

E in STEM-Major Project
Amy Donohue

Touch Down
Engineering Notebook

What is the Touchdown Design Challenge?

In this engineering design challenge, the students will design and build a shock-absorbing system that will protect two "astronauts" when they land on Mars. Adopted from JPL's education website, students will follow the engineering design process to design and build a shock-absorbing system out of paper, straws, and mini-marshmallows. They will attach their shock absorber to a cardboard platform and improve their design based on testing results. This challenge mimics how engineers had to develop solutions for landing different vehicle types on the moon and Mars. Timeline: 2-3 hours

<https://www.jpl.nasa.gov/edu/teach/activity/touchdown/>

Materials and Introduction

Materials:

- One piece of stiff cardboard (4x5 inches)
- Small paper cup
- 3 index cards (3x5)
- Two lego figures (astronauts)
- 10 mini marshmallows
- 3 rubber bands
- 8 plastic straws
- Scissors
- One meter of tape

Introduction:

Explain to students why it's important to have a spacecraft that can land gently when getting astronauts to and from the Moon or Mars. Tell them they will need to design and build a spacecraft that can land on Mars without injuring astronauts or damaging the spacecraft. For this challenge, their spacecraft must land safely when you drop it on the floor.

Show JPL's *7 minutes of Terror* on how engineers designed the entry, descent and landing for NASA's Mars rover Curiosity

<https://www.jpl.nasa.gov/video/details.php?id=1090>

Identify the Problem:

To design and build a shock absorbing system that will protect two “astronauts” when they land.

Criteria:

- The “astronauts” must stay in the lander.
- The lander cannot tip over.
- The cup has to stay open. No lids.
- The “astronauts” cannot be taped down in the lander.

Constraints:

- Limited materials
- Time

Student samples:

Identify the Problem:

1.

To design and a shock absorbing system that will protect two "astronauts" when they land.

Criteria:

- 1) The "astronauts" must stay in the lander.
- 2) The lander can't tip over.
- 3) The cup has to stay open. No lids.
- 4) The "astronauts" can't be taped down.

Constraints:

- 1) Limited materials
- 2) Time

Signature Per [Signature] Date 7/10/20

Disclosed to and Understood By Matthew Pepe Date 7/10/20 Proprietary Information

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Identify the Problem:

To design and build a shock absorbing system that will protect two "astronauts" when they land.

Criteria:

- 1) The astronaut must stay in the lander
- 2) The lander can't tip over
- 3) The cup has to stay open
- 4) The "astronaut" can't be taped down

Constraints:

- 1) Limited materials
- 2) Time

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Brainstorming

Think about how to build a spacecraft that can absorb the shock of a landing.

- What kind of shock absorber can you make from these materials that can soften a landing?
- How will you make sure the lander doesn't tip over as it falls through the air?

Student samples:

2

Brainstorming: Think about how to build a spacecraft that can absorb the shock of a landing.

What kind of shock absorber can you make from the given materials that can soften a landing?

- the bag
- cup
- marshmello
- cardboard
- straws

How will you make sure the lander doesn't tip over as it falls through the air?

- tape the cup the middle

Signature	Matthew Lopez	Date	7/10/20
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Proprietary Information	Joe		

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2

Brainstorming: Think about how to build a spacecraft that can absorb the shock of a landing.

What kind of shock absorber can you make from the given materials that can soften a landing?

- cardboard
- straws
- marshmello
- the bag
- cup
- tape

How will you make sure the lander doesn't tip over as it falls through the air?

- tape
- put it in the middle

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Design- Student samples

Design: Be sure to label and identify all parts of your design.

Signature: Matthew Pepe Date: 7/10/20

Disclosed to and Understood By: J.D. Date: 7-10-20 Proprietary Information: J.D.

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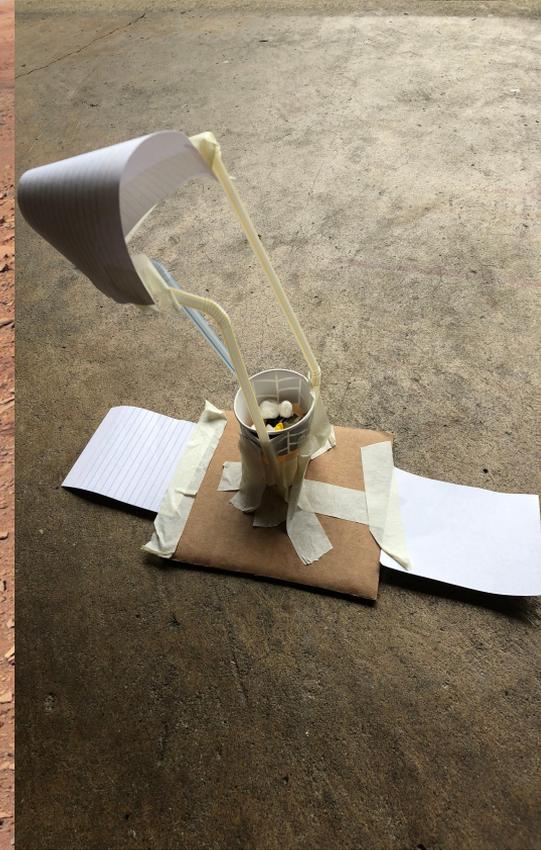
Design: Be sure to label and identify all parts of your design.

Signature: J.D. Date: 7/10/20

Disclosed to and Understood By: J.D. Date: 7-10-20 Proprietary Information: J.D.

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Build- Student samples



Test and Evaluate



Test:

Decide on a test for the model and try it out

Record your results.

Evaluate:

List of strengths:

List of weaknesses:

Did your design solve the problem?

Student samples:

(11)

Test and Evaluate:

Test:

- Decide on a test for the model and try it out:
we will drop from 6 ft
- Record your results:
2 astronauts fell

Evaluate:

- List the strengths of your design:
Plac went of cap - didn't tip over
- List the weakness of your design:
The parachute
the impact zone

Did your design solve the problem?
no

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Proprietary Information JOE	

(9)

Test and Evaluate:

Test:

- Decide on a test for the model and try it out:
We will drop from 6 feet
- Record your results:
No everything was bad
- ~~tip~~ Tip over and as astronauts fell

Evaluate:

- List the strengths of your design:
The bag
- List the weakness of your design:
Straws

Did your design solve the problem?
No

Signature Andrew C	Date Joe
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Redesign

Based on the results of your test, make improvements to your design.

What changes are you going to make?

Why are you making these changes?



Student samples:

⑤

Re design:

- Based on the results of your tests, make improvements to your design.
- take the straws off
- What changes are you going to make?

←

- Why are you making these changes?
Straws got in the way

Signature Andrew: Joe	Date 7/10/20	Proprietary Information Joe
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⑦

Re design:

- Based on the results of your tests, make improvements to your design.
- What changes are you going to make?
better impact zone
add straws on each side of based

- Why are you making these changes?
because it will help absorb the shock.

Signature Joseph Cortal	Date 7/10/20	Proprietary Information
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Share the Solution

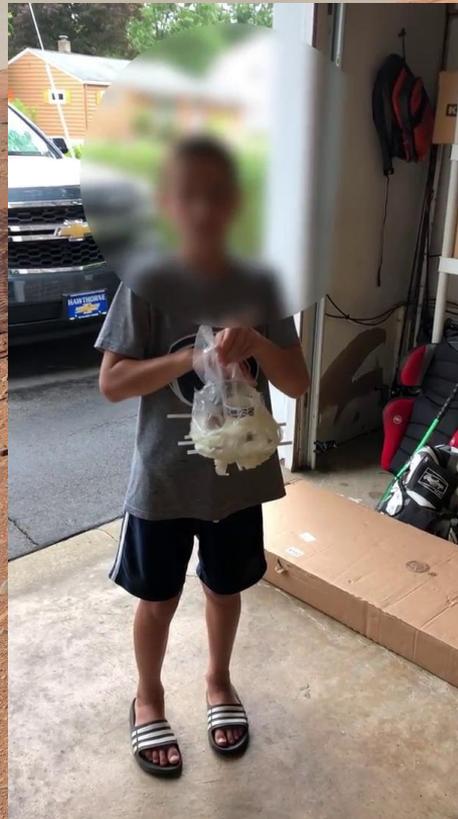
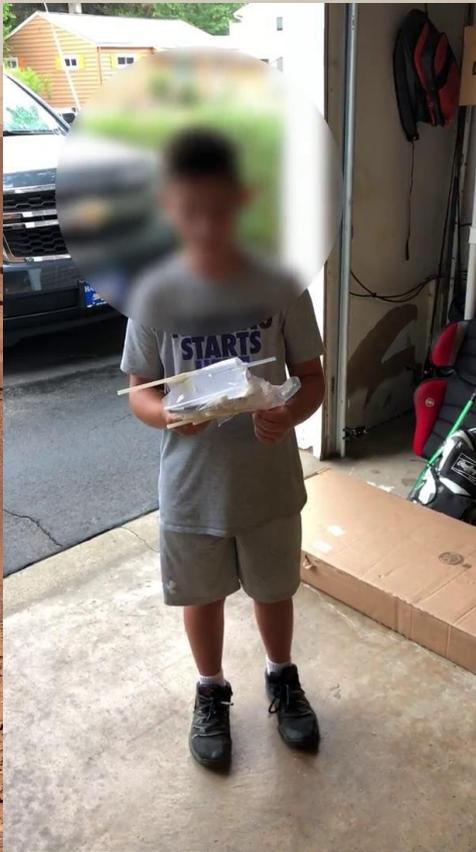
What did you discover as you tested your design?

What did you learn from your peers?

If you were to build this again, what would you do differently?



Student samples:



Reflection:

a. What went well with the engineering design challenge?

In this engineering design challenge, there were several parts that I thought went well. I felt that the students had good discussions while brainstorming ideas for the lander. They talked to each other about what materials would be the best for cushioning the lander. They also brought up ideas about how to slow the lander down by building a parachute. I also liked how during the design phase, each student had different ideas and all of their designs were unique.

Reflection:

b. What did not go well with the engineering design challenge?

Some parts of the design challenge did not go as well as I had hoped. First of all, I did this activity with my son and his friends who are all entering 5th grade this fall. This was difficult because 5th grade boys who are all friends could be rather silly. Also, because of social distancing I had the students work mostly as individuals. I didn't want to create groups or partners where I would have definitely have done that in the classroom. I found it challenging to get the boys to write down everything in their engineering notebook. They didn't want to elaborate or include a lot of detail. They also because a bit competitive and didn't want others copying their ideas.

Reflection: What concepts were covered (list standards and topics where appropriate)

The big concept I want to cover in this design challenge is Force and Motion. I also want to focus heavily on the engineering design process as well.

5-PS2-1. Motion and Stability- Forces and Interactions. Support an argument that the gravitational force exerted by Earth (in this case, moon) on objects is directed down.

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

8.2.5.ED.2: Collaborate with peers to collect information, brainstorm to solve a problem, and evaluate all possible solutions to provide the best results with supporting sketches or models.

8.2.5.ED.3: Follow step by step directions to assemble a product or solve a problem, using appropriate tools to accomplish the task.

8.2.5.ED.4: Explain factors that influence the development and function of products and systems (e.g., resources, criteria, desired features, constraints).

8.2.5.ED.5: Describe how specifications and limitations impact the engineering design process.

8.2.5.ED.6: Evaluate and test alternative solutions to a problem using the constraints and trade-offs identified in the design process.

8.2.5.NT.1: Troubleshoot a product that has stopped working and brainstorm ideas to correct the problem.

Reflection:

d. How did the ED process help teach the science and mathematics concepts?

The ED process of this design challenge definitely helped when teaching science concepts. Concepts introduced or reinforced were acceleration due to gravity, potential and kinetic energy, shock absorption, and air resistance. Measurement of the different heights from which the lander was dropped helped teach some mathematics concepts. Many, if not all, of the science and engineering practices were also included such as asking questions and defining problems, using models, analyzing data, designing solutions and engaging in discussions using science discourse.

Reflection:

- e. Did I choose an appropriate engineering design process? Should I simplify or make more complex?
- f. How can I improve this activity to use with future students?

I feel that for this particular age group that the engineering design process that I chose was appropriate. If I had more time to work with the students. I would have like to have spent more time on some of the science concepts such as acceleration due to gravity and potential and kinetic energy. I would have also liked to have had the students drop their lander from higher heights and discuss what modifications were needed to have a successful landing. I also would have liked to have compared the differences in trying to land something here on Earth compared to the moon or Mars.