

Teacher Background

The idea for this challenge is one that I have toyed with numerous times! My thought was to offer materials to students and then reveal what they would be building with every group building something different. We added the budgeting feature to help teams really think about what they are building and choosing the right materials for the task. The kids loved it!

In this challenge students will be assigned a structure to build and given a list of possible materials. Teams will have to work together to choose the right materials to build their structure and stay within a purchasing budget for those materials. To make it really fun, every team will build something different. (You can also opt to have all teams build the same thing- which makes this challenge packet last a long time! Just use one challenge card for everyone and do all 6!)

Students will follow the steps of the Engineering Design Process for this challenge. Procedures for the teacher are marked with the steps of the process as well as the student lab sheets. The teacher directions include hints in shaded boxes and photographs. A student answer key is *not* provided as there are so many different things being built.

This package will give you a list of materials, preparation ideas, and then step-by-step procedures to make this a successful event. Change the materials to suit your needs and student population. This is a *shortened* version of STEM Challenges you can find at *Teachers are Terrific* with only 3 pages of teacher directions and 1 page of photos. Look for longer and more detailed instructions with the large selection of challenges in my store!

MATERIALS

- Craft sticks
- Paper clips
- Rubber bands
- Cardboard tubes
- Cups
- Straws
- Craft foam
- Foil in 12-inch lengths
- Toothpicks
- Pipe cleaners
- Cardstock
- Masking tape
- Small bowls
- Pennies
- Markers
- Marbles
- Small toy figure (like a Lego man)
- Copies of student lab sheet

HINTS about SUPPLIES:

Cardboard tubes- We used paper towel and toilet tissue tubes.
Masking tape- Tear off the length needed and stick to the edge of work tables.
Paper clips- Do consider having a rule for the use of these! My students were told they could not straighten them to poke through anything!
Cups- I offered 3 ounce and 8-ounce cups.
Craft foam- This is something I purchase at the dollar store in a 4x6 inch size. Wal-Mart also has these in large pieces.
Foil- This is another thing I purchase at the dollar store in a pack of 30 pre-cut sheets. It's just faster!
Toothpicks- Pointed toothpicks can be a safety issue. Depending on the age of your students you may opt not to use these at all or use flat toothpicks.
Small bowls- These need to fit at the top of towers or on some of the structures. You can use a 3-ounce cup.
Pennies- These are used for weights. You can substitute with washers, small erasers, marbles, etc.
Toy figure- We used a Lego man. You can substitute with any small plastic figure or use an eraser, interlocking cube, binder clip, etc.

EDITABLE FORMS IN FILE 2

PREPARATION

BEFORE CLASS:

- Prepare supplies. These need to be easily accessible when it is time for kids to gather the items they request.
- Copy the Challenge cards. I provided 6 options for this challenge. You can do this in two different ways:
 - Make 1 copy of each Challenge card. Every team makes something different.
 - Have every team make the same item and copy enough of that challenge card for each group.
- Decide how you will introduce this challenge. You can use the plan we used or create your own.
- Copy the Cost sheet for this challenge. Each group will need one copy. You can also choose to just give every group some of all the materials and not use the budget feature.
- Determine a way to divide your class into teams. For this challenge we had teams of 3.
- Allow 1 class period to complete this challenge.

SUPPLIES: I placed individual items in plastic bins and set these up on my work table. When kids came with their Cost Sheet I gathered the items listed and placed them in another plastic bin for kids to carry back to the work tables. You can leave supply bins out for kids to collect their own materials if you like.



BACKGROUND

Introduce this challenge by talking about mysteries and how they are solved. Keep going with a discussion of choosing the right materials for a job. Then, how does solving a mystery fit with choosing the right materials? (Notes from our discussion are listed in the hint box below.) Explain that the mystery students will be solving is how to choose the right materials for a job based on the constraints or rules of the task.

OUR BACKGROUND: I began by asking about mysteries, what did kids already know, how do you solve a mystery, etc. I was told, "A mystery is something that you cannot immediately know an answer for, but you use clues to find a solution. Clues are things that are like hints." Next I asked students how you decide what the right tools or materials are for a job. One reply was, "You have to look at what you are trying to build and then pick the things that make the most sense." I gave several examples of specific jobs to see if kids could respond with proper materials for the job. One example: What kinds of things would you need to build a treehouse? The kids responded with: a tree, pieces of wood, nails, a swing, zip line rope, windows, and a safety net. (Obviously some of them wanted a pretty fancy treehouse!) Next, I asked, "How does solving a mystery fit with finding the right materials for a job?" One answer, "Well, you have to think about what the problem is. You can't just grab some wood for any mystery, but you might if wood was involved in the mystery. You would need to look at the clues and then decide exactly what it will take." Nice thinking!

