CHAPTER 13
PO 140 – PARTICIPATE IN AEROSPACE ACTIVITIES

ROYAL CANADIAN AIR CADETS

LEVEL ONE

INSTRUCTIONAL GUIDE

SECTION 1

EO M140.01 – BUILD AND LAUNCH A MODEL ROCKET

Total Time:	90 min

INTRODUCTION

PRE-LESSON INSTRUCTIONS

A complete list of resources needed for the instruction of this EO is located at Chapter 2 of the QSP. Specific uses for said stores are identified throughout the Instructional Guide, within the teaching point for which they are required.

Prior to instructing this lesson the instructor shall:

- review the lesson content, and become familiar with the material;
- create model rockets at various stages of completion for demonstration purposes;
- inform the cadets they will not be in uniform for this EO;
- ensure the following materials are collected for cadet use (per pair) during the lesson:
    - heavy paper (60 to 110 index stock) or construction paper;
    - plastic 35 mm film canisters with internal sealing lids;
    - photocopies of reference as described in Annexes A and B;
    - transparent tape;
    - scissors;
    - effervescing antacid tablets;
    - paper towels;
    - water;
    - eye protectors; and
    - markers and pencil crayons.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

The interactive lecture method was chosen as it allows the instructor to make a semi-formal presentation of the material where the cadets can participate by asking or responding to questions and commenting on the

material. For this lesson, this method is most effective as it matches well the taxonomic level of the material and is age-appropriate by virtue of its participatory nature.

The demonstration and performance methods were chosen due to the practical nature of the subject matter. These methods provide the instructor the opportunity to introduce the subject matter, demonstrate procedures and observe the cadets practicing and performing the skill. The demonstration and performance methods must always be used when the taxonomic level of the material requires a performance of a skill. These methods are highly developmentally appropriate for young cadets.

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall be expected to:

- identify important moments in space history;
- build a model rocket; and
- launch a model rocket.

IMPORTANCE

In the last century there have been a number of developments that have allowed mankind to explore beyond the atmosphere of the Earth. Aerospace is an important industry in Canada, which employs over 80 000 Canadians. This industry has demonstrated excellence in areas such as satellite, communication and robotics technologies. Through the introduction of satellites, there have been significant advancements made to make global communication and observation much more efficient. None of this would be possible without the introduction of rockets to the world of science.

Teaching Point 1 **Discuss Important Events in Space History**

Time: 15 min Method: Interactive Lecture

THE FIRST ROCKETS

Prior to 1900, rockets were mainly used as weapons or fireworks. In 1898 a Russian school teacher proposed the idea of space exploration through the use of rockets. On 4 October 1957, the Soviet Union launched the satellite Sputnik I, the first successful use of a space-going rocket. The United States followed in January of 1958, launching their satellite with the use of a rocket.

MANNED SPACE MISSIONS

The United States became the first and only country to land on the moon when Neil Armstrong set foot on the moon in 1969. Marc Garneau was the first Canadian astronaut, sent to space in 1984. In 1992, Canada sent its first woman into space, Roberta Bondar.

FURTHER SPACE EXPLORATION

Manned space missions continue today, focusing on both orbital missions as well as missions to the International Space Station. Satellites continue to be used for space exploration, but have also found a role in a number of other areas, including radio and television, as well as Earth observation through weather monitoring. Navigation systems have also improved from satellites such as global positioning systems. Landers have also been used in recent history, most notable the recent Mars Exploration Rover Missions in 2003. Commercial space travel has also gained interest in the last few years, with civilians paying substantial amounts of money

for an opportunity to travel into both sub-orbit and orbit. All of these aspects of space exploration depend on rocket technologies in order for them to be successful.

The instructor should research this field before teaching the class, and is encouraged to include any related current events, because information is continually changing.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What was the name of the satellite launched by the first successful space-going rocket? When was it launched?

Q2. Who was the first Canadian astronaut in space?

Q3. What are some uses for satellites?

ANTICIPATED ANSWERS

A1. Sputnik I, 4 October 1957.

A2. Marc Garneau.

A3. Surveillance, exploration, and communication (e.g. satellite television and radio).

