ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 7

EO C340.05 – SIMULATE LIFE IN SPACE

Total Time: 90 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

A practical activity was chosen for TP 1 as it is an interactive way to allow cadets to experience some aspects of life in space. This activity contributes to the development of knowledge of life in space in a fun and challenging setting.

An in-class activity was chosen for TPs 2 and 3 as it is an interactive way to provoke thought and simulate some of the challenges of living in space.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson, the cadet shall have experienced simulated aspects of life in space.

IMPORTANCE

It is important for cadets to realize the challenges of living in a space environment in order to understand the Canadian Space Program. A space environment requires many considerations for the human body to exist comfortably including eating, washing, and working.

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.

Teaching point 1 **Explain the Medical Effects of Weightlessness**

Time: 35 min Method: Practical Activity

MEDICAL EFFECTS OF WEIGHTLESSNESS

On Earth, gravity pulls everything down. Thus, the lower torso and legs carry the weight of the body. In space, because of zero gravity, astronauts float and the legs are not used to support the body.

In space, the lower back and leg muscles are affected the same way as muscles that have been in a cast for a while. Muscles become flabby and lose tone and mass and the astronaut experiences “bird leg syndrome”. “Bird leg syndrome”, called muscular atrophy, makes the limbs thinner. The bones also become weaker because of the loss of minerals like calcium, potassium, and sodium.

The weightlessness of space also affects the cardiovascular system. On Earth, because of gravity, blood naturally pools in the legs, forcing the heart to pump against gravity to supply enough blood to the brain. In space, the heart acts the same as it would on Earth. However, because there is no gravity, the blood rushes to the torso and head. In space the astronaut experiences “puffy face syndrome”. The veins in the neck and face stand out more, and the eyes become red and swollen.

Astronauts try to lessen “puffy face” and “bird leg” syndromes by exercising as often as possible. Astronauts must exercise at least two hours every day to keep their muscles healthy. Astronauts use exercise machines to work both the lower and the upper body muscles. They use a series of straps and restraints to remain secure against the exercise equipment.

ACTIVITY

Time: 25 min

OBJECTIVE

The objective of this activity is to have the cadets simulate exercises that astronauts must perform to maintain bone density and muscle mass when living in a space environment.

RESOURCES

N/A.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Have the cadets stretch for two minutes.

2. Have the cadets alternate between running on the spot and jumping jacks for eight minutes.

3. Have the cadets stretch for two minutes.

4. Have the cadets brainstorm and design exercises that will allow astronauts to keep a set of muscle groups fit in a weightless environment.

SAFETY

N/A.

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What do astronauts use to exercise?

Q2. What happens to an astronaut in zero gravity?

Q3. How is the cardiovascular system affected in space?

ANTICIPATED ANSWERS

A1. Astronauts use exercise machines to work both the lower and the upper body muscles.

A2. Astronauts float and their legs are not used to support the body.

A3. Due to the lack of gravity the blood rushes to the torso and head.

Teaching point 2 **Explain the Challenges of Living in Space**

Time: 30 min Method: In-Class Activity

CHALLENGES OF LIVING IN SPACE

Washing Hands With Rinseless Soap

In space, astronauts cannot wash with water, as water is very difficult to contain in a zero gravity environment. If water drops were left floating in the space vehicle, they could cause serious problems with the equipment. Astronauts use rinseless soap during space missions to clean themselves. Rinseless soap applies easily, the same way as regular soap or hair shampoo, and does not require water to be effective. The alcohol in the rinseless soap kills bacteria.

Sampling Space Food

There are many factors to consider when astronauts live in a space environment and one of these is food. The preparation of the food itself requires special considerations. Storage and transport require the product to be lightweight and have a long shelf life without refrigeration. Weight is critical during a space mission due to transport cost and efficiency. Some methods of food preparation and storage include freeze-drying, retort packing at 125 degrees Celsius, vacuum packing, and dehydrating. Preservation of taste and texture can be difficult with some of these methods. An example of space food is freeze-dried ice cream or strawberries.



Have the cadets feel how light the package of space freeze-dried ice cream or strawberries are by allowing them to hold the wrapped product.

Some dehydrated foods require rehydration, such as macaroni and cheese or spaghetti. The water is kept contained during the transfer from reservoir to food package to avoid loss. An oven is provided in the space shuttle and the space station to heat foods to the proper temperature.

Condiments such as ketchup, mustard, and mayonnaise are provided. Salt and pepper are available, but only in a liquid form, because astronauts cannot sprinkle salt and pepper on their food. The salt and pepper would simply float away. The particles could clog air vents, contaminate equipment or enter an astronaut's eyes, mouth, or nose.

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.

Astronauts eat three meals a day – breakfast, lunch and dinner. Nutritionists ensure the food astronauts eat provides a balanced supply of vitamins and minerals. Caloric requirements differ for different astronauts. For instance, a small astronaut weighing approximately 54 kg would require only about 1900 calories a day, while a large astronaut weighing 100 kg would require about 3200 calories a day.

