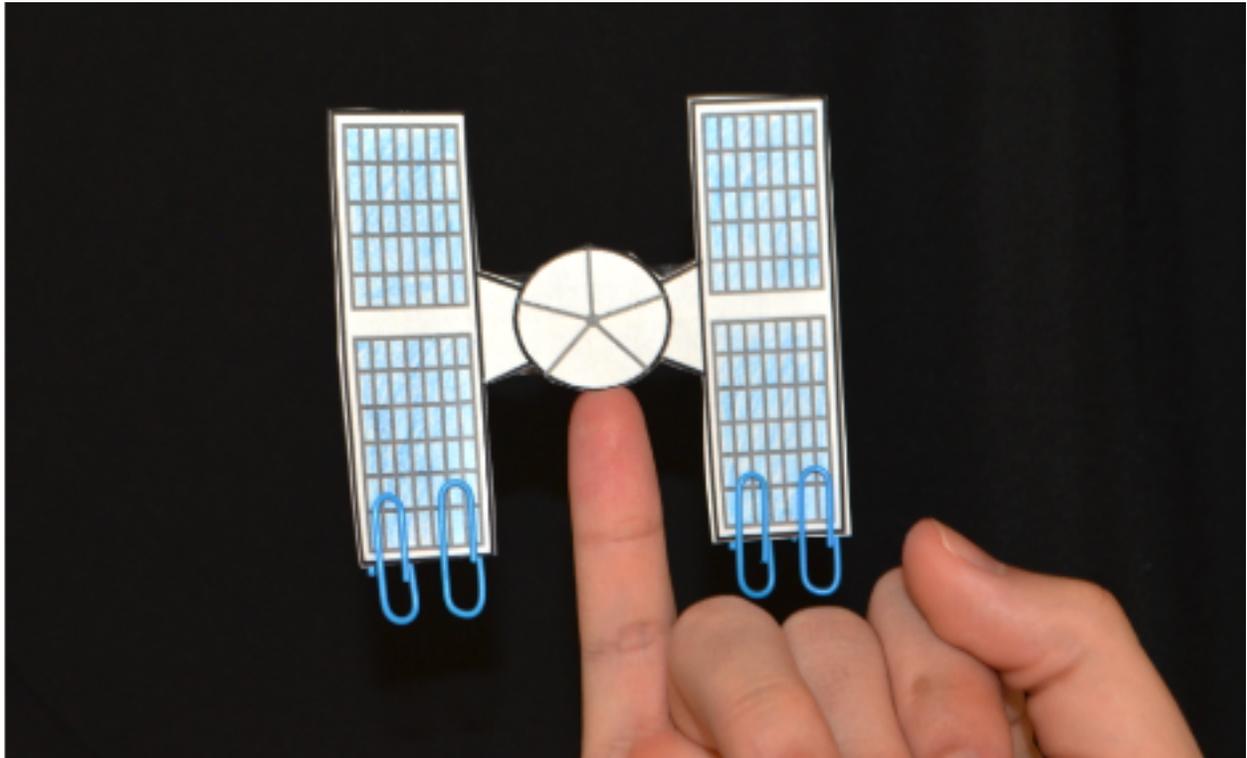


## Balancing Satellite - Center of Gravity

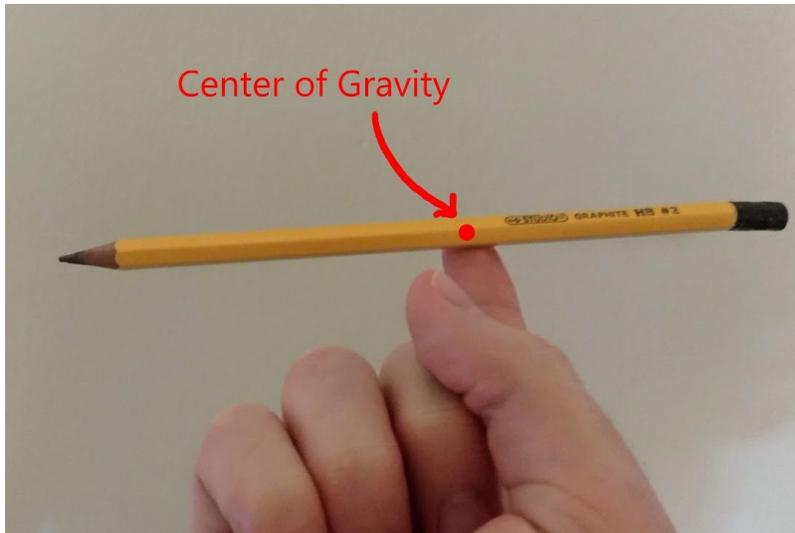


### Introduction:

The balancing satellite is a fun experiment that will show how the center of gravity affects balance. Without knowing how this experiment works it may seem like magic but it is actually just simple physics!

### Concepts:

The *center of gravity* is the average point of the weight of an object. If you tried to balance a pencil on your finger the point at which it is balanced would be the center of gravity.



The location of the center of gravity affects an object's stability. The lower the center of gravity the more stable an object is. One example of this is that race-cars have a low center of gravity so that they can make quick turns without flipping over. Another example would be if you stood up in a canoe. It is much harder to keep the canoe from flipping over when you are standing rather than sitting, since you have a higher center of gravity. In this experiment you will be making a paper satellite that is able to balance on your finger.

### **Objectives:**

- Understand the concept of center of gravity
- Observe the effect of center of gravity on stability
- Build a balancing satellite

### **Materials:**

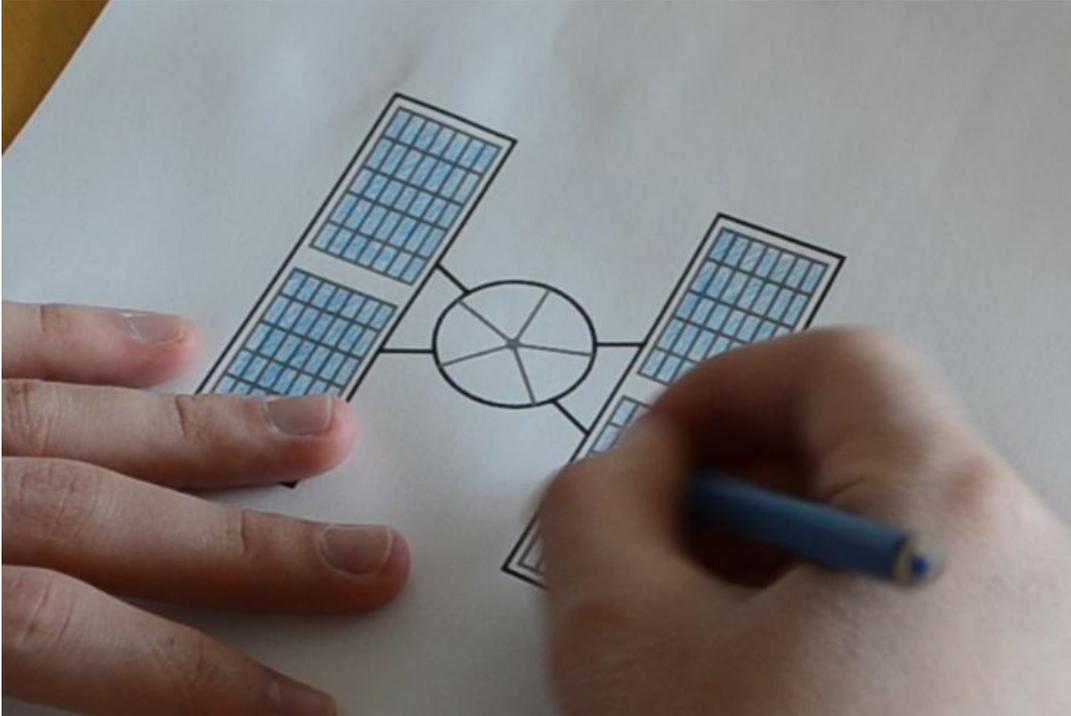
- Paper
- 4 Paper clips
- 3 Toothpicks
- Scissors
- Clear Tape
- Optional: coloured pencils or crayons

### **Time:**

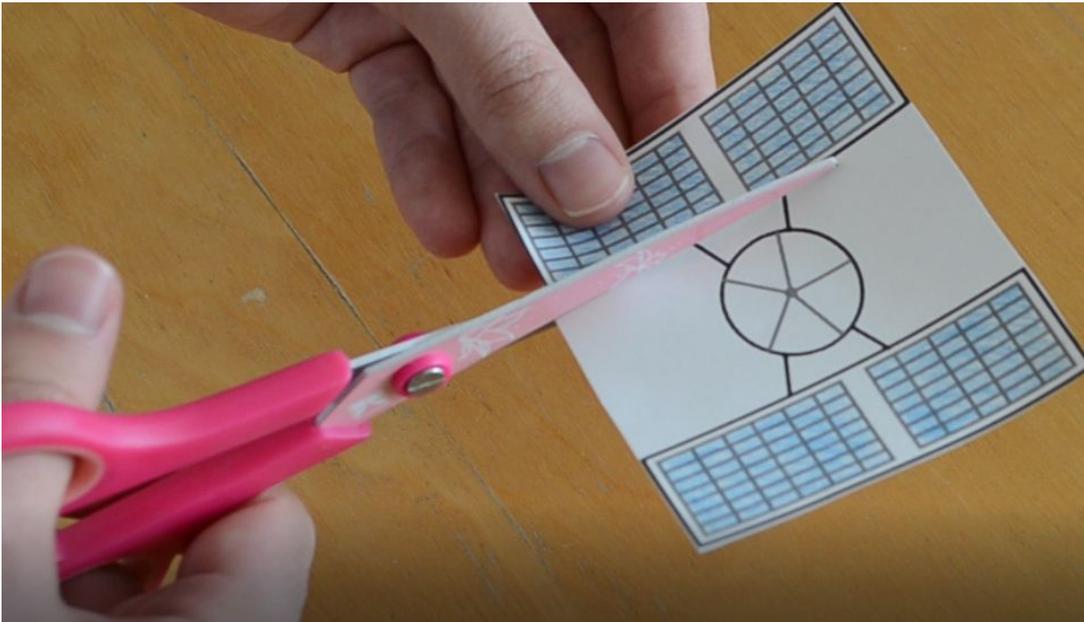
15 minutes

## Instructions:

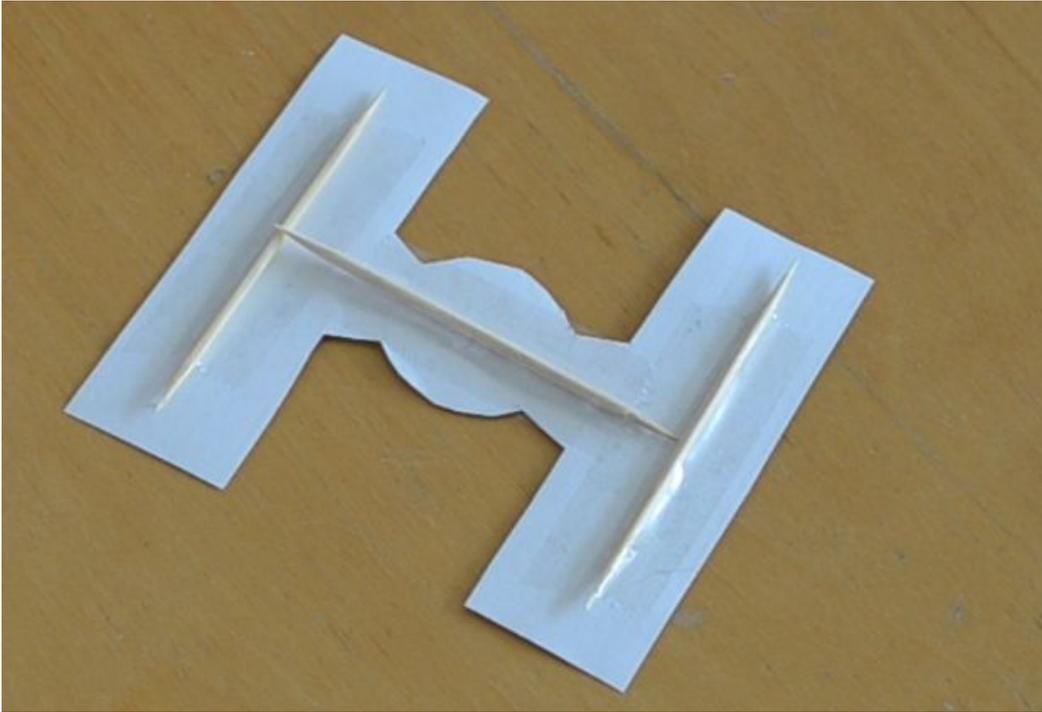
1. Print out the satellite outline provided on the last page and colour it in.



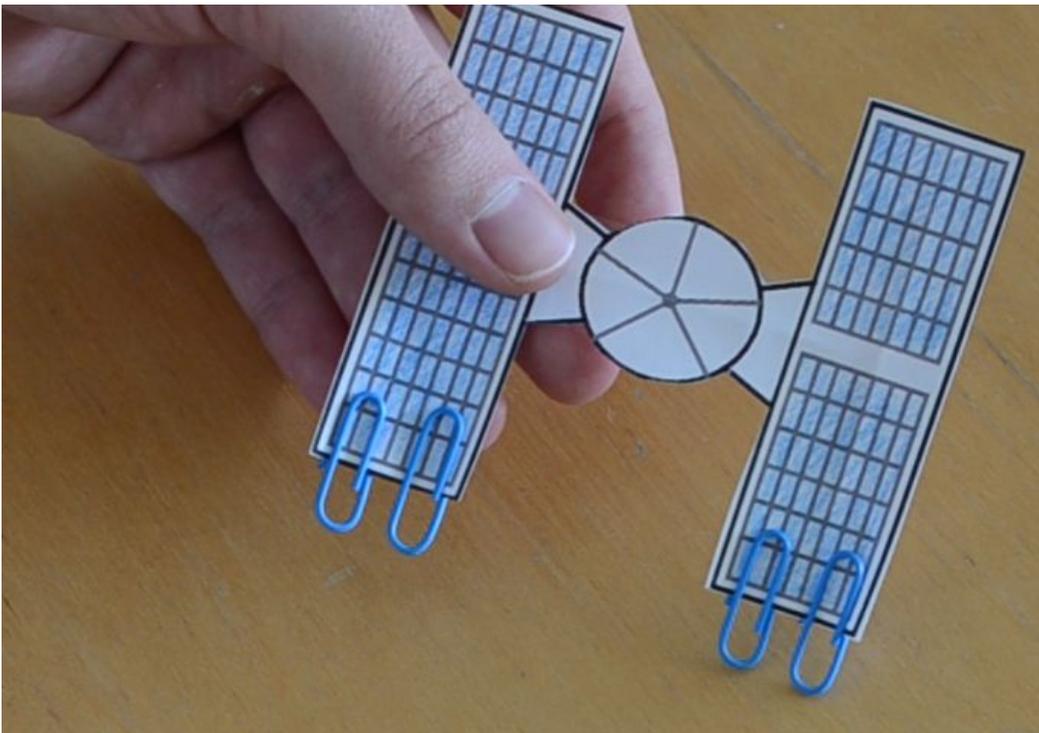
2. Cut out the satellite template along the outside of the thick black lines.



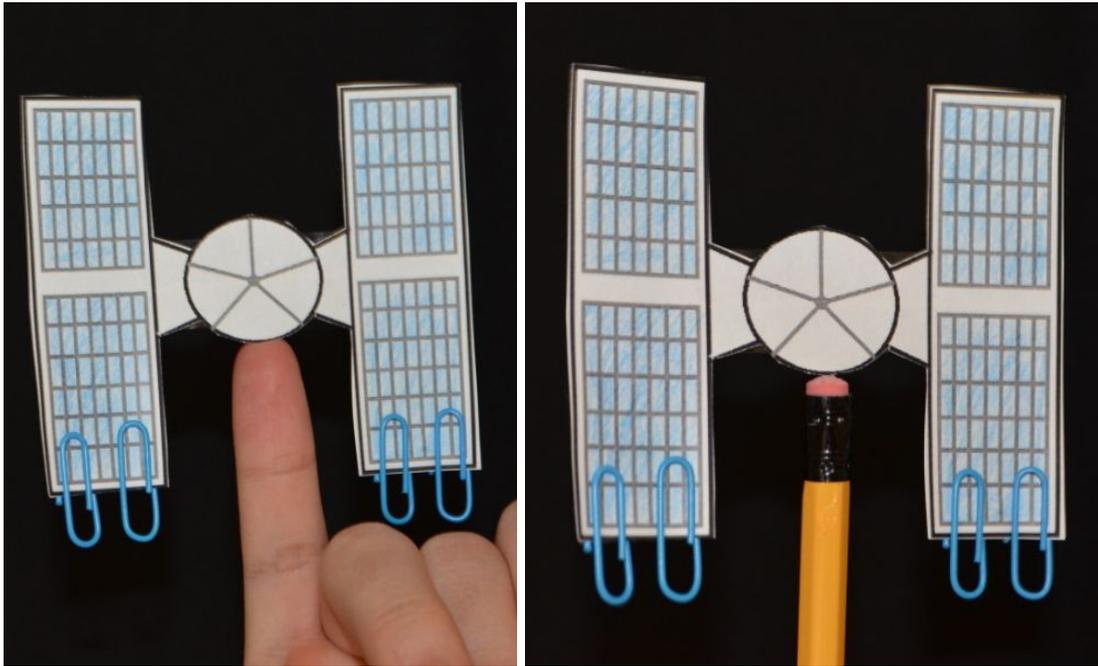
3. Tape toothpicks to the back of the satellite as shown below.



4. Put four paperclips on the bottom of the satellite, two on each side. Make sure they are equally spaced on both sides and also around the same height.



5. Try balancing the satellite on your finger or on anything else you can find as shown in the picture below.



6. Try to balance the satellite again in the same way without the paper clips, with paper clips only on one side and paper clips on top. Look around for other things in your home and try to find their center of gravity. Why do you think it is harder to balance some things on your finger and easier to balance others?

### Questions:

1. Using the concept of center of gravity, explain what happens when you try to balance the satellite a) without the paper clips and b) with paper clips on one side.
2. Using the concept of center of gravity, explain how a ballerina is able to balance on her toes.

## Conclusion:

The center of gravity is something that you come across everyday in your life. In order for you to be able to balance something you need to know where its center of gravity is. A satellite was used for this project because the center of gravity is very important for space exploration. Satellites are sent to space on the top of rockets in casings called fairings. The center of gravity must be taken into careful consideration for rockets because the smallest unbalance can cause them to crash during takeoff. This is partially because rockets are thin and tall so they need to be balanced perfectly in order to fly straight up. Imagine if you tried to balance a pencil on your finger vertically, it would be much harder than balancing it horizontally. Since satellites are attached to the top of rockets their effect on the rocket's center of gravity must also be considered. They should not be too heavy because it would make the rockets unstable. Similarly, when you put the paper clips on top of the paper satellite, it was difficult to balance. Once in space the center of gravity does not matter as much because the effects of gravity are much less. If you would like to learn more about how satellites are sent to space and how they are able to stay up there you can go to the video link in the references section. The key takeaways from this fun experiment are understanding the center of gravity and finding out how and why things are able to balance.

## References:

*TestTube 101. (2015, November 30). How Do We Launch Satellites Into Space? Retrieved January 26, 2021, from <https://www.youtube.com/watch?v=ZBOtaEOSmil>*

*Hodgkins, L. (2020). Stability. Retrieved January 26, 2021, from [https://www.schoolphysics.co.uk/age11-14/Mechanics/Statics/text/Stability\\_/index.html](https://www.schoolphysics.co.uk/age11-14/Mechanics/Statics/text/Stability_/index.html)*

*Hall, N. (2015, May 05). Center of Gravity. Retrieved January 26, 2021, from <https://www.grc.nasa.gov/WWW/K-12/airplane/cg.html>*

## Satellite Template:

