GET A LEG UP

Activity topic selected from NASA's KSNN™ 21st Century Explorer newsbreak "How would your body change in space?"

Educator Section

Grade Level: 3-5

Connections to Curriculum: Science and Health

Science Process Skills: observing, predicting, measuring, comparing, communicating, inferring, number relationships
(Association for the Advancement of Science)

Teacher Preparation Time: 20 minutes

Lesson Duration: 60 minutes

Prerequisite: none

National Education Standards addressed in this activity include Science (NSES) and Health (NHES). For an alignment to standards in this activity, see page 5.

Introduction

Trading Earth's environment for the environment of space is exciting. As the environment changes, so will an astronaut's body change. Less gravity is one of the major changes of living in space. Traveling to Mars and, perhaps into deep space, will involve living in space for months or years. How will an astronaut's body change and adapt as a result of living in a reduced gravity environment for that long?

Lesson Objective

This lesson simulates the fluid shift felt by astronauts upon entering space.

Problem

On Earth, how can I simulate the fluid shift felt by astronauts when they enter space?

Learning Objectives

The students will

- gather data by measuring the circumference of the leg before and during the simulation.
- use data to explain the changes observed in the circumference of the leg.
- develop a conclusion based upon the results of this activity.
- compare individual results to class results to look for patterns.

Materials Required

metric measuring tapes or
string and metric rulers

washable markers or masking tape

stopwatch, watch or clock

_____

NASA's KSNN™ 21st Century Explorer 30-second newsbreak – "*How would your body change in space*?"

Materials

- NASA's KSNN™ 21st Century Explorer 30-second newsbreak, "How would your body change in space?" (Download the newsbreak at http://ksnn.larc.nasa.gov.)
- stopwatch, or timepiece with a second hand (watch or clock)

Per group (2 students working together)

- metric measuring tape or string and metric ruler
- washable marker or masking tape

Per student

- Get A Leg Up Student Section

Safety
Remind students about the importance of safety. Take into consideration any medical issues that may limit a student's participation in this activity.

Pre-lesson Instructions
- Students should work in groups of 2.
- Students will need to take measurements on their bare legs. Ask students to dress appropriately.

Lesson Development
To prepare for this activity, the following background information is recommended:

- Read NASA's KSNN™ 21st Century Explorer Web Text Explanation titled "How would your body change in space?" at http://ksnn.larc.nasa.gov.
- Read the following text taken from the Observation Section of the Get A Leg Up Student Section.

Observation
While on Earth, gravity causes most of the body's fluids to be distributed below the heart. In contrast, living in space with less gravity allows fluids in the body to spread equally throughout the body.

When astronauts first travel into space, they feel as if they have a cold and their faces look puffy. Many astronauts talk about not feeling thirsty because of this fluid shift. The body records this shift as an increase in blood volume. The body takes care of this fluid shift by eliminating what it thinks are extra fluids as it would normally – that's right – through the kidneys -- resulting in visits to the restroom. Once this "extra fluid" is flushed from the body, astronauts adjust to space and usually feel fine.

Puffy faces and chicken legs are short-term changes that astronauts feel. Within three days of returning to Earth, the fluid level of the astronauts return to normal, and the body is "back to normal."

In this experiment, you will mimic this fluid shift felt in space by staying in a reclined position for a certain amount of time. You will record the effect this position has on your body's fluid distribution.

- If needed, additional research can be done on the following science topics:
    - reduced gravity effects on the human body
    - countermeasures used to reduce the effects of low gravity on the human body
    - research at NASA on the human in space (http://haco.jsc.nasa.gov)

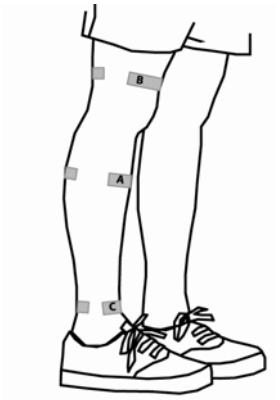
Instructional Procedure
Throughout this lesson, emphasize the steps involved in the scientific method. These steps are identified in ***bold italic*** print throughout the Instructional Procedure Section.

1. Show NASA's KSNN™ 21st Century Explorer newsbreak "How would your body change in space?" to engage students and increase student knowledge about this topic.
2. Remind students about the effects of reduced gravity on the human body.
3. Review the problem with the students.
   Problem: On Earth, how can I simulate the fluid shift felt by astronauts when they enter space?
4. Have the students read the ***Observation*** Section in the Get A Leg Up Student Section and discuss in their groups.