There are many foods an astronaut can choose from, such as:

- fruits,
- nuts,
- peanut butter,
- chicken,
- beef,
- seafood,
- candy, and
- brownies.

Possible drinks include:

- coffee,
- tea,
- orange juice,
- fruit punches, and
- lemonade.

As on earth, space food comes in packages that must be disposed of. Astronauts must dispose of the packages in a trash compactor inside the space shuttle when they are finished eating. Some packaging actually prevents food from floating away. Food packages are designed to be flexible, easy to use and to maximize space when being stowed or disposed of.

ACTIVITY

Time: 20 min

OBJECTIVE

The objective of this activity is to have the cadets simulate how astronauts wash and eat in space.

RESOURCES

- Freeze-dried strawberries,
- Other freeze-dried fruit as available,
- Freeze-dried ice cream, and
- Rinseless soap.

ACTIVITY LAYOUT

N/A.

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups of three.
2. Distribute rinseless soap to each group of cadets.
3. Have the cadets wash their hands.
4. Distribute a package of freeze-dried ice cream and strawberries to each group of cadets.
5. Have the cadets taste the freeze-dried ice cream and strawberries.

SAFETY

- Warn cadets and staff that are lactose intolerant that the ice cream contains milk products.
- Warn cadets and staff with an allergy to strawberries that the freeze-dried strawberries are real strawberries.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Why are dehydrated foods used by astronauts for some of their meals?

Q2. What do astronauts use to wash their hands and hair?

Q3. Why would salt and pepper be a problem in a space environment?

ANTICIPATED ANSWERS

A1. Dehydrating food is used to reduces weight and increases shelf life.

A2. They use rinseless soap and shampoo.

A3. The grains of salt or pepper could clog air vents, contaminate equipment or enter an astronaut's eyes, mouth, or nose.

Teaching point 3 **Have the Cadets Simulate Working in Space by Installing a Nut on a Bolt Wearing Two Pairs of Thick Work Gloves**

Time: 20 min Method: In-Class Activity

Working in zero gravity is a challenge. Often, the only resistance felt by astronauts is the spacesuit itself. In weightless space, any movement in any direction encounters Newton's Third Law and causes an equal force in the opposite direction. For example, when turning a bolt, the force applied in any direction results in an equal force in the opposite direction. Astronauts must attach themselves to, or hold on to, any object to work on it so that they can control the opposite reactive effect.



Newton's Third Law: for every action there is an equal and opposite reaction.

Spacesuits introduce constraints on movement because they are bulky and, being pressurized, they are stiff. The pressure in an astronaut's spacesuit is 4.3 pounds per square inch (psi). That is less than one-third of the pressure of Earth's atmosphere at sea level (14.7 psi). The air pressure outside an airplane flying at 35 000 feet

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.

is near 4.3 psi. It is also about the same as the extra pressure that keeps a football inflated, and like a football, the suit is hard to bend.

Pressure is especially noticeable when wearing gloves. Spacesuit gloves are designed so that there is little pressure when the hand is at rest, but resistance can be felt when the hand is open. This makes manipulating objects difficult when working in the spacesuit.

Tools used in a space environment must be two to three times larger than normal because the gloves are bulky and make manipulating the regular-sized tools difficult. In space, it becomes difficult to do tasks that would be easy to do on Earth. Small details like threading nuts onto bolts require more effort and, worse, dropped objects can be hazardous as they continuously float around and may damage other instruments, controls, or surfaces.

ACTIVITY

Time: 15 min

OBJECTIVE

The objective of this activity is to have the cadets simulate what astronauts do to manipulate objects in a space environment.

RESOURCES

- Work gloves, and
- 1/2-inch National Coarse nuts and bolts.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups of six.
2. Give each group of cadets two pair of gloves and a bolt and a nut.
3. Have one cadet from each group put on two pairs of work gloves and try to pick up the bolt.
4. Put the nut in the cadets' gloved hand and ask the cadet to put the nut on the bolt.
5. Have each cadet perform Steps 3. and 4.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What are some of the constraints of the spacesuit?

Q2. What law of motion applies to moving in space?

Q3. Why are tools used in space two to three times larger than tools used on Earth?

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.

ANTICIPATED ANSWERS

A1. A spacesuit is suit is stiff because it is pressurized and it is bulky.

A2. Newton's Third Law of motion: for every action there is an equal and opposite reaction.

A3. Spacesuit gloves are stiff and bulky, which restricts the ability to manipulate smaller objects.

END OF LESSON CONFIRMATION

The cadets' participation in all the activities will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Astronauts living in a space environment face many challenges, even in simple things such as washing and eating. With careful planning and consideration of these challenges, life in space can be comfortable and fun.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-183 (ISBN 978-0-75662-227-5) Graham, I. (2006). *DK Online, Space Travel*. New York, NY: DK Publishing, Inc.

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.

THIS PAGE INTENTIONALLY LEFT BLANK

Unofficial convenience copy of A-CR-CCP-803/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-803-PF-001/A-CR-CCP-803-PF-001.pdf.
Verify against the official publication.