After this brief discussion explain to students that each team will be receiving a challenge card. The cards are all different. Based on what the card describes the team must determine what materials will be best in building the structure. Students will also need the lab sheet in order to get started.

Teacher Directions

ASK

The lab sheet begins with a question to set a purpose for this task.

How can you determine which materials to use to build your mystery model? How will you use those materials to successfully complete the structure?

This is the beginning of the Engineering Design Process. The Ask step is the place to address the task and/or problem that will be solved. This question or stated problem will set a purpose for the task, just like the question that begins the scientific method.

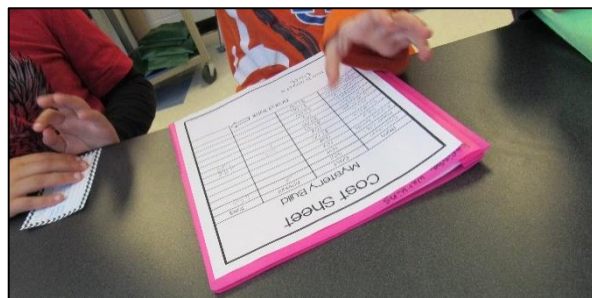
IMAGINE

Each group will now need its Challenge card and a Cost Sheet. Also, show the students your array of materials so they can see what each item looks like. You might have these displayed so that students can actually touch them or try fitting pieces together as they plan.

As soon as the teams know what is being built each student needs to respond to the first section on the lab sheet. This is the Imagine section and asks them to write about what they are building and what materials they think might be needed. Students will also add the name of what their group is building to the top of the lab sheet.

PLAN

Students should now independently sketch an idea for the structure. You can opt to have the group talk about it and make decisions without independent sketches. Hints below explain why we do independent drawings first.



PLANNING: We have a purposeful planning time. Each student writes and/or sketches about the structure. I do emphasize to students to label drawings with the materials being used. After each team member has a drawing then each one stands before the others and shares their drawing and explains it. Then the group talks about the best features of each plan and decides what to do. This allows every student to be part of the decision making for the structure being built. Having a voice right from the beginning helps all students- especially the quiet, shy ones.

TAPE: The tape is not listed on the cost sheet and is considered *free*. I usually give groups 3 feet of masking tape. If you want this challenge to be more difficult, give students less tape!

Part of the planning will be to fill in the cost sheet for the materials needed for the structure. You may have to show students how to fill this in before they begin making decisions. You can also provide calculators if you like.

Teacher Directions

CREATE/IMPROVE

Students will now need to bring cost sheets to the supply station and collect the items needed to start building their mystery item. Some groups will need additional items. The marble run group needs a marble or two, the swing set group needs a toy figure, and several of the groups will need a bowl of pennies to test their structures. Most groups will also need a ruler. Check over the math portion of the cost sheet and provide each group with the items needed. Students will begin working!

After 10 minutes or so, remind students to keep adding to their lab sheets as they work. They will need to complete the Create step of the lab which asks them to describe the plan they followed, including specific jobs. The Improve step asks them to list ways they improved or modified their structure as they worked.

IMPROVING: This is a natural occurrence as students work. As soon as they see something is not working correctly, they will find a way to modify it. You may have students that stop and take things apart to begin with Plan B. Students may be frustrated, but they will persist with finishing the task. If you have a group that is stalled, stop and ask them directed questions to encourage them. I find that just asking each team member for a new idea will get them all to talk and suddenly they will hit upon a new possibility!

As students are working they will also discover that the materials chosen might not work or they may need more. As long as more items fit their budget they can return to the supply station. The cost sheet will have to be altered and the final total changed before they revisit.

You will have to decide if they can trade in items that have not been used, in lieu of purchasing new items. Students that are out of money will have to find a way to get the structure built anyway!

Some groups may want to add decorative things to their structures. (My groups used markers and scrap construction paper for this.) We had a building time of 30 minutes.

PRESENT

When all teams have completed their structures or when your time has expired it will be time to share. This is an important part of the process. Kids love to talk about the building time and their final devices. Give each team a few minutes to prepare their presentation and then gather around one group at a time. Each group will talk and show its mystery building. Prompt them with questions if a group needs some help- like, "What was your favorite part? What was the hardest? What frustrated you the most?"

SHARING: We turned our presentation time into another mystery! Before a team revealed what the structure actually was supposed to be, we allowed the others to guess what it was. This was fun! Some structures were easily guessed, while others resembled many things.

REFLECT

The challenge ends with a reflecting time. Talk as a class about what worked or didn't work. What did they learn? How did they do with choosing the right materials for the structures? The lab sheet has space for some final reflection questions.

CHALLENGE CARD

Build a Tower

- It must be at least 20 cm tall.
- It must have 4 or more legs.
- It must hold a bowl of pennies at the top.