Teaching Point 2 **Build a Model Rocket**

Time: 45 min Method: Demonstration and Performance

ACTIVITY – BUILD A MODEL ROCKET

Time: 45 min

OBJECTIVE

The objective of this activity is to build a model rocket, which will foster interest in rocketry and familiarize the cadets with basic rocket components.

RESOURCES

- Heavy paper (60 to 110 index stock) or construction paper.
- Plastic 35 mm film canisters with internal sealing lids.
- Photocopies of reference as described in Annexes A and B.
- Transparent tape.
- Scissors.
- Markers and pencil crayons.
- Model rockets (completed at various stages).

ACTIVITY LAYOUT

The instructor will:

1. divide the class into pairs;
2. show the model rocket to the cadets so they understand what the finished project should look like;
3. ensure each pair has been issued with materials including heavy paper, a film canister, tape, and scissors (extra materials should be given out if the cadets make mistakes); and
4. demonstrate each step of construction, showing an example of a rocket at that stage, and then having the cadets complete that step.

SAFETY

N/A.

INSTRUCTOR GUIDELINES

- Prior to the lesson, read the general instructions on pages 43 to 46 of the reference, *Rockets: A Teacher's Guide with Activities in Science, Mathematics, and Technology*. Copies of the general instructions for this activity are included as Annexes A and B. The instructions for rocket construction and launching are also included in the Interactive Handbook for the cadets' reference.
- Encourage the groups to think about the design of their rocket before cutting the heavy paper. Inform the cadets they may design the rockets as they wish, remembering that the design will affect its performance.
- Encourage the cadets to draw and colour designs on the paper prior to the construction of the rocket.

Teaching Point 3 **Launch a Model Rocket**

Time: 20 min Method: Demonstration and Performance

ACTIVITY – LAUNCH A MODEL ROCKET

Time: 25 min

OBJECTIVE

The objective of this activity is to launch a model rocket, which will foster interest in rocketry and familiarize the cadets with the fundamentals of rocket propulsion.

RESOURCES

- Effervescing (antacid) tablets.
- Paper towels.
- Water.
- Eye protectors.
- Model rockets.

ACTIVITY LAYOUT

- Once the rockets are complete, move the class outside to an area suitable for launching rockets.

- The instructor will put on eye protection, demonstrate the launching process (see Instructor Guidelines) and answer any questions the cadets may have.
- The groups will then be given their effervescing tablet, water and eye protection.
- Cadets will then launch the rockets one at a time, with assistance from the instructor as required.

SAFETY

The instructor will ensure that all cadets wear eye protection during launching of the rockets and ensure that the rockets are being launched in a suitable location.

INSTRUCTOR GUIDELINES

- The launching process is as follows (see instructions in Annex B for more details):
  1. turn the rocket upside down and fill the canister 1/3 full with water;
  2. drop in 1/2 of an effervescing tablet;
  3. swirl the mixture quickly;
  4. place lid on;
  5. set rocket down on launch platform (flat surface), and
  6. stand back.
- The instructor may give prizes for the highest vertical distance, or furthest distance, as well as for the best constructed or decorated rocket.

END OF LESSON CONFIRMATION

To confirm cadets' comprehension of the material, pose the following questions to the class as reflection questions:

Q1. What causes the rocket to lift-off?

Q2. What forces are acting on the rocket?

Q3. How does the design of the rocket affect how high it will fly?

A1. The rocket lifts off because it is acted upon by an unbalanced force (Newton's first law of motion).

A2. The forces that are acting on the rocket are gravity (drag) and the force of thrust caused by the combination of water with the effervescing tablet.

A3. Slim rockets are less resistant to forces such as drag than wider rockets. The smoother (more aerodynamic) the surface of the rocket is, also reduces the amount of drag acting on the rocket.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO will not be formally assessed.

CLOSING STATEMENT

The amount of research that has gone into aerospace over the past century has been very extensive. Advancements in technology have been able to take items such as rockets, satellites, and probes to scientific heights once unheard. These advancements have allowed mankind to explore the solar system in a greater depth, as well as increased the communication and observation abilities throughout Earth. Rockets play a fundamental part in making all of this possible.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-016 (EG-2003-01-108-HQ) NASA. (2003). *Rockets: A Teacher's Guide With Activities in Science, Mathematics, and Technology*. Washington, DC: NASA.