5. Encourage your students to discuss and make ***observations*** about this topic by completing the first two columns in the KWL (KNOW/WANT TO KNOW/LEARNED) chart on the Get A Leg Up Student Section. Use the KWL chart to help students organize prior knowledge, identify interests, and make real-world connections. As students suggest information for the "KNOW" column, ask them to share "How they have come to know this information."
6. Ask your students if they have predictions relating to this activity and the "problem question". Help them refine their predictions into a ***hypothesis***. In their Student Section, they should restate the "problem question" as a statement based upon their observations and predictions. Encourage students to share their hypothesis with their group.
7. Students will ***test*** their hypothesis following this procedure.
(The following steps are taken from the Student Section. Educator specific comments are in italics.)

   Students should work in groups of 2. One person will be the test subject while the other person measures and records data. Identify the calf as one place to measure and allow the students to choose the other two places to measure on the leg.

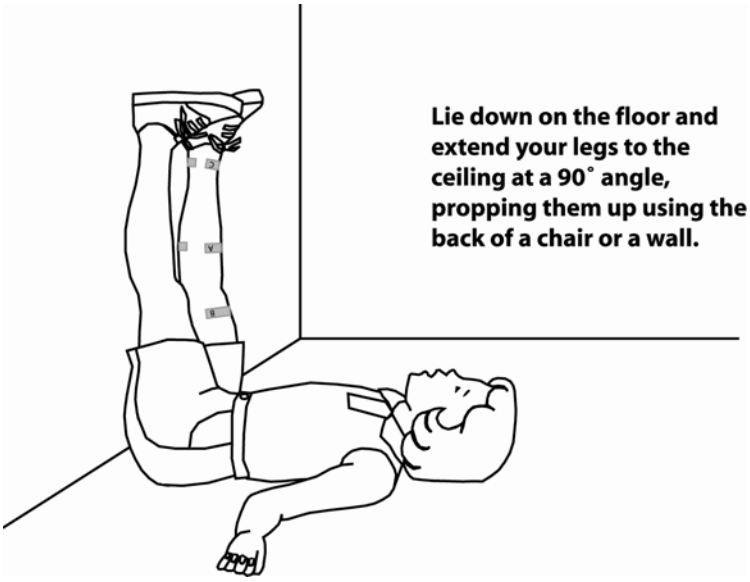
   1. Try to be relaxed and stand for 10 minutes. While standing, do the following:
      - With a partner, identify three places to measure on your bare leg. Make sure one of the places measured is the calf.
      - Your partner should use a washable marker or small pieces of masking tape to mark the places to be measured on the front and back of your leg. Label these as A, B, C. (See diagram.)
      - Identify these places to measure on the Leg Circumference Data Sheet.
      - Your partner should measure the distance around your leg at each of the three places. This distance is the circumference. Note: Be sure to pull the tape measure or string firmly around the leg, but not so tight that there are "dents" in the skin.
      - Record all data on the Leg Circumference Data Sheet. Double check your measurements.



Label the places you will measure as A, B, and C.

   If time allows, have all students measure their legs before the first test subject lies down.

   2. Predict what will happen to the circumference of your leg if you lie down for 10 minutes. Record your prediction on the Leg Circumference Data Sheet.
   3. Lie down on the floor, and place your data sheet, measuring instrument and pencil close to you. Extend your legs to the ceiling at a 90° angle. Keep both legs raised for 10 minutes, propping them up using the back of a chair or a wall. (See diagram below.)



Your partner should remain standing for these 10 minutes.

While your partner is standing, they should identify three places on their own leg to measure, as in step 1 above. If your partner needs additional help, they may ask another person who is also standing for assistance.

Taking shoes off is recommended if using a wall, so no scuff marks are left on the wall.

The partner that has not been measured should remain standing for those 10 minutes. For time efficiency, the teacher should lead the timing.

Suggested activities for the 10 minute "lying down" period:

- *Singing "Take Me Out to the Ball Game" lasts about 20 seconds. Let the students know that this is the same amount of time it takes your heart to pump blood to every cell in your body.*
- *Read the next steps to the students.*
- *Have the students brainstorm songs that have the word heart in them.*
- *Think of titles of heart poems you know.*
- *Create heart poems.*
- *Sing heart songs.*
- *Read and explain the Web Text Explanation titled "How would your body change in space?" to the students.*

4. After 10 minutes, do not stand up. Your partner should remain standing and measure the circumference of all three places on the leg again. Note: Be sure to pull the tape measure or string firmly around the leg, but not so tight that there are "dents" in the skin.

   While measuring, the test subject must remain lying down.

5. ***Record*** data on the Leg Circumference Data Sheet. Double check your measurements.
6. Repeat steps 2-5 for your partner.
7. After taking all measurements, **study the data** and **draw conclusions** by answering the questions following the Leg Circumference Data Sheet.

   Using this information, ask students to determine if the data supports or refutes their hypotheses.

