Teacher's Notes for

Dizzying Heights: Your Body in Space

GroundStation Canada presentation of the H.R. MacMillan Space Centre

The GroundStation Canada Theatre is sponsored by MacMillan Bloedel

Program description: This live presentation explores the questions of balance and space sickness in the micro-gravity environment of Earth's orbit. With the help of Canadian Astronaut research and through a series of stomach staggering, live demonstrations, audience members will experience the disorientation of space motion sickness right here on Earth.

Advance preparation: Studies have shown that people, especially children, learn better when they feel secure in their surroundings and know what is expected of them. We recommend that you orient your students to the main areas of our facility, make sure the purpose of the field trip is clear and link the trip to the students' learning in the classroom. For a map of the facility and more suggestions for a successful field trip download the Orientation Package on our website www.hrmacmillanspacecentre.com.

These Teacher's Notes are designed to help you further prepare your students and include enrichment activities that can be done before or after your visit. *These activities cover topics related to those in your programme and are therefore not necessarily the same.*

Curriculum connections: Grades 3-6 and 9

Earth and Space Science IRP Connections:
P=Living in Space presentation, A=Suggested Classroom Activities

It is expected that students will:

Grade 3	
describe the basic structure of the organs involved in hearing	P
Grade 4	
relate the life processes of an organism (human) to its use of nutrients, water, and oxygen	P/A
relate dietary habits and behaviour to an organism's (human) health	P/A
Grade 5	
describe the basic structure and function of the organs in the sensory system	A
Grade 6	
list the contributions that space exploration has made to everyday life	P
Grade 9	
describe how organ systems monitor, regulate, and respond to changes in the internal and external environments	P

Background Information – SAS

Space Adaptation Syndrome (SAS) ore space motion sickness is experienced by approximately 40% of astronauts. Contrary to popular belief, this is not a problem with the stomach, but with the inner ear balance organs, which sense the pull of gravity. The brain coordinates body movement by combining this information with data from the eyes and touch sensors.

The vestibular apparatus of the inner ear consists of three semi-circular canals, which act as angular accelerometer, one for each of the three dimensions of space in which we move. A rotation of the head rotates the semi-circular canals, but fluid (called endolymph) inside the canals responds more slowly to the motion because if its inertia. The relative motion of the fliuid and the walls of the canals is picked up by little hairs which are connected by nerve fibers to the brain. A signal reports the angular motion to the brain.

In addition to the three semi-circular canals there are two otolith organs, which send information to the brain about linear movements and the direction of gravity relative to the head.

Scientists believe that SAS occurs in space because the gravitational information from the ear does not match with the optical and tactile information. If the eyes and receptors in muscles, tendons and bones (mechanoreceptors) or other sense organs send conflicting information, the brain has to decide which is correct and possibly do something to fix the problem.

The vestibular system is part of a poison-detection system in humans and the brain interprets this misinformation concluding that poisoning has occurred and we feel nauseous and/or vomit. This is what is happening when astronauts may experience disorientation, dizziness, nausea, headaches and possibly severe vomiting. Most astronauts are able to adapt quickly by relying more on their eyes for orientation.

Activity One – Disorientation Maze

Objective: Students will be able to better understand the difficulties associated with the disorientation astronauts feel when they first enter a microgravity environment. For black line originals of the Disorientation Maze, please see our web site at: www.hrmacmillanspacecentre.com, visit our teachers room and enter the lesson plans section. If you do not have internet access please phone 604-738-7827 ext. 253.

Materials: pencils
1 "Disorientation Maze"/pair of students (page5)
small hand mirrors (one per pair of students)
stopwatches (or clock/watches with second hand)

What to do:

1. Have students work in partners.
2. Using the Disorientation Maze on the last page of this Teacher's Guide, have one student draw through Maze A, without lifting the pencil, as fast as possible without touching the sides. The other student records the time it takes for the student to complete the maze.
3. Now have the student who just completed Maze A hold a hand mirror so that (s)he can see the reflection of Maze B in the mirror. The other student should take a piece of blank paper and cover the drawing hand of the student who is going to complete

Maze B so that (s)he can only see the reflection of the maze in the mirror and not her/his hand. Looking only at the reflection in the mirror, the student should draw through Maze B and the other student should record the time it takes for the student to complete the maze.

4. Have the students switch roles and do the activity again.
5. Compare the times it took to draw through the maze without the mirror and with the mirror. Which took longer? Which was more accurate (staying in the lines)? What made the task more difficult? Do you think you could improve your performance with practice?

Activity Two – Getting Dizzy

Objective: Students will become aware of the vestibular system and how it affects balance. Students will experience and observe how the inner ear responds to the microgravity environment of space.

Materials: 1 office chair with wheels
1 blindfold

What to do:

1. Have a blindfolded student sit on the chair with his/her head tilted sideways on one shoulder so that the head is roughly horizontal.
2. Start the chair spinning and let it spin in one direction for a while.
3. Stop the chair. Have the student place the head in a normal vertical position, keeping the blindfold on. Have a strong student or two stand to the side and behind the subject in case he/she falls.
4. Take the blindfold off and observe what happens.

What happened?

As the chair was rotating, the fluid in the semi-circular canal caught up and began to flow in the direction of the back of the head. When the rotation stopped, the fluids kept moving.