C3-036 Canadian Space Agency. (2006). *Canada's Astronauts*. Retrieved 26 April 2006, from www.space.gc.ca/asc/eng/astronauts/bio.asp.

C3-037 Canadian Space Agency. (2006). *Space Exploration.* Retrieved 26 April 2006, from www.space.gc.ca/asc/eng/exploration/exploration.asp.

ROYAL CANADIAN AIR CADETS

LEVEL ONE

INSTRUCTIONAL GUIDE

SECTION 2

EO C140.01 – PARTICIPATE IN AN ACTIVITY ABOUT CANADIAN ASTRONAUTS

Total Time: 30 min

INTRODUCTION

PRE-LESSON INSTRUCTIONS

A complete list of resources needed for the instruction of this EO is located at Chapter 2 of the QSP. Specific uses for said stores are identified throughout the Instructional Guide, within the teaching point for which they are required.

Prior to instructing this lesson the instructor shall:

- review the lesson content, and become familiar with the material;
- set up the classroom into four stations; and
- copy Annexes C to G and ensure there are enough copies for the stations.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

The small group activity was selected to allow for maximum participation in the learning process. It is an interactive way to illustrate and substantiate the lesson material in a concrete manner.

The group discussion method was chosen to allow the cadets to share their knowledge, opinions, and feelings about the subject matter while still allowing the instructor to control the direction of the discussion. The instructor must ensure that points not brought forth by the class are presented. If the instructor follows the Instructional Guide, including the questions posed, this will allow the cadets to express, in their own words, what they learned from this lesson and how they may apply the information.

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall be expected to participate in a discussion on Canadian astronauts.

IMPORTANCE

Being introduced to Canadian astronauts will promote an interest in aerospace. Discussing these astronauts will give the cadets a broader understanding of how Canadians are involved in space exploration.

BACKGROUND KNOWLEDGE

MARC GARNEAU

Education

- Received a Bachelor of Science degree in Engineering Physics from the Royal Military College of Kingston in 1970.
- Received a Doctorate in Electrical Engineering from the Imperial College of Science and Technology, London, England in 1973.
- Attended the Canadian Forces Command and Staff College of Toronto from 1982 to 1983.

Awards

- Companion of the Order of Canada.
- Named Chancellor of Carleton University in 2003.
- Awarded a Doctor of Science degree, *honoris causa* by York University in 2002 and the University of Lethbridge in 2001.
- Prix Montfort en sciences in 2003.
- Golden Jubilee Medal in 2002.
- NASA Exceptional Service Medal in 1997.
- NASA Space Flight Medals in 1984, 1996 and 2000.
- Canadian Decoration (military) in 1980.
- Athlone Fellowship in 1970.
- National Research Council Bursary in 1972.
- Honorary Doctorates by the University of Ottawa in 1997, the College militaire royal de Saint-Jean in 1990, the Universite Laval, Quebec in 1985, the Technical University of Nova Scotia in 1985 and the Royal Military College, Kingston, Ontario in 1985.
- Co-recipient of the F.W. (Casey) Baldwin Award in 1985 for the best paper in the *Canadian Aeronautics and Space Journal.*

Missions and Highlights

- **STS-41G**
    - The shuttle for this mission was the Challenger and was launched on 5 October 1984 at 7:03:00 a.m. EDT from Kennedy Space Center.
    - It landed back on earth on 13 October 1984 at 12:26:38 p.m. EDT at Kennedy Space Center.
    - The mission lasted for 8 days, 5 hours, 23 minutes, 38 seconds.
    - During the mission the shuttle orbited 133 times and traveled 5.47 million kilometres.
    - On this mission, Marc Garneau became the first Canadian to go into space. This was the first time NASA ever sent a seven-person crew into space.