Conclusion

- Discuss the answers to the Get A Leg Up Student Section questions.
- Have the students update the LEARNED column in their KWL chart.
- Ask students to compare their individual data to the class data. What patterns can be found?
- Ask students "what they wonder now?" Encourage students to design their own experiments.

Assessment

- Assess student knowledge through questioning.
- Observe and assess student performance throughout the activity using the attached Scientific Investigation Rubric.

Activity Alignment to National Education Standards

National Science Education Standards (NSES):
Content Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry (K-8)
- Understandings about scientific inquiry (K-8)

Content Standard C: Life Science

- The characteristics of organisms (K-4)
- Organisms and their environment (K-4)
- Structure and function in living systems (5-8)
- Diversity and adaptations of organisms (5-8)

Content Standard E: Science and Technology

- Abilities of technological design (K-8)

Content Standard F: Science in Personal and Social Perspectives

- Changes in environments (K-4)

National Mathematics Education Standards (NCTM):
Data Analysis and Probability Standard:

- Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
  - collect data using observations, surveys, and experiments
- Develop and evaluate inferences and predictions that are based on data
  - propose and justify conclusions and predictions that are based on data and design studies to further investigate the conclusions and predictions

Health Education Standards (NHES):
Standard 4: Students will analyze the influence of culture, media technology and other factors on health.

- Describe ways technology can influence personal health (K-4)

Curriculum Explorations

To extend the concepts in this activity, the following explorations can be conducted:

Mathematics

Students can create a double bar graph to compare their data.

Ask students to compare gender with a graphic organizer.

Ask students to display their data in other ways. Ask them to justify their choices.

Have students compare all their graphs with the rest of the class. They should analyze the data and graphs looking for patterns and trends.

National Mathematics Education Standards (NCTM) (3-5):

Algebra Standard:

- Understand patterns, relations, and functions
  - represent and analyze patterns and functions, using words, tables, and graphs

Data Analysis and Probability Standard:

- Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
  - collect data using observations, surveys, and experiments
  - represent data using tables and graphs such as line plots, bar graphs, and line graphs
- Develop and evaluate inferences and predictions that are based on data
  - propose and justify conclusions and predictions that are based on data and design studies to further investigate the conclusions or predictions

Health

Have the students compare heart rates while they are standing up and lying down by using one of the target spots for pulse (in front of your ear at the temporal artery, the carotid artery below your chin at your throat, or over the radial artery on your wrist).

Standard 4: Students will analyze the influence of culture, media technology and other factors on health.

- Describe ways technology can influence personal health (K-4)

Language Arts

Ask students to explain the experiment. How might students improve this experiment? Where might there have been mistakes made? How might these mistakes have affected the results?

National Council of Teachers of English Standards (NCTE):

- Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

Sources and Career Links

Thanks to subject matter experts Dr. Steven Platts and Dr. Charles Lloyd for their contributions to KSNN™ and Noticiencias NASA™ on the development of this education material.

Find out more about Steve Platts, PhD, and the work that he does as a Research Scientist at the Cardiovascular Laboratory at NASA Johnson Space Center here http://haco.jsc.nasa.gov/labs/cardiovascular.htm.

Dr. Charles Lloyd works at NASA Johnson Space Center as the Non-exercise Physiological Countermeasures Program Manager and the Human Resource Project Education and Outreach Program Manager. Learn more about his work at http://haco.jsc.nasa.gov/projects/pnut.cfm and http://slsd.jsc.nasa.gov.

This activity was adapted from National Space Biomedical Research Institute (NSBRI) activity, Student Investigation 2.2, the Human Physiology in Space found at http://www.nsbri.org/HumanPhysSpace/index.html. Find out more about the publication, "Human Physiology in Space" at the National Space Biomedical Research Institute web site, http://www.nsbri.org/Education/High_Act.html.

Lesson development by the NASA Johnson Space Center Human Health and Performance Education Outreach team.

Scientific Investigation Rubric

Experiment: GET A LEG UP

Student Name _____ Date _____

Performance Indicator	0	1	2	3	4
The student developed a clear and complete hypothesis.					
The student followed all lab safety rules and directions.					
The student followed the scientific method.					
The student recorded all data on the data sheet and drew a conclusion based on the data.					
The student asked engaging questions related to the study.					
The student described at least one recommendation for NASA researchers to help astronauts over come fluid shift.					
Point Total					

Point total from above: _____ / (24 possible)

Grade for this investigation _____

Grading Scale:

A = 22 - 24 points

B = 19 - 21 points

C = 16 - 18 points

D = 13 - 15 points

F = 0 - 12 points

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Student Section Student Name _____

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Problem

On Earth, how can I simulate the fluid shift felt by astronauts when they enter space?