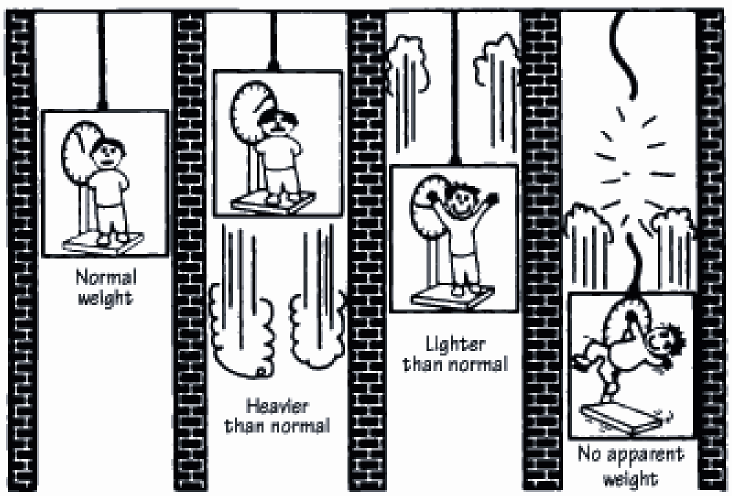
When the head was returned to the upright position, the fluid kept moving around toward the back of the head. When the blindfold was removed, the student’s eyes saw that the motion had stopped. The student lurched backward to steady him/herself because the fluid moving toward the back of the head was indicating that the body was tilting rapidly forward.

Gravity and Microgravity

Gravity is a force that causes an action on a body, usually as a downward pull. It is the force associated with mass and can act without contact. *Resistive forces* counter gravitational pull so that the two together result in a net force of zero.

Microgravity is an environment where the effects of gravity are very small. The extent to which gravity seems to disappear – the quality of microgravity that is achieved – is the extent to which the resistive forces are eliminated.

Gravity and resistive forces affect the human body externally. On Earth, gravity acts uniformly on all parts of the body, but resistive forces act only on contacting surfaces such as the ground and a person's feet. The total force on the human body is zero because the body reacts to distribute the force evenly throughout even though the resistive force acts only on the feet. In a microgravity environment, the resistive forces are very small and therefore, there is no internal force distribution.



Acceleration and Weight
The person in the stationary elevator car experiences normal weight. In the car immediately to the right, apparent weight increases slightly because of the upward acceleration. Apparent weight decreases slightly in the next car because of the downward acceleration. No weight is measured in the last car on the right because of free fall.

NASA Microgravity – A Teacher's Guide with Activities in Science, Mathematics and Technology, EG-1997-08-110-HQ, Education Standards Grades 5-8

Resources

NASA Space Online – hundreds of well researched and well organized free space resources for teachers http://spacelink.nasa.gov/

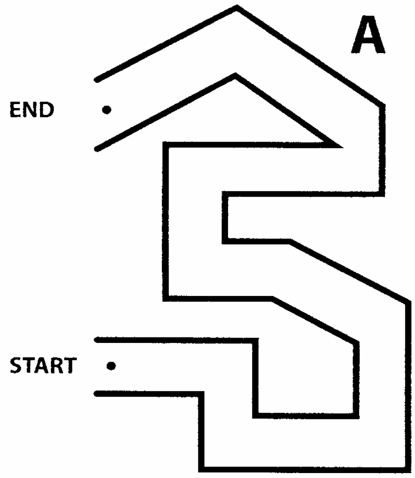
Sighting Opportunities for ISS and other Spacecraft
http://spaceflight.nasa.gov/realdata/sightings/

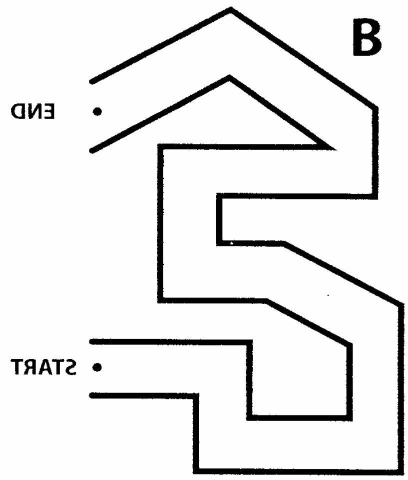
H.R. MacMillan Space Centre (astronomical information)
http://hrmacmillanspacecentre.com or 604-738-7827 ext. 228

Canada In Space – A student centered web experience highlighting the International Space Station and Canada's contribution to space (available October 31st, 2003 at canadainspace.ca)

DISORIENTATION MAZE

■ YOU

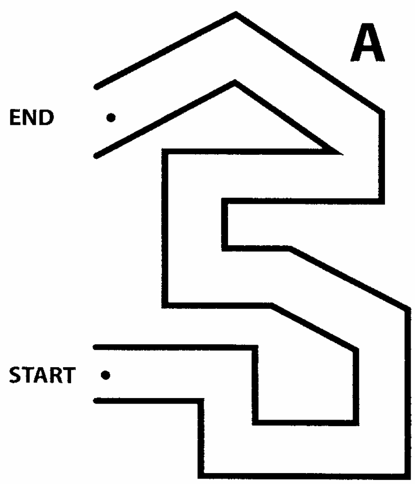


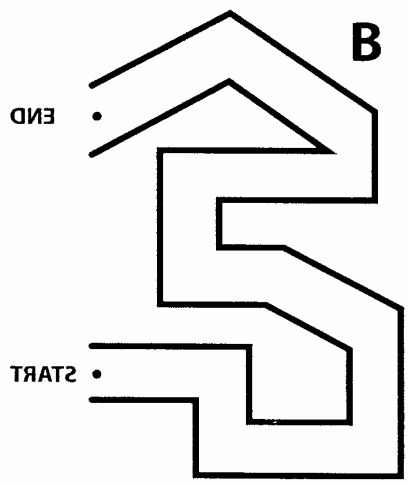


Time without mirror: ______ seconds

Time with mirror: ______ seconds

■ YOUR PARTNER





Time without mirror: ______ seconds

Time with mirror: ______ seconds