- **STS-77**
    - The shuttle for this mission was the Endeavour and was launched on 19 May 1996 at 6:30:00 a.m. from Kennedy Space Center.
    - It landed back on earth on 29 May 1996 at 7:09:18 a.m. EST at Kennedy Space Center.
    - The mission lasted for 10 days, 0 hours, 39 minutes, 18 seconds.
    - During the mission, the shuttle orbited 161 times and traveled 6.60 million kilometres.
    - Marc Garneau became the first Canadian to make a return trip to space. The SPACEHAB-4 laboratory module, housed in the shuttle's cargo bay, was used to conduct microgravity research in many different fields of study. Marc Garneau manoeuvred the Canadarm during the retrieval of the Spartan 207 satellite.
- **STS-97**
    - The shuttle for this mission was the Endeavour and was launched on 20 November 2000 at 10:06:00 p.m. EST from Kennedy Space Center.
    - It landed back on earth on December 11, 2000 at 6:04:20 PM EST at Kennedy Space Center.
    - The mission lasted for 10 days, 19 hours, 58 minutes, 20 seconds.
    - During the mission, the shuttle orbited 171 times and traveled 7.20 million kilometres.
    - Marc Garneau became the first Canadian astronaut to make a third journey into space. This mission was the sixth construction flight for the International Space Station (ISS) and the primary goal was to attach the P6 truss, which included the first pair of large solar power arrays for the space station. He used the Canadarm to remove the P6 truss from the payload bay and then he positioned it in place while two "space walking" American astronauts attached it to the ISS.

ROBERTA BONDAR

Education

- Received a Bachelor of Science in zoology and agriculture from the University of Guelph in 1968.
- Received a Masters of Science in experimental pathology from the University of Western Ontario in 1971.
- Received a Ph.D. in neurobiology from the University of Toronto in 1974.
- Received a M.D. from McMaster University in 1977.
- Admitted as a Fellow of the Royal College of Physicians and Surgeons of Canada as a specialist in neurology in 1981.

Awards

- Officer of the Order of Canada.
- Canada 125 Medal.
- NASA's Space Medal.
- Hubertus Strunghold Award.
- Space Medicine Branch.

- Aerospace Medicine Association.
- Award of Merit, University of Western Ontario.
- 1995 Women's Intercultural Network International Women's Day Award.
- 1993 Alumnus of the Year, University of Guelph.
- Outstanding Canadian, Armenian Community Centre of Toronto.
- YWCA Woman of Distinction Award, Prince Albert, Saskatchewan.
- Kurt Hahn Award, Outward Bound.
- 1992 Paul Harris Recognition Award.
- Rotary Club of Ancaster.
- Inductee into the Hamilton Gallery of Distinction.

Missions and Highlights

- **STS-42**
    - The shuttle for this mission was the Discovery and was launched on 22 January 1992 at 9:52:33 a.m. EST from Kennedy Space Center.
    - It returned back to earth on 30 January 1992 at 8:07:17 a.m. PST at Edwards Air Force Base.
    - The mission lasted 8 days, 1 hour, 14 minutes, 44 seconds.
    - During the mission the shuttle orbited 129 times and traveled 4.70 million kilometres.
    - Roberta Bondar became the first Canadian woman to go into space. The International Microgravity Laboratory (IML) module was taken into space for the first time. The IML was carried in the cargo bay and was connected by a tunnel to the shuttle's middeck. It was used to explore in depth the complex effects of weightlessness on living organisms.

CHRIS HADFIELD

Education

- Received a Bachelor Degree in Mechanical Engineering (with honours), Royal Military College, Kingston Ontario in 1982.
- Conducted post-graduate research at the University of Waterloo, Ontario in 1982.
- Received a Master of Science in Aviation Systems at the University of Tennessee in 1992.

Awards

- Recipient of the 1988 Liethen-Tittle Award (top pilot graduate of the USAF Test Pilot School).
- U.S. Navy Test Pilot of the Year Award in 1991.
- Honorary Doctorate of Engineering from the Royal Military College in 1996.
- Member of the Order of Ontario in 1996.
- Honorary Doctorate of Laws from Trent University in 1999.

- Vanier Award in 2001.
- Meritorious Service Cross in 2001.
- NASA Exceptional Service Medal in 2002.
- Queen's Golden Jubilee Medal in 2003.
- Inducted into Canada's Aviation Hall of Fame in 2005.