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CHALLENGE CARD

Build a Rocking Chair

- It must be at least 20 cm tall.
- It must rock!
- The seat must hold a bowl of at least 20 pennies.

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CHALLENGE CARD

Build a Rocket

- It must be at least 25 cm tall.
- It must resemble a rocket.
- It must have wings.
- It must stand alone.

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CHALLENGE CARD

Build a Bridge

- The bridge opening must be at least 10 cm wide.
- It must have end supports.
- It cannot have a center support.
- It must hold a bowl of at least 20 pennies.

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CHALLENGE CARD

Build a Swing Set

- It must be at least 15 cm tall.
- It must have a seat or container that freely swings.
- The seat must securely hold a small toy figure.

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CHALLENGE CARD

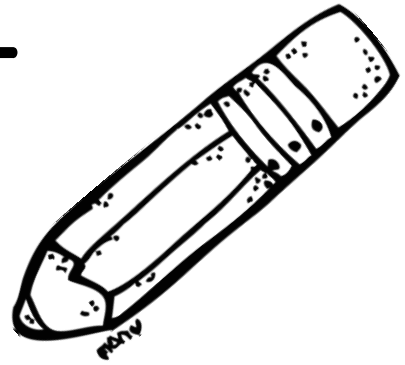
Build a Small Marble Run

- The marble run will resemble a roller coaster.
- It must have a turn or curve in it.
- A marble must travel the path.
- It must have one tunnel.

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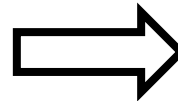
Cost Sheet

Mystery Build



Item	Cost	Amount	Total
Craft Sticks	50¢ each		
Paper Clips	10¢ each		
Rubber Bands	10¢ each		
Tubes	\$2.00		
Small Cup	\$1.00		
Large Cup	\$2.00		
Straws	10¢ each		
Craft Foam	\$1.00 each		
Foil- 12 inches	\$2.00		
Toothpicks	10¢ each		
Pipe cleaner	\$1.00 each		
Card stock	\$1.00 each		

Grand Total



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The Budget is \$10.00.

NAME _____

Mystery Build _____

ASK

How can you determine which materials to use to build your mystery model? How will you use those materials to successfully complete the structure?

IMAGINE

What is the Mystery your team will build? What materials do you think should be chosen and why?

PLAN

Sketch and label your idea for structure.

Describe how the structure was built. What was your job on the team?

CREATE

IMPROVE

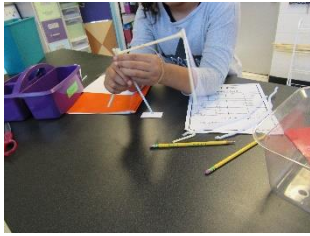
Describe some ways you improved your structure as you worked.

REFLECT

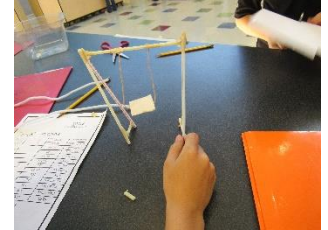
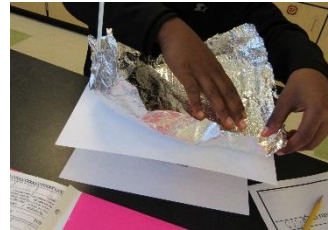
Was your team successful with choosing the right materials to use for your structure? What did not work as you expected it to?

Describe this building experience. What was the hardest part? What surprised you? What did you learn?

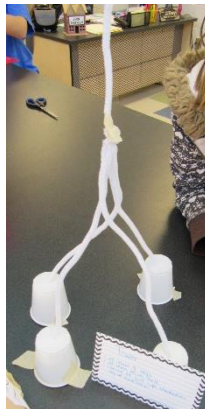
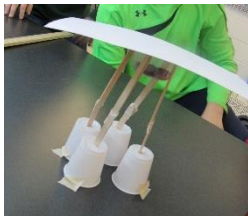
Photographs



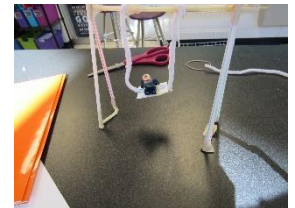
Building time was very interesting. As students began they were either very happy with the chosen materials or they quickly realized that a choice was not good. I would hear them talking about what they should have purchased!



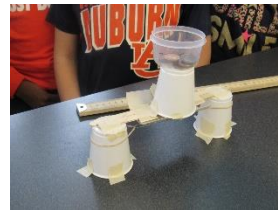
TOWER



SWING SET



BRIDGE



ROCKING CHAIR

ROCKET



MARBLE RUN





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