Observation

While on Earth, gravity causes most of the body's fluids to be distributed below the heart. In contrast, living in space with less gravity allows fluids in the body to spread equally throughout the body.

When astronauts first travel into space, they feel as if they have a cold and their faces look puffy. Many astronauts talk about not feeling thirsty because of this fluid shift. The body records this shift as an increase in blood volume. The body takes care of this fluid shift by eliminating what it thinks are extra fluids as it would normally – that's right – through the kidneys -- resulting in visits to the restroom. Once this "extra fluid" is flushed from the body, astronauts adjust to space and usually feel fine.

Puffy faces and chicken legs are short-term changes that astronauts feel. Within three days of returning to Earth, the fluid level of the astronauts return to normal, and the body is "back to normal."

In this experiment, you will mimic this fluid shift felt in space by staying in a reclined position for a certain amount of time. You will record the effect this position has on your body's fluid distribution.

Use the first column of this KWL chart to organize your observations about how the heart pumps blood through your body.

Brainstorm with your group what you want to know about the fluid shift that happens in space, then list in the second column of this KWL chart.

KNOW	WANT TO KNOW	LEARNED

Hypothesis

Based on your observations, answer the "problem question" with your best guess. (On Earth, how can I simulate the fluid shift felt by astronauts when they enter space?) Your hypothesis should be written as a statement.

My hypothesis: _____

Materials

Per group

- metric measuring tape or string and metric ruler
- washable marker or masking tape

Safety

Review your classroom and lab safety rules.

Test Procedure

1. Try to be relaxed and stand for 10 minutes. While standing, do the following:
    - With a partner, identify three places to measure on your bare leg. Make sure one of the places measured is the calf.
    - Your partner should use a washable marker or small pieces of masking tape to mark the places to be measured on the front and back of your leg. Label these as A, B, C. (See diagram.)
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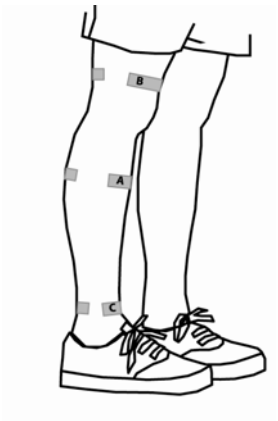

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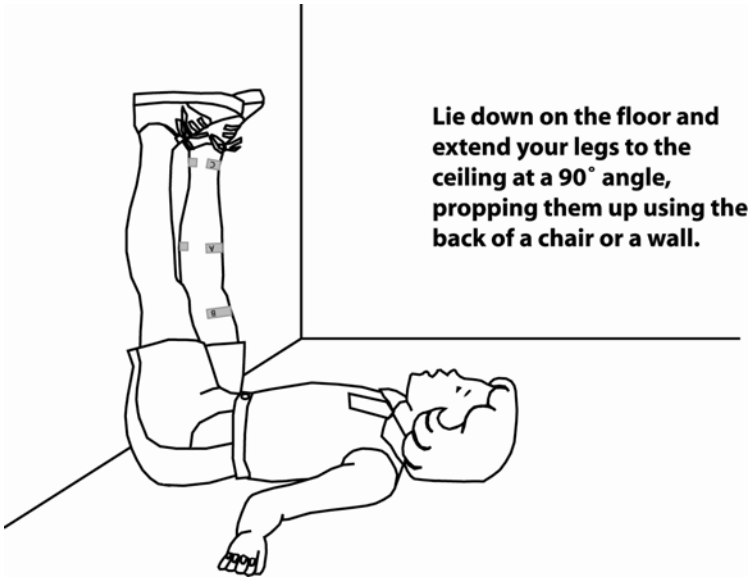

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5. Collect and record all data on the Leg Circumference Data Sheet. Double check your measurements.
6. Repeat steps 2-5 for your partner.
7. After taking all measurements, study the data and draw conclusions by answering the questions following the Leg Circumference Data Sheet.

Record Data

Leg Circumference Data Sheet

Measurement Location	My measurement standing (cm)	My prediction Will my leg become smaller? larger? remain the same?	My measurement reclined (cm)
A calf			
B			
C			

Study Data

1. What happened to the circumference of the leg after it was raised for 10 minutes? Why do you think this happened?

2. Compare your results with what might happen to astronauts when they are in a reduced gravity environment.

3. Explain why we call what astronauts look like in space, the puffy face, and chicken leg syndrome. Did you get chicken legs during this activity?

4. How do you think the fluid shift you experienced might affect other parts of your body?

5. Does this data support your hypothesis? Why or why not?

6. How do your results compare to your partner's results? To the class results?

7. Based on your findings, what would you suggest to NASA researchers about helping astronauts overcome the fluid shift while in space?

Conclusion

- Update the LEARNED column in your KWL chart.
- Restate your hypothesis and explain what happened during testing.