Missions and Highlights

- **STS-74**
    - The shuttle for this mission was the Atlantis and was launched on 12 November 1995 at 7:30:43 a.m. EST from Kennedy Space Center.
    - It returned to earth on 20 November 1995 at 12:01:27 p.m. EST at Kennedy Space Center.
    - The mission lasted 8 days, 4 hours, 31 minutes, 42 seconds.
    - During the mission the shuttle orbited 129 times and traveled 5.5 million kilometres.
- **STS-100**
    - The shuttle for this mission was the Endeavour and was launched on 19 April 2001 at 2:41:42 p.m. EDT from Kennedy Space Center.
    - It returned to earth on 1 May 2001 at 9:11:42 p.m. PDT at Edwards Air Force Base.
    - The mission lasted 11 days, 21 hours, 30 minutes, 0 seconds.
    - During the mission the shuttle orbited 187 times and traveled 7.9 million kilometres.

JULIE PAYETTE

Education

- Received an International Baccalaureate in 1982 at the World International College of the Atlantic in South Wales, UK.
- Received a Bachelor of Electrical Engineering in 1986 from McGill University.
- Received a Master of Applied Science – Community Engineering in 1990 from the University of Toronto.

Awards

- Received one of six available Canadian scholarships to attend the International UWC of the Atlantic in South Wales, UK in 1980.
- Greville-Smith Scholarship in 1982 to 1986.
- Highest undergraduate award at McGill University.
- McGill Faculty Scholar in 1983 to 1986.
- NSERC post-graduate Scholarship from 1988 to 1990.
- Massey College Fellowship from 1988 to 1990.

- Canadian Council of Professional Engineers awarded her its 1994 distinction for exceptional achievement by a young engineer.
- National Order of Quebec.

Missions and Highlights

- **STS-96**
  - The shuttle for this mission was the Discovery and was launched on 27 May 1999 at 6:49:42 a.m. EST from Kennedy Space Center.
  - It returned to earth on 6 June 1999 at 2:02:43 a.m. EDT at Kennedy Space Center.
  - The mission lasted 9 days, 19 hours, 13 minutes, 57 seconds.

ACTIVITY

Time: 15 min

OBJECTIVE

The objective of this activity is for the cadets to discuss and present their findings about several Canadian astronauts.

RESOURCES

- Astronaut information found in Annexes C through F.
- Questions found in Annex G.
- Flipchart paper.
- Flipchart markers.

ACTIVITY LAYOUT

- Set-up the classroom with four stations (one per astronaut). If the class is big, more stations with overlapping astronauts are acceptable.
- Each station should have the information for the astronaut (found in the Annexes C through F), a set of questions to answer (found in Annex G) and flipchart paper and markers.
- Divide the class into four groups (or more if the class is big).
- Assign each group to a station.
- At the stations, the groups are to read the information (a reader or readers can be selected at the station) and write the answers to the questions provided at the station on the flipchart paper.

SAFETY

N/A.

INSTRUCTOR GUIDELINES

At this point the instructor shall brief the cadets on any safety rules or any other guidelines pertaining the activity.

- Supervise to ensure all cadets are participating.
- Gather the groups together after 10 minutes for the presentations.
- Ensure the cadets have presented all of the information for their astronaut.

REFLECTION

Time: 10 min Method: Group Discussion

GROUP DISCUSSION

At this point, each group will present their astronaut to the class.

Instructor shall ensure that all lesson objectives are drawn out towards the end of the reflection stage.

DISCUSSION QUESTIONS

TIPS FOR ANSWERING/FACILITATING DISCUSSION

- Ask questions that help facilitate discussion; in other words, avoid questions with yes or no answers.
- Prepare questions ahead of time.
- Be flexible (you are not bound to only the prepared questions).
- Encourage cadets to participate by using praise such as “great idea” or “excellent response, can anyone add to that?”.
- Try to involve everyone by directing questions to non-participants.

SUGGESTED QUESTIONS

Q1. What did you find interesting about this class?

Other questions and answers will develop throughout the reflection stage. The discussion should not be limited to only those suggested.

CONCLUSION

REVIEW

Upon completion of the group discussion, conclude by summarizing the discussion to ensure that all teaching points have been covered. Take the opportunity to explain how the cadet will apply this knowledge in the future.

MAIN TEACHING POINTS

TP1. Marc Garneau.

TP2. Roberta Bondar.

TP3. Chris Hadfield.

TP4. Julie Payette.

Instructors shall reinforce those answers and comments discussed during reflection, but must ensure that the main teaching points have been covered. Any main teaching point not brought out during the group discussion shall be inserted during review.

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

There is no formal assessment of this EO.

CLOSING STATEMENT

Canadian astronauts are active in space exploration. Discussing them will encourage the cadets to research other astronauts and have an understanding of how they are involved in space exploration.

INSTRUCTOR NOTES/REMARKS

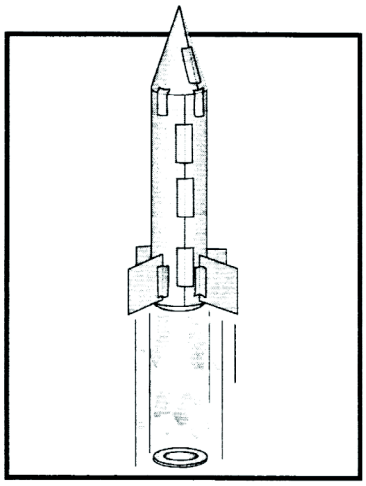
N/A.

REFERENCES

C3-028 Big Sky Astronomical Society. (2006). Retrieved 27 April 2006, from http://www.bigsky.ab.ca/education.htm.

C3-029 National Aeronautics and Space Administration. (1997-2006). Retrieved 27 April 2006, from http://www.jsc.nasa.gov/bios/index.html.

MODEL ROCKET



Teacher Information

3-2-1 POP!

Objective:
To demonstrate how rocket liftoff is an application of Newton's Laws of Motion.

Description:
Students construct a rocket powered by the pressure generated from an effervescing antacid tablet reacting with water.

Science Standards:

Physical Science - Position and motion of objects
Science and Technology - Abilities of technological design - Understanding about science and technology

Process Skills:

Observing
Communicating
Making Models
Inferring

Management:
For best results, students should work in pairs. It will take approximately 40 to 45 minutes to complete the activity. Make samples of rockets in various stages of completion available for students to study. This will help some students visualize the construction steps.

A single sheet of paper is sufficient to make a rocket. Be sure to tell the students to plan how they are going to use the paper. Let the students decide whether to cut the paper the short or long direction to make the body tube of the rocket. This will lead to rockets of different lengths for flight comparison.

The most common mistakes in constructing the rocket are: forgetting to tape the film canister to the rocket body, failing to mount the canister with the lid end down, and not extending the canister far enough from the paper tube to make snapping the lid easy. Some students may have difficulty in forming the cone. To make a cone, cut out a "Pacman" shape from a circle and curl it into a cone. See the pattern on the next page. Cones can be any size.

Materials and Tools:

- Heavy paper (60-110 index stock or construction paper)
- Plastic 35 mm film canister*
- Student sheets
- Cellophane tape
- Scissors
- Effervescing antacid tablet
- Paper towels
- Water
- Eye protection

* The film canister must have an internal-sealing lid. See management section for more details.

ROCKETEER NAMES

_____

_____

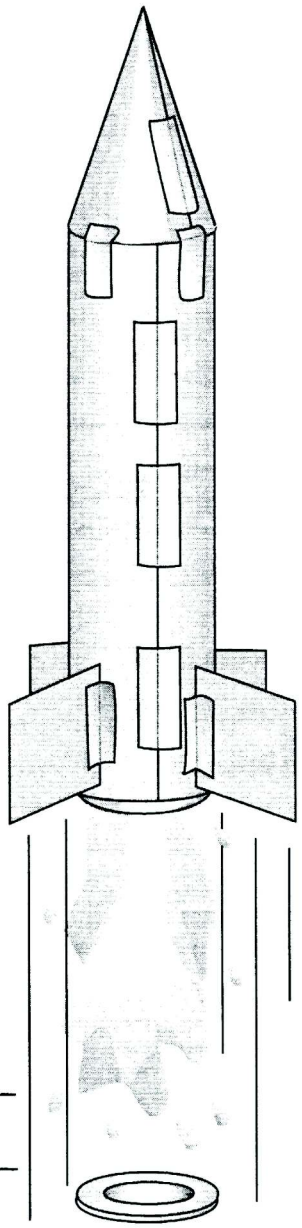
COUNTDOWN:

1. Put on your eye protection.
2. Turn the rocket upside down and fill the canister one-third full of water.

Work quickly on the next steps!

3. Drop in 1/2 tablet.
4. Snap lid on tight.
5. Stand rocket on launch platform.
6. Stand back.

