALS: KEVA planks, rulers, graphing packet

NOTE: KEVA planks are constructed so that 3 KEVA thicknesses equal the width of 1 KEVA, and 5 KEVA widths equal the length of 1 KEVA.

PROCEDURE:

1. Have students attempt to determine the relationships between KEVA planks for themselves.
2. Have the class build towers of varying heights. Give separate groups different height requirements to meet. (5, 10, 15, 20, 25 KEVA planks)
3. Using what they have discovered about the ratio relationship of the KEVA planks, the students should be able to determine the exact height of their towers expressed in KEVA units of height. Determine as a class whether you will record your answers in KEVA heights, thicknesses or widths; or, students are free to choose any of these three options.
4. After the height of the towers has been calculated in terms of KEVA, the students will return to desks to convert their measurements to English or metric units by measuring the dimensions of 1 KEVA plank and multiplying.
5. Students will then make estimations about the height of other classmates’ towers based on the height of the tower they constructed.
6. Discuss as a class the tower heights and have students discuss their estimations and whether or not they were correct.
7. Collect graphing journals to grade student’s ratios and math.
Measuring with KEVA- STUDENT COPY

**Essential Question:** Can you correctly use ratios to build a tower with KEVA blocks to meet the required height?

**Scenario:** You and your “coworkers” are required to build a model of a tower that your architecture company is building but you don’t have any rulers or measuring tools with you. You must use KEVA blocks to build the tower and to measure the correct height.

**Materials:** KEVA planks and a graphing packet

**Procedure:**

1. Before building begins, make sure you and all of your teammates have a work journal. Complete questions 1 through 4 and wait for Miss Ashton to give your group a height requirement.
2. When given a height requirement for your group, you may collect 100 KEVA planks.
3. Begin building your tower, measuring with KEVA planks and using KEVA units. You must meet your height requirement but feel free to build beyond that. Be creative with your tower!
4. When done building, leave tower standing and quietly return to seat. Begin converting measurements in journal and finish any remaining questions.
Measuring with KEVA- Student Work Journal

Name___________________________    Height Requirement_____________________

1. What is a ratio?

2. How can you use ratios to measure the height of your tower?

3. Answer the following questions:
   • _____ KEVA thickness=width of _______ KEVA
   • _____ KEVA widths=length of _______ KEVA

4. Draw a sketch of your tower and label height and width in KEVA units
5. What is the exact height of your tower in KEVA units? Width?

6. You have been provided with rulers! Convert measurements into metric units. Convert KEVA units into centimeters. Show math below:

7. Now that you have an idea of how tall your tower is in centimeters, estimate how tall the other towers are around the classroom. Write estimations below:

8. Write the actual measurements below in centimeters. Circle tower number if your estimation was within 10 centimeters.
Construct a Tower

Grade: 6 - 12

**STEM Content Standards:** Identify content standards from as many of the STEM fields as possible, but don’t try to deliver everything known to humankind in one design brief (2 or 3 standards is enough).

**Big Ideas:** The major concept of this assignment is to teach building stability and with as few materials as possible and have the ability to do so with a strong tower.

**Essential Question:** How did you manage the weight and why do you think that it worked?

**Scenario:** You are an engineer that has been asked to build a tall tower and a giant glass pool on the top. Your job is to build your tower as high as possible with a 15 x 15 base. Try to be sparing with materials! You’re new to construction and don’t have the fullest wallet.

**Challenge:** Build a tower that is at least a foot tall and has a 15 x 15 lego base that supports the weight of a brick.

**Tools, Materials, and Resources:** students may use the surface of one desk and 300 legos to make this tower.

**Deliverables:** completed handout with design loop answered and a tower that is to specification.

**Parameters or constraints:** 300 legos, surface of one desk, one foot tall, 15 x 15 base.
You are an engineer that has been asked to build a tall tower and a giant glass pool on the top. Your job is to build your tower as high as possible with a 15 x 15 base. Try to be sparing with materials! You’re new to construction and don’t have unlimited funds.

For this project you will be building a tower of legos that will support the weight of a brick. You will be given 300 legos to work with. You must make a tower that is at least a foot tall and has a volume of 15x15 legos on the bottom most layer. You will have to adjust your tower to support the weight of the brick. Also the brick will be placed on the top of the tower. Use the Design Loop to help you figure out the best design to make you successful!
What is the Problem?

Brainstorm and draw some solutions (2 or 3)

What is your best solution? (draw and label)

What steps did you use to get to this point?

What materials did you decide on using and why?

How did your solution do when tested?

What could you have done to improve your design?

What did you learn from this experience?

What would you do differently with this project if you were teaching it?
Rubric Planning Sheet

Project or Assignment: David and Goliath Sling

<table>
<thead>
<tr>
<th>Category</th>
<th>1 pts.</th>
<th>2 pts.</th>
<th>3 pts.</th>
<th>4 pts.</th>
<th>Score</th>
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<tbody>
<tr>
<td>Unacceptable Level Performance</td>
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<tr>
<td>Intermediate Level Performance</td>
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<td>Accomplished Level Performance</td>
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<td>Superior Level Performance</td>
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15x15?

1ft tall?

Taller/wider then asked?

Did it support the weight?

Handout Completing

Comments: Total Points: /20
**GETTING STARTED: DESIGN BRIEF DIRECTIVE SHEET**

<table>
<thead>
<tr>
<th><strong>Standard(s):</strong> What standard and/or local curriculum component is addressed?</th>
<th><strong>Assessment:</strong> What evidence will be used to determine whether students have learned?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>If they completed the assignment and if their tower failed they understand why it failed.</td>
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<thead>
<tr>
<th><strong>Prior Knowledge/Experiences:</strong> What prior content knowledge/skills will the students need?</th>
<th><strong>Challenge:</strong> What will the students be required to do?</th>
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</thead>
<tbody>
<tr>
<td>The students will need to know a little about the ability to support weight before this assignment</td>
<td>They will be required to build a tower and fill out a handout.</td>
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</table>

<table>
<thead>
<tr>
<th><strong>Result:</strong> What will students know, value, and be able to do as a result of this lesson? What's the big idea?</th>
<th><strong>Laboratory Preparation:</strong> Will special arrangements need to be made?</th>
</tr>
</thead>
<tbody>
<tr>
<td>The big idea is that they will learn how to make an object stable and be loose with materials</td>
<td>Lots of legos and safety equipment so that if a brick falls no one gets hurt.</td>
</tr>
<tr>
<td><strong>Materials/Equipment:</strong></td>
<td>What materials and equipment will students need to successfully complete this lesson/activity?</td>
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<td>-------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
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<tr>
<td></td>
<td>They will need 300 legos and fill out the handout provided.</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th><strong>Summary/Connections:</strong></th>
<th>How will this design activity connect with future learning, other disciplines, work world, etc.?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>If they are going into engineering it is an early precursor to what they will be doing.</td>
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<tr>
<th><strong>Grade Level:</strong></th>
<th>6 - 12</th>
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<tr>
<th><strong>Time Involved:</strong></th>
<th>1 class period</th>
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</table>
Survive the Quake
Grade: 9-12

STEM Content Standards:

- **STL Standard-20:**
  - Infrastructure is the underlying base or basic framework of a system.

- **Common Core Math Standard-Q.A.2**
  - Define appropriate quantities for the purpose of descriptive modeling.

- **Next Generation Science Standard-ESS2.B 6-8**
  - Plate tectonics is the unifying theory that explains movements of rocks at Earth’s surface and geological history.

Big Ideas:

- The framework of a structure must be built to withstand the movement of Earth’s crust that is caused by tectonic plate shifting.

**Essential Question:** How does an earthquake affect the framework of a structure?

**Scenario:** You are an architect designing a skyscraper in Los Angeles, California. Because of the building’s close proximity to the San Andreas Fault line, you must design a building that could withstand an earthquake.

**Challenge:** With your partner, design a building’s infrastructure that can withstand a simulated earthquake using only Legos.

**Tools, Materials, and Resources:**

- 350 Legos of the same size.
- Tape Measure

**Content Information:** Earthquakes cause the infrastructure of a structure to bend with the movement of the quake.

**Deliverables:**

- Completed Tower
- Design loop worksheet
- Vocabulary word search
Parameters or Constraints:

- Only the 350 Legos given to each group can be used -- no more.
- Your structure must be at least 18” tall.
- Your structure must be able to attach to the Lego base that is provided.
- Keep in mind that your structure must resemble a skyscraper that can hold office spaces, utility rooms, equipment storage, etc.

Evaluation: Assessment of the structure will be done via a design rubric. The Design loop worksheet, and the word search will be assessed by use of a point system.
Survive the Quake

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1. Identify the problem needing to be solved in this design challenge.

2. Cite some sources you used in your research.

3. Draw sketches of your design here.

4. Explain the parameters of your testing.

5. What were your findings from your tests?

6. Does your final product solve the problem? If so, how?
Word Search

BODY
COMPRESSION
EARTHQUAKE
FAULT
INFRASTRUCTURE
MAGNITUDE
PLATE
TECTONICS
TENSION
WAVES

ISEQUSCINOTCETN
SNMDEZYRACPOEOX
KMFTUXJSEAMEZA
VFARSTPCASMPOTM
JLQKADIRBEARUBX
PPBCTSTNXAUEHOR
WEQJOHTRGOQSZDZ
AWHDQLBRZAPSSYY
ADAUNFNDUXMIARC
IBAVWYOVUCIOWIP
XKFKEJIGUFTNOSG
EHFMYSSPTG IKMA
UFZXZANFAULTRHV
ZGHWWVEJTDLFFED
NXUTTFTYHNGETBG
Survive the Quake

Name:

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<th>Evaluation Area</th>
<th>Poor (0-2 pts)</th>
<th>Average (3-5 pts)</th>
<th>Good (6-8 pts)</th>
<th>Great (yes) (9-10 pts)</th>
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<td><strong>Parameters</strong></td>
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<td>Does your design</td>
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Score: _________

Notes: