WHAT'S YOUR SPACE HEIGHT?

trainlikeanastronaut.org/mission-data/html/whats-your-space-height

Your Mission

Problem: How can I find my space height?

How tall are you? Are you sure you know the answer? Does your height change in your life, and how much time does it take for your height to change?

So, how tall are you? That seems like a fairly easy question to answer. However, did you know our height changes throughout the day? In fact, our height changes from morning to night. It really has very little to do with the sun and moon, though. Instead, our height becomes less – yes, we shrink – as the day goes on because gravity compresses our bodies. When we lie down at night, gravity no longer pulls in a direction to make us shorter so our bodies stretch and we return to our taller height again. Imagine what happens to astronauts who don't experience the effect of gravity for months at a time! That's right; they grow taller. In fact, NASA Astronaut and MissionX ambassador Kate Rubins grew from her "Earth height" of 171 cm to her "space height" of 174.4 cm.

Mission X: Mission Handout

In this NASA video from NASA's Human Research Program, NASA astronaut Mike Barratt and NASA Principal Investigator Sudhakar Rajulu discuss how the body changes in space while explaining the science behind the activity, "What's Your Space Height?"

Lesson Objectives

Students will:

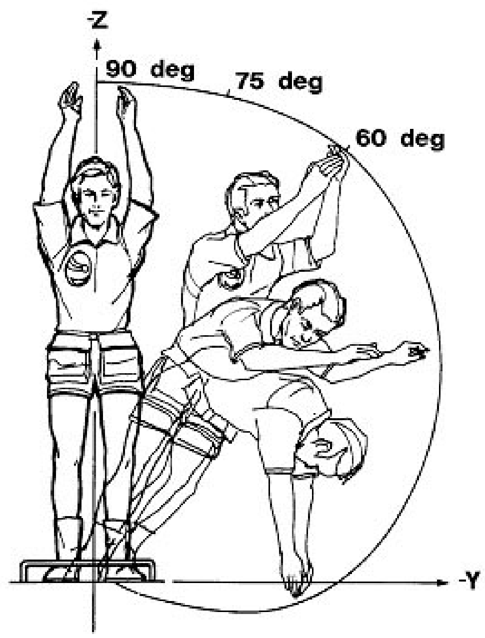
- Measure their body for height, leg length and arm span
- Compare measurements for their class

Teacher Note

Suggestions for student engagement: To help engage the students, have them line up by height or ask them questions such as what is keeping them on the ground, can they stretch and rotate in different directions (to show spine flexibility). Also, watch the video, "What's your space height?" **NOTE:** Some children will not measure their height at night. For this situation, use the provided 3% growth graph to estimate their Space Height.

Background

Each human is unique, yet there are trends within populations. Credit: NASA



NASA drawings showing range of motion and body measurements. Credit: NASA

The study of body measurements is called anthropometry. At NASA, there is an entire team of people who are anthropometrists. These scientists work and collaborate with a wide variety of design teams because human measurements dictate spacecraft design for seat sizes, hatch openings, spacesuit construction, and much more. NASA has found that the height of astronauts increases approximately 3% over the first 3 to 4 days of weightlessness in space. There are many factors that influence each individual, so each astronaut will experience more or less of an increase than others. As soon as astronauts return back to Earth, gravity pulls on them once again and astronauts will typically return to their pre-flight height in a short amount of time. In space, almost all of this height increase comes from changes in the spinal column, which affects body measurements such as sitting height, eye height, standing height, how space suits fit, and much more. Remember, even though astronauts are floating in space and don't stand and walk around like we do on Earth, their height measurements are important to calculate whether they can perform tasks such as reach buttons and switches or grasp objects. To work on the International Space Station (ISS), the astronauts often brace themselves by placing their feet under bars on the floor to keep from floating away from their work area. The diagram pictured shows this bracing action and the scientists in NASA's Johnson Space Center Human Factors group study many measurements of astronauts to make sure everyone can reach the variety of features on the ISS. It is interesting to note that as astronauts increase height, their shoulder height increases as well. This means that in space, their arms are farther from the floor than on Earth which allows them to reach higher objects when in space. An increasing spinal column length is an important factor to consider when designing spacecraft and habitats. Astronauts must be able to reach everything! Spacecrafts must be built correctly before they fly, because changing the walls or control locations is either not possible or overly expensive once the craft has launched to space.

Engage

Expedition 26, with ESA astronaut Paolo Nespoi standing in the center. Credit: NASA

NASA astronaut Kate Rubins returns to Earth 3.4 cm taller than when she left! Credit: NASA

Take a look at the picture of the astronauts in the picture. Astronauts come in all shapes and sizes! For reference, Paolo Nespoli is the Italian astronaut standing in the center of the picture. According to the European Space Agency, Paolo is about 188 cm (74 inches) tall on the Earth. Paolo is taller than most astronauts. Many features in a spacecraft are adjustable for the astronauts using them. Before each flight, the seats of the spacecraft are adjusted to fit each astronaut. And remember, astronauts will be a different height when they return! This means the spacecraft and space suits will fit differently whether one is launching to or returning from space. Do your pajamas fit differently from when you go to bed at night to when you wake up? Let's investigate that concept together! In this activity, you and your crew members will measure your height and discuss the factors involving how your bodies might change in space. This is just like what astronauts do in space. Astronauts must take scientific measurements, work as a team, and clearly communicate with others. In fact, just like in this activity, astronauts measure their bodies when in space, too!
Safety: This activity has no reasonable associated safety risks.

Materials: Tape measure

Explore

Procedure

Suggested step – by – step instructions to perform activity.

1. In class, measure your height and learn how to measure yourself when you are at home.

2. You will measure yourself at night, and then again in the morning when you first wake up. - decide on which units you will use in measuring (cm, meters, inches) - It is important to measure yourself as soon as you stand up in the morning, before you walk around too much. Try to measure yourself before gravity can reduce your height!

3. You will record your height changes in your height chart.

4. You will graph the class results, or analyse a teacher-provided graph.

Conversion Chart

Graph showing 3% growth, representing an average increase of height during space flight.

TRY IT YOURSELF!

Earth Height (cm):

Space Height (cm):

Explain

The following are taken from the student section.

1. How tall were you at night? ________ cm or _______ inches

2. How tall were you in the morning? ________ cm or _______ inches

3. How much is the difference in those two heights? ________ cm or _______ inches

4. What is the reason your height changed?

5. Do you think taller people or short people would have the greatest change in their height?

Evaluate

1. Compare your own measurements with those of your teammates.

2. Which student had the largest difference in their height? Which student had the least change?

3. Based on your class information was your answer correct from question #5 in the Explain section? (Do you think taller people or short people would have the greatest change in their height?) _____ yes ___no

4. Astronaut Paolo Nespoli is 188 cm tall on Earth. Using what you have learned for how much you grew while you were in bed, how tall do you think he might have become when he was in space? _____ cm

5. Astronaut Kate Rubins has an Earth height of 171 cm to a space height of 174.4 cm. How did your height change compare with Kate's?

Elaborate

The fitting of a space suit can change once the body changes. Imagine wearing a suit that is slightly too short for you. When you stand up, the suit may pull on your neck, your arms, or through the pants and seat area. Other measurements can change due to spaceflight, or may be influenced by changes in height. As an example, try this: untuck your shirt and place your hands by your side and look where the bottom of your untucked shirt touches your pants. Now raise your hands and point to the sky. Did your shirt raise? If you were wearing a tight suit, it would not have the necessary volume to let you raise your arms. Too loose of a suit can also be a problem, too. Suit sizing is critical for astronauts. Another way to see the issues with how space suits must fit for a variety of movements can be tested like this: Let one arm hang by your side with your fingers relaxed towards the ground. Reach across your chest with your other hand, grab the fabric near your elbow and hold it to the side of your chest. Now, without letting the fabric move from your side, try to raise your arm. Could you raise it all the way up? Why or why not?

Remember, the suits are designed for many people to wear them. This means they must fit loose enough for people of different sizes to be able to move inside the suits without being too baggy or too tight. And, the spacesuits must protect the astronauts from extreme temperature differences and contain all the necessary functions for humans to survive for many hours, such as air to breathe and water to drink. While wearing the suit, the astronauts must be able to move freely inside. Also keep in mind that even with the great variety in astronauts, all astronauts must be able to fit in to only two suit sizes. That means the suits must be flexible to accommodate a wide range of human shapes and sizes. That is not an easy suit to design!

Try This!

1. There are many measurements in our life. For example, what if there were no chairs in your classroom and you had to stand to write at your desk. How high off the ground would you want your desk? Compare the height you would want your desk with the heights your teammates would want.

2. How high from the floor are the door knobs in your classroom? Are all the doorknobs at the same height in your school? Why do you think that height was chosen?

3. Hold your arms to your side and have a teammate hold the bottom of your shirt close to your sides. Now try to raise your arms. How do you think astronaut suits must be made in order for astronauts to be able to raise their arms?

Extend

Are there other ways to estimate our Space Height?

As we have seen in this activity, people’s heights change. The exact amount of height change in each astronaut is too difficult to predict before the astronauts fly. However, from measurements taken of astronauts over the years, scientists such as Dr. Sudhakar Rajulu and his team of anthropometricians at NASA’s Johnson Space Center can make educated estimates to help engineers as they design everything from sizing of spacesuits to where the buttons should be placed on spaceships. Dr. Rajulu has noticed an average of 3% growth for astronauts when they fly to space. Keep in mind that each human changes differently, so not many of the astronauts grow by exactly 3%; some change more and some change less, but the combined average growth is about 3%. Such measurement data can be displayed with graphs. Using the graph above, answer the following questions:

1. Use the graph above to find your height here on Earth. _______

2. Use the graph to find your estimated Space Height. _________

3. How did your estimated Space Height compare with the measurement you made first thing in the morning when you woke up?

Contributors Section

A special thanks to NASA astronaut Dr. Michael Barratt and NASA Principal Investigator Dr. Sudhakar Rajulu for their extra efforts in helping create this activity. Dr. Barratt is a medical doctor and flight surgeon, was Manager of the Human Research Program at JSC, has flown to space twice and, as of this publication in 2017, serves in the International Space Station Operations and Integration branches to handle medical issues and onorbit support. Dr. Rajulu leads a team of scientists in the Anthropometry and Biomechanics Facility at NASA's Johnson Space Center, where they improve the living and working conditions in space. If you would like more information about this topic please visit www.nasa.gov/centers/johnson/capabilities/hhp. Perhaps one day you may want to persue a career in anthropometry!

Crew time on the ISS is finite, with every minute scheduled and planned for maximum efficiency. The Anthropometry and Biomechanics team uses its data to improve crew living and working conditions in order to enhance productivity and operational efficiency. This includes biomechanics and ergonomics research studies that deal with issues humans will encounter while living, working and exploring in space. Engineers and scientists have been instrumental in evaluating crew work procedures and equipment, spacesuit design, spacewalk or Extravehicular Activities (EVA) and Intravehicular Activities (IVA) human performance issues, EVA/IVA tool design and EVA/IVA crew-induced loads. This group is also heavily involved in conducting and supporting projects for evaluating space suit and human performance data for future missions. It is one of the very few facilities in the world that has gathered both suited and unsuited human strength data relevant to Earth, Lunar and Martian gravitational environments. The majority of this work is completed in the Anthropometry and Biomechanics Facility (ABF).

A very special thank you goes to Anna Murgano, from Scoula Media Nicola Festa in Italy and Tim Vigorito, from Height's Elementary School in the USA. Along with their wonderful students, these two educators helped develop this activity by providing feedback and guidance. Their input is very much appreciated and we thank their students for being the first ones to find out **What's Your Space Height**!

This lesson was developed by the NASA Human Research Program Communications team at NASA Johnson Space Center by Scott Townsend and Tim Gushanas.