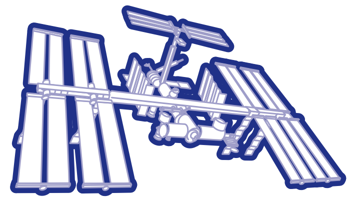
Educational Product	
Educators	Grades 5-8

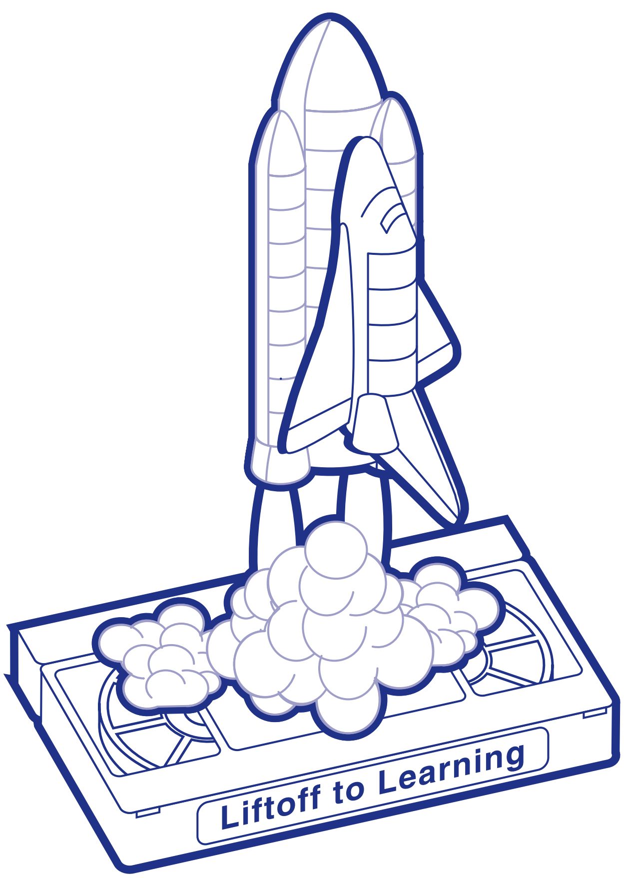
National Aeronautics and
Space Administration

Liftoff to Learning



Assignment: Spacelab!

A Videotape for Life Science and Physical Science



Video Resource Guide

EV-1997-07-002-HQ

Video Synopsis

Title: Assignment: Spacelab!

Length: 16:05

Subjects: Scientific experimentation in micro-gravity.

Description:
This program shows how the unique microgravity environment of Earth orbit is used for scientific experiments and how the rules of scientific experimentation and safety that apply to research on Earth also apply to astronauts in space.

Science Standards:
Life Science
-Organisms and environments
-Regulation and behavior
-The cell
Physical Science
- Properties of objects and materials
Unifying Concepts and Processes
-Change, constancy, and measurement

Science Process Skills:
Observing
Communicating
Measuring
Collecting Data
Inferring
Predicting
Making Graphs
Hypothesizing
Interpreting Data
Controlling Variables
Defining Operationally
Investigating

Mathematics Standards:
Measurement

Background

In the past three decades, hundreds of astronauts have rocketed into space. Each time, the astronauts' bodies adapted to the unique microgravity environment of space and then readapted to Earth's gravity upon return. In spite of this extensive experience, the mechanisms responsible for that adaptation remain a mystery.

The Spacelab Life Sciences (SLS) missions (two flights so far) have sought to collect data that will enable scientists to solve the mystery. During the second SLS mission (SLS-2), a series of comprehensive experiments were conducted that provided researchers from across the nation access to the most unique laboratory available to science--the microgravity environment of space.

In microgravity, virtually every human physiological system undergoes some form of adaptation. The capacity of the cardiovascular system diminishes. Muscle and bone density also begin to decrease. A shifting of the body's fluids affects the renal and endocrine systems, as well as the way the blood system operates. In addition, the balance and position sensing organs of the neurovestibular system must readapt to an environment where up and down no longer matter.

SLS-2 consisted of 14 experiments focusing on the cardiovascular, regulatory, neurovestibular, and musculoskeletal systems of the body. Eight of the experiments used the astronaut crew as subjects and six used rats. A broad range of instruments helped gather data on the human subjects including: a Gas Analyzer Mass Spectrometer, a rotating dome, a rotating chair, a Body Mass Measuring Device, an In-flight Blood Collection System, a Urine Monitoring System, strip chart recorders, incubators, refrigerator/freezers, a low-gravity centrifuge, and an echocardiograph.

The primary goal of the SLS-2 mission was to address important biomedical questions about the human body's physiological responses to microgravity and subsequent readaptation to gravity. The science was also constructed to ensure crew health and safety on missions of up to 16 days in duration. A third goal of SLS-2 was to demonstrate the effectiveness of hardware standardization in experiment-to-rack interfaces for future applications on the International Space Station.

Video Background Information

The original idea for this videotape came from a group of LaPorte, Texas teachers who were concerned with getting students to follow laboratory safety procedures. As a result, this videotape emphasizes the importance of safety while conducting basic procedures in space and on Earth. In particular, the importance of eye protection is stressed. Also covered are the reasons for scientific controls and detailed laboratory procedures, such as labeling, to ensure the validity of the experimental data collected.

The video features the SLS-2 flight because of the strong science emphasis of its mission. Detailed laboratory procedures, scientific controls, and safety procedures were essential to the success of the mission.

Terms

Control - The portion of a scientific experiment used as a reference base to compare the action of variables.
Cardiovascular Deconditioning - A weakening of the cardiovascular system caused by the effects of microgravity.
Cardiovascular System - A body system consisting of the heart, arteries, and veins.
General Purpose Workstation - An enclosed retractable cabinet used to contain materials that might easily get loose in the Spacelab.
Hypothesis - An unproven theory that tentatively explains a phenomena.
Mass - The amount of matter contained in an object.
Mass Measurement Device - A device used to measure mass in microgravity.
Microgravity - An environment, produced by free-fall, that alters the local effects of gravity and makes objects seem weightless.
Repeatability - Conducting the same experiment several times to confirm that the results are consistent.
Spacelab - A cylindrical laboratory module containing scientific facilities that is carried in the payload bay of the Space Shuttle.
Variable - Materials or conditions that can be changed in a scientific experiment.

Classroom Activities

The following activities can be used to demonstrate some of the concepts presented in this videotape.

Designing For Space Science Experiments

Materials

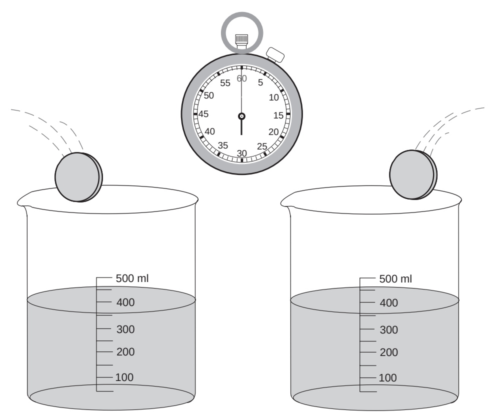
Paper and pencils

Procedure

Challenge students to design a science experiment that could be conducted in microgravity on the Space Shuttle. The students should state a hypothesis to be tested and design the research procedures to be followed. The design should include a sketch of the apparatus used. If time is available, students can construct working models of their apparatus and actually conduct the ground-based control portion of the experiment. Students can gather information for their experiments by connecting to Spacelink via computers and modems. See the reference section of this guide for details.

Antacid Tablet Experiment

Materials (per experiment setup)
Antacid tablet
Beakers or jars
Cold and hot water
Stopwatch
Thermometer
Eye protection



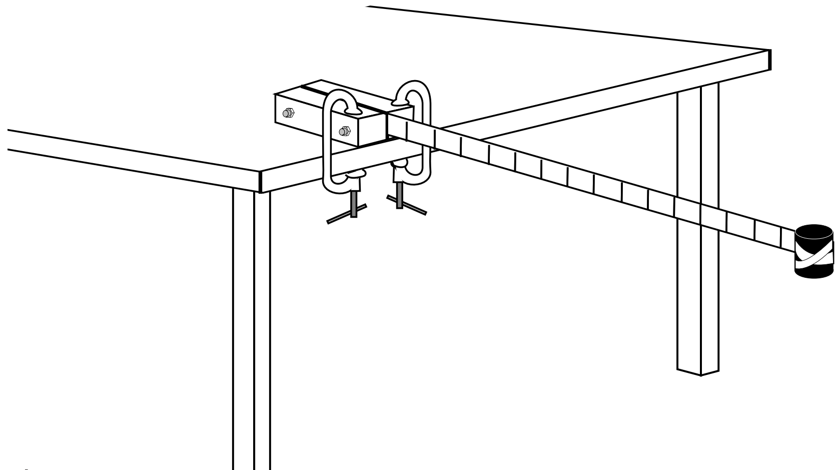
Procedure

Partially fill two beakers with water. The water in one beaker should be hot and the other cold. Measure and chart the temperature of the two beakers. Formulate a hypothesis that relates the amount of time required to consume an antacid tablet with the temperature of the water into which it is placed. Using a stopwatch to time the reaction, drop an antacid tablet in each beaker. How long did it take for each tablet to be consumed?

If small groups of students are each conducting the experiment, the temperatures of each beaker can be varied so that groups can share a broad range of data with each other. Have students plot a graph for the time it takes for each tablet to be consumed against the temperature of the water. Analyze the results to confirm or reject the experiment hypothesis.

Inertial Balance

(This activity was adapted from the NASA curriculum resource Microgravity - Teacher's Guide With Activities for Physical Science, EG-103. Refer to the reference section for more information about this guide.)



Materials

Metal yardstick*
2 C-clamps*
Plastic 35mm film canister
Pillow foam (cut in plug shape to fit canister)
Masking tape
Wood blocks
2 bolts and nuts
Drill and bit
Coins or other objects to be measured
Graph paper, ruler, and pencil
Pennies and nickels
Stopwatch
*Available from hardware store

Background

On Earth, mass measurement is simple. The samples and subjects are measured on a scale or beam balance. Calibrated springs in scales are compressed to derive the needed measurement. Beam balances measure an unknown mass by comparison to a known mass (kilogram weights). In both of these methods, the measurement is dependent upon the force produced by Earth's gravitational pull.

In space, neither method works because of the free-fall condition of orbit. However, a third method for mass measurement is possible using the principle of inertia. Inertia is the property of matter that causes it to resist acceleration. The amount of resistance to acceleration is directly proportional to the object's mass.

To measure mass in space, scientists use an inertial balance. An inertial balance is a spring device that vibrates the subject or sample being measured. The frequency of the vibration will vary with the mass of the object and the stiffness of the spring (in this diagram, the yard stick). For a given spring, an object with greater mass will vibrate more slowly than an object with less mass. The object to be measured is placed in the inertial balance, and a spring mechanism starts the vibration. The time needed to complete a given number of cycles is measured, and the mass of the object is calculated.

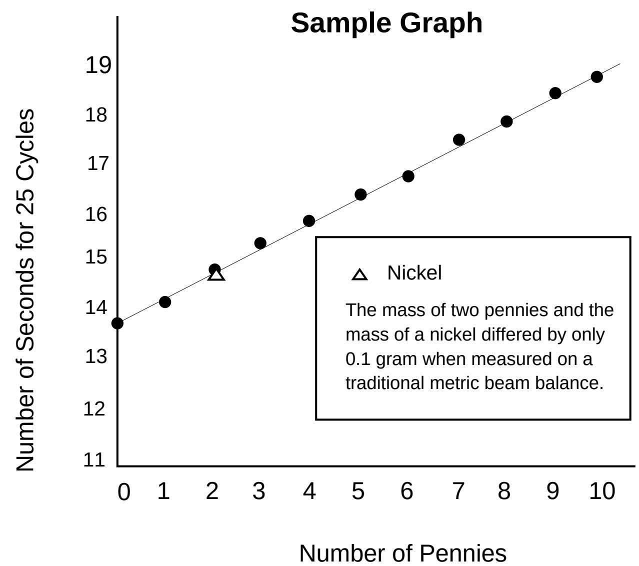
Procedure

Using the drill and bit to make the necessary holes, bolt two blocks of wood to the opposite sides of one end of the steel yardstick. Tape an empty plastic film canister to the opposite end of the yardstick. Insert the foam plug. Anchor the wood block end of the inertial balance to a table top with C-clamps. The other end of the yardstick should be free to swing from side to side.

Calibrate the inertial balance by placing objects of known mass (pennies) in the sample bucket (canister with foam plug). Begin with just the bucket. Push the end of the yardstick to one side and release it. Using a stopwatch or clock with a second hand, time how long it takes for the stick to complete 25 cycles. Plot the time on a graph above the value of 0. (See sample graph) Place a single penny in the bucket. Use the foam to anchor the penny so that it does not move inside the bucket. Any movement of the sample mass will result in an error (oscillations of the mass can cause a dampening effect). Measure the time needed to complete 25 cycles. Plot the number over the value of 1 on the graph. Repeat the procedure for different numbers of pennies up to 10. Draw a line on the graph through the plotted points.

Use your inertial balance to measure the mass of unknown objects by placing them in the film canister. Find the horizontal line that represents the number of vibrations for the unknown object. Follow the line until it intersects the graph plot. Follow a vertical line from that point on the plot to the penny scale at the bottom of the graph. This will give the mass of the object in "penny" units.

Note: This activity makes use of pennies as a standard of measurement. If you have access to a metric beam balance, you can calibrate the inertial balance into metric mass measurements using the weights as the standards.



Questions

1. Does the length of the ruler make a difference in the results?
2. What are some of the possible sources of error in measuring the cycles?
3. Why is it important to use foam to anchor the pennies in the bucket?

References

NASA On-line Resources for Educators provide current educational information and instructional resource materials to teachers, faculty, and students. A wide range of information is available, including science, mathematics, engineering, and technology education lesson plans, historical information related to the aeronautics and space program, current status reports on NASA projects, news releases, information on NASA educational programs, useful software and graphics files. Educators and students can also use NASA resources as learning tools to explore the Internet, access information about educational grants, interact with other schools, and participate in on-line interactive projects, communicating with NASA scientists, engineers, and other team members to experience the excitement of real NASA projects.

Access these resources through the NASA Education Home Page:
http://education.nasa.gov

Other web sites of interest:

http://www.jsc.nasa.gov
http://shuttle.nasa.gov
http://www.hq.nasa.gov/office/olmsa

Curriculum Guides:

Lujan, B. & White, R. (1994), Human Physiology In Space, Teacher's Manual, National Institute of Health, The Universities Space Research Association and The University of Texas Southwestern Medical Center, 1994.

Vogt, Gregory L., Wargo, Michael J. Microgravity - Teaching Guide With Activities for Physical Science, EG-103, National Aeronautics and Space Administration, 1995.

Videotapes:

Baker, Diedra, dir. Space Basics, National Aeronautics and Space Administration, 1991.

All Systems Go!, National Aeronautics and Space Administration, 1992.

Newman, Jeanne, et al, dir., From Undersea to Outer Space, National Aeronautics and Space Administration, 1993.

STS-58 Crew Biographies

Commander: John E. Blaha (COL, USAF)
John Blaha was born in San Antonio, Texas. He received a bachelor of science degree in engineering science from the U.S. Air Force Academy, and a master of science degree in astronautical engineering from Purdue University. As an operational pilot, he flew F-4, F-102, F-106, and A-37 aircraft and completed 361 combat missions in Vietnam. As a test pilot, he flew stability/control, performance, spin, and weapons delivery flight tests in the A-7, F-104, Jaguar, Buccaneer, Hawk and Jet Provost aircraft. Blaha worked for the Assistant Chief of Staff, Studies and Analyses, at USAF Headquarters in the Pentagon, during which time he presented F-15 and F-16 study results to Department of Defense, State Department, and congressional staffs. He has logged 6,000 hours of flying time in 34 different aircraft, and written numerous technical articles on spacecraft performance and control. Blaha was selected as an astronaut in 1980 and served as pilot aboard STS-29 and STS-33, then as commander of STS-43. This was his fourth spaceflight.

Pilot: Richard A. Searfoss (Lt. COL, USAF)
Richard Searfoss was born in Mount Clemens, Michigan, but considers Portsmouth, New Hampshire, his hometown. He earned a bachelor of science degree in aeronautical engineering from the U.S. Air Force Academy in 1978, and a master of science degree in aeronautics from the California Institute of Technology on a National Science Foundation Fellowship in 1979. He flew the F-111 as an aircraft commander, instructor pilot, and weapons and tactics officer at Lakenheath, England, and Mountain Home Air Force Base, Idaho. A graduate of the USAF Fighter Weapons School and the U.S. Naval Test Pilot School, Searfoss was a flight instructor at the USAF Test Pilot School at Edwards Air Force Base

in California when selected for the astronaut program in 1990. He has logged over 3,500 hours flying time in 56 different types of aircraft. This was his first spaceflight.

Payload Commander: M. Rhea Seddon (M.D.)
Rhea Seddon was born in Murfreesboro, Tennessee. She earned a bachelor of arts degree in physiology from the University of California-Berkeley in 1970, and a doctorate in medicine from the University of Tennessee College of Medicine in 1973. Between her surgery internship and residency, Dr. Seddon worked as an emergency room physician at several hospitals in Mississippi and Tennessee, and currently serves in this capacity in the Houston area in her spare time. She has also performed clinical research into the effects of radiation therapy on nutrition in cancer patients. Dr. Seddon became an astronaut in 1979 and she served as a mission specialist aboard STS-51D and STS-40. STS-58 was her third flight.

Mission Specialist: Shannon W. Lucid (Ph.D.)
Shannon Lucid was born in Shanghai, China, but considers Bethany, Oklahoma, her home. She received a bachelor of science degree in chemistry from the University of Oklahoma in 1963, and a master of science and doctor of philosophy degrees in biochemistry from the University of Oklahoma in 1970 and 1973, respectively. Dr. Lucid's experience includes a variety of academic assignments, including working as a chemist at Kerr-McGee in Oklahoma City, Oklahoma; and as a research associate with the Oklahoma Medical Research Foundation in Oklahoma City. She is a commercial, instrument, and multi-engine-rated pilot. Since becoming an astronaut in 1979, her work has included serving as Chief of Mission Support and Chief of Astronaut Appearances. A veteran of four spaceflights, Dr. Lucid served as a mission specialist aboard STS-51G, STS-34, STS-43. and STS-58.

Mission Specialist: David A. Wolf (M.D.)
David Wolf was born in Indianapolis, Indiana. He earned a bachelor of science degree in electrical engineering from Purdue University in 1978, and a doctorate in medicine from Indiana University in 1982. At the NASA Johnson Space Center in Houston, Texas, he was assigned to direct development of the Space Bioreactor and associated cancer research and tissue culture applications which utilize controlled gravitational conditions. His expertise includes designing real-time computer process control systems, bioprocessing, and human aerospace physiology. Dr. Wolf was named NASA Inventor of the Year in 1992, and carries patents on a new class of 3-dimensional human tissue culture instrumentation. He is a flight surgeon in the Air National Guard, and has logged over 500 hours of air combat training as a weapons systems officer in the F-4 Phantom jet. He is also a proficient aerobatic pilot, primarily flying the Pitts Special and Christen Eagle airplanes. Dr. Wolf became an astronaut in 1991. STS-58 was his first spaceflight.

Mission Specialist: William S. "Bill" McArthur, Jr. (Lt. COL, USAF)
William "Bill" McArthur, Jr., was born in Laurinburg, North Carolina, but calls Wakulla, North Carolina, his hometown. He earned a bachelor of science degree in applied science and engineering from the U.S. Military Academy at West Point, New York, in 1973, and a master of science degree in aerospace engineering from the Georgia Institute of Technology in 1983. He has served in a variety of Army assignments including the 2nd Infantry Division in the Republic of Korea, the 24th Infantry Division in

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Savannah, Georgia, and the 82nd Airborne Division in Fort Bragg, North Carolina. Following completion of studies at the Georgia Institute of Technology, he taught in the Department of Mechanics at West Point as an assistant professor. Upon graduating from the U.S. Naval Test Pilot School in 1987, he was assigned to NASA as a space operations officer. A Master Army Aviator, he has logged over 3,300 flight hours in 38 different aircraft. McArthur became an astronaut in 1991. STS-58 was his first spaceflight.

Payload Specialist: Martin J. Fettman, D.V.M., Ph.D.
Martin Fettman considers Brooklyn, N.Y., his hometown. He graduated from Midwood High School in Brooklyn in 1973 and received a bachelor of science degree in animal nutrition from Cornell University in 1976. He received a master of science degree in nutrition and a doctorate of veterinary medicine from Cornell University in 1980 and a doctorate in physiology from Colorado State University in 1982. He is a diplomate of the American College of Veterinary Pathologists. Fettman served in the Department of Pathology of the College of Veterinary Medicine and Biomedical Sciences at Colorado State University as an assistant professor of clinical pathology from 1982 to 1986. From 1983 to the present, he has held a joint appointment in the Department of Physiology at Colorado State University. His research and teaching interests have focused on selected aspects of the pathophysiology of nutritional and metabolic diseases. In 1988, Fettman assumed the duties of Section Chief of Clinical Pathology in the Veterinary Teaching Hospital, Colorado State University. From 1989 to 1990, Fettman took a sabbatical leave as a visiting professor of medicine at The Queen Elizabeth Hospital and the University of Adelaide in Australia. He was named a Professor of Pathology at Colorado State in 1992. This was his first spaceflight.

NASA Liftoff to Learning
Assignment: Spacelab!

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Video Resource Guide

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3. This is a valuable video and video resource guide.
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