Lesson 11: What is an Engineer?

Arizona Science Standards

6.P2U1.4 – Predict how forces act on objects at a distance.

Crosscutting Concepts: Patterns, Cause and Effect, Scale, Proportion **and** Quantity, Systems and System Models, Energy and Matter, **Structure** and Function, Stability and Change.

Background Information: Gravity is the universal attraction between **all** objects, however large or small, although it is only apparent when **one** of the objects is very large. Gravitational forces are always **attractive**. There is a gravitational force between any two masses, but it **is** very small except when one or both objects have large mass.

Hello, welcome to Engineers of the Future remote learning. My name is Karl Witbeck, and I am an Engineer with Valley Metro. I am going to be your mentor for today's lesson.

Our program is going to teach you about science, technology, engineering, and math. It is called STEM learning. These are important skills to have when you do your schoolwork and will prepare you for college or finding a job.

We will get to the fun project we are going to build together in a few minutes on **balance**, but first I want to tell you more about engineering.

What does an engineer do?

- Engineers create and design many important things in our lives. Stuff we use every day.
- Things like the light rail project here in Phoenix, those big building
- Also, the roads we are drive on, bridges, and schools you attend.
- These are just some of the thing's engineers help to build and create.

So, what exactly is an engineer?

"Engineers, as practitioners of engineering, are professionals who:"

- **Invent** – Develop a new product, system, or process that has never existed before.
- **Innovate** – Improve an existing technological product, system to solve practical problems.
- Design
- Analyze
- Build and Test machines

"Engineers fulfill functional objectives and requirements while considering limitations imposed by:"

- Practicality
- Regulation
- Safety
- Cost

Engineers Work to Solve Many Kinds of Problems

- An electrical engineer may help to create safer vehicles.
- A pharmaceutical/chemical engineer may find cures for diseases.
- A computer engineer may help Google search even better.
- A mechanical engineer may help build a wind turbine to save energy
- An agricultural engineer may design new and improved farming equipment to work more efficiently.

"Engineers are very important for things in our lives from transportation, to buildings, roads, and Valley Metro light rail."

CIRCUS TRICK BALANCE PROJECT

Alright let us get to our lesson today on balance. It is a **CIRCUS BALANCE EXERCISE**.

Credit: Sabine De Brabandere, PhD, Science Buddies

- Have you ever wondered why it is harder to keep your balance with a heavy backpack on? Or why it is difficult to make a toddler's sippy cup tip over?
- Maybe you are the kind of person who wonders about circus balancing acts and would like to learn how to ride a bike on a rope.
- In this science activity, you will get to investigate balance using marshmallows, skewers, and toothpicks

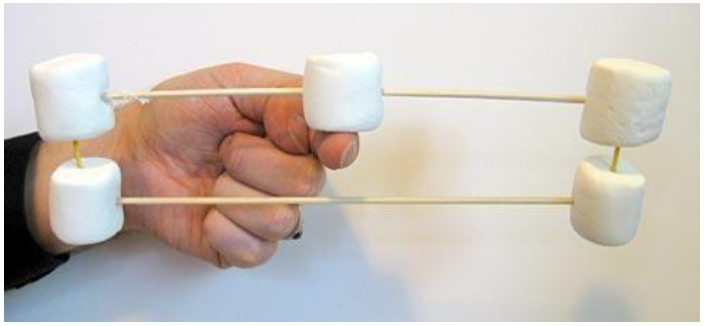
So, we are going to figure out how to balance anything.

These are the **key concepts** we are going to learn today.

"Physics, Balance, and Mass"

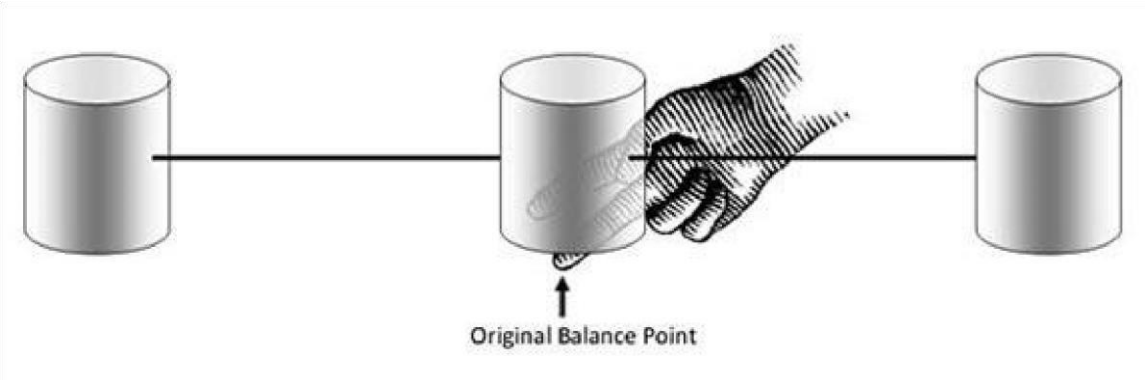
Materials:

- Large marshmallows
- Toothpicks
- Bamboo skewers
- Paper and a pen or pencil

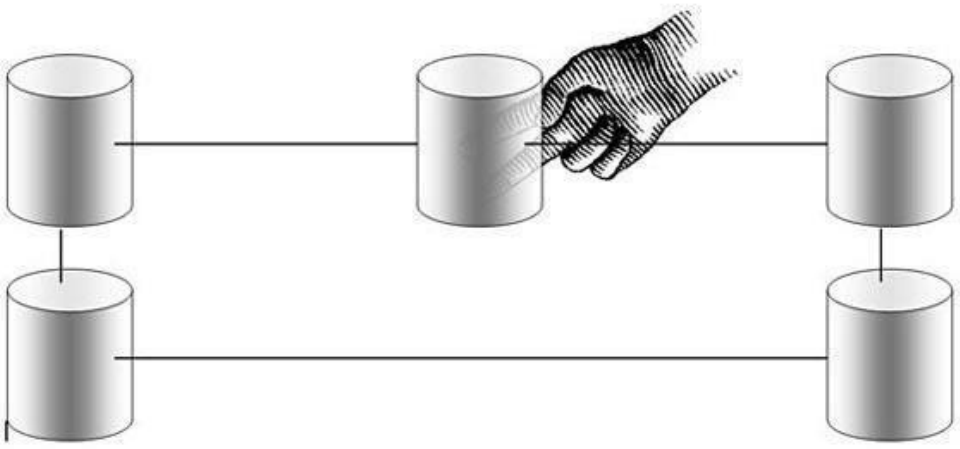


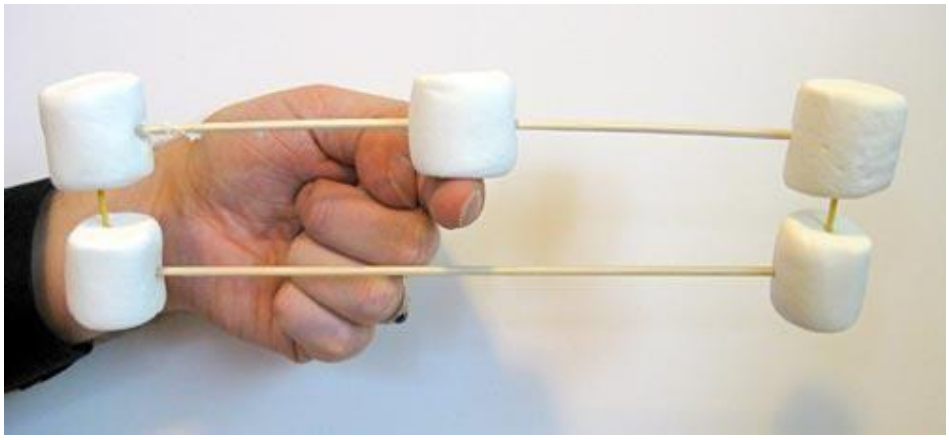
Procedure

1. On a skewer, place one marshmallow in the middle and one on each end. Place the tip of your finger under the middle marshmallow and try to balance the structure on your finger.
2. If you cannot balance it, move the middle marshmallow a bit to one side or the other until you find just the right spot that enables you to balance the structure with your finger. We will call this spot the original balance point.

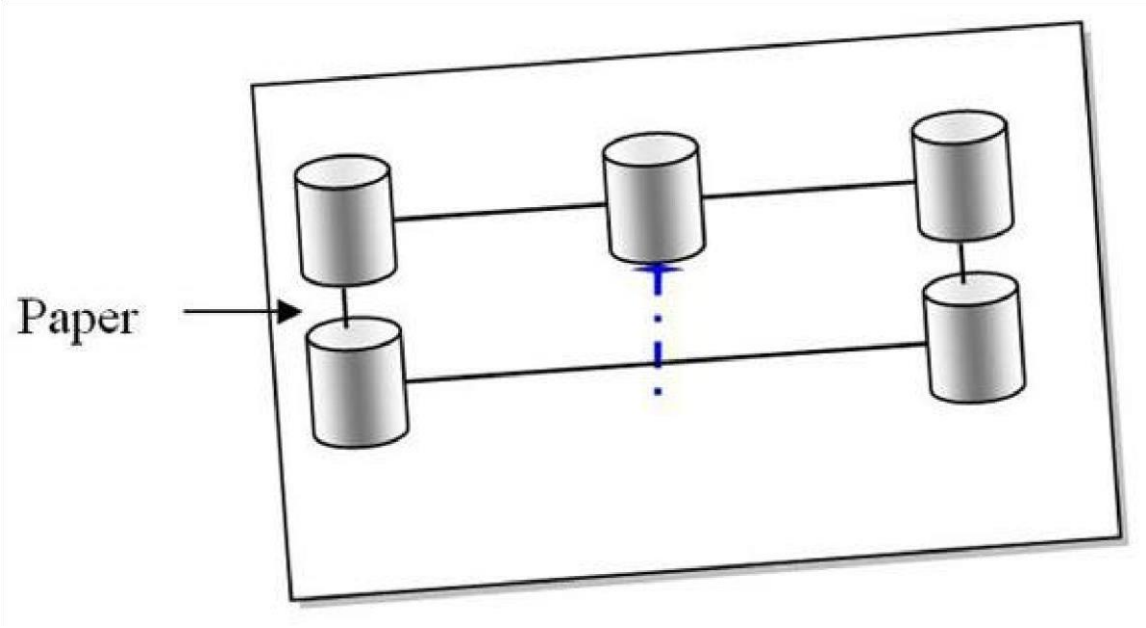


3. Poke a toothpick into each end marshmallow. Add one marshmallow to the end of each toothpick and connect the two new marshmallows with a skewer so you get a rectangular shape (with a marshmallow on each corner and one marshmallow on the center of one skewer).
4. Place your finger under the original balance point on your new rectangular structure (with most of the structure hanging below this point) and try to balance it on your finger. Can you balance it? Is it easier or more difficult than balancing?
5. the simpler structure? If you cannot balance this structure, move the middle marshmallow a bit to one side or the other until you can balance the structure.



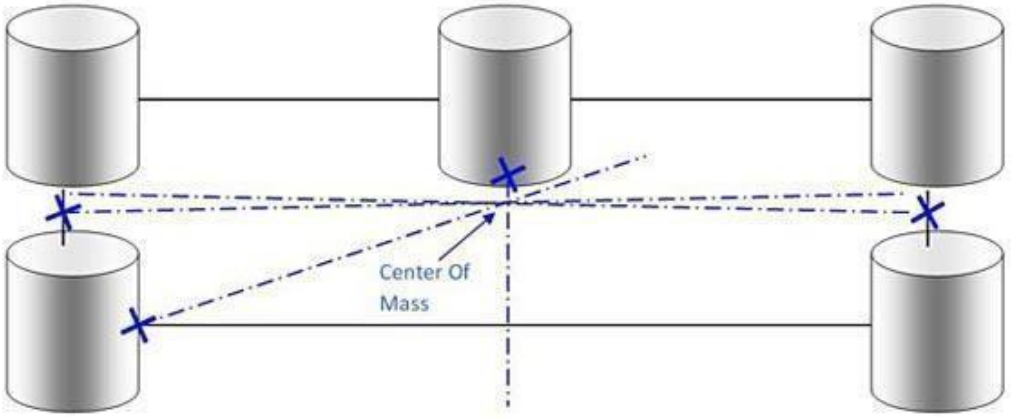


6. Draw the structure on a piece of paper and then try to balance the structure by putting your finger under the original balance point again. Is the structure
7. Rotate the paper your drawing is on so that it has the same angle as your actual structure. On your drawing, mark where your finger is with an "X" and draw a vertical line down from the X.



8. Now balance the structure by putting your finger under one of the toothpicks. Is the structure hanging down completely vertically, or is it tilted? Rotate the paper your drawing is on so that it has the same angle as your actual structure. Make an "X" where your finger is and draw a vertical line down from the X.
9. Now balance the structure by putting your finger under one of the two corner marshmallows that are farthest away from the middle marshmallow. Is the structure hanging down completely vertically, or is it tilted? Rotate the paper your drawing is on so that it has the same angle as your actual structure. Make an "X" where your finger is and draw a vertical line down from the X.
10. On your drawing, the area where the three lines intersect is the center of mass of your structure.

Where is the center of mass of your structure? Where is it in relation to the middle marshmallow?



11. Reorient your structure so that the middle marshmallow is on top. On the middle marshmallow, use toothpicks to attach two more marshmallows, clustered near the middle marshmallow. Place your finger under the original balance point and try to balance it on your finger. Can you balance it? Is it easier or more difficult than balancing the previous structure?
12. Repeat the drawing steps you did before to determine where the three lines intersect and figure out where the center of the mass is now.

Based on your new drawing, where is the center of mass of your new structure? Where is it in relationship to the middle marshmallow? If it has changed, how has it changed? Why do you think this is?

What Happened?

You should have felt like the 5-marshamallow rectangular structure you made was the easiest to balance. In that structure the center of mass was just below the middle marshmallow. When you added two more marshmallows above, the center of mass shifted up and the structure became harder to balance.

I hope you enjoyed our lesson today. Thanks for watching. We will have more lessons on the Engineers of the Future YouTube Channel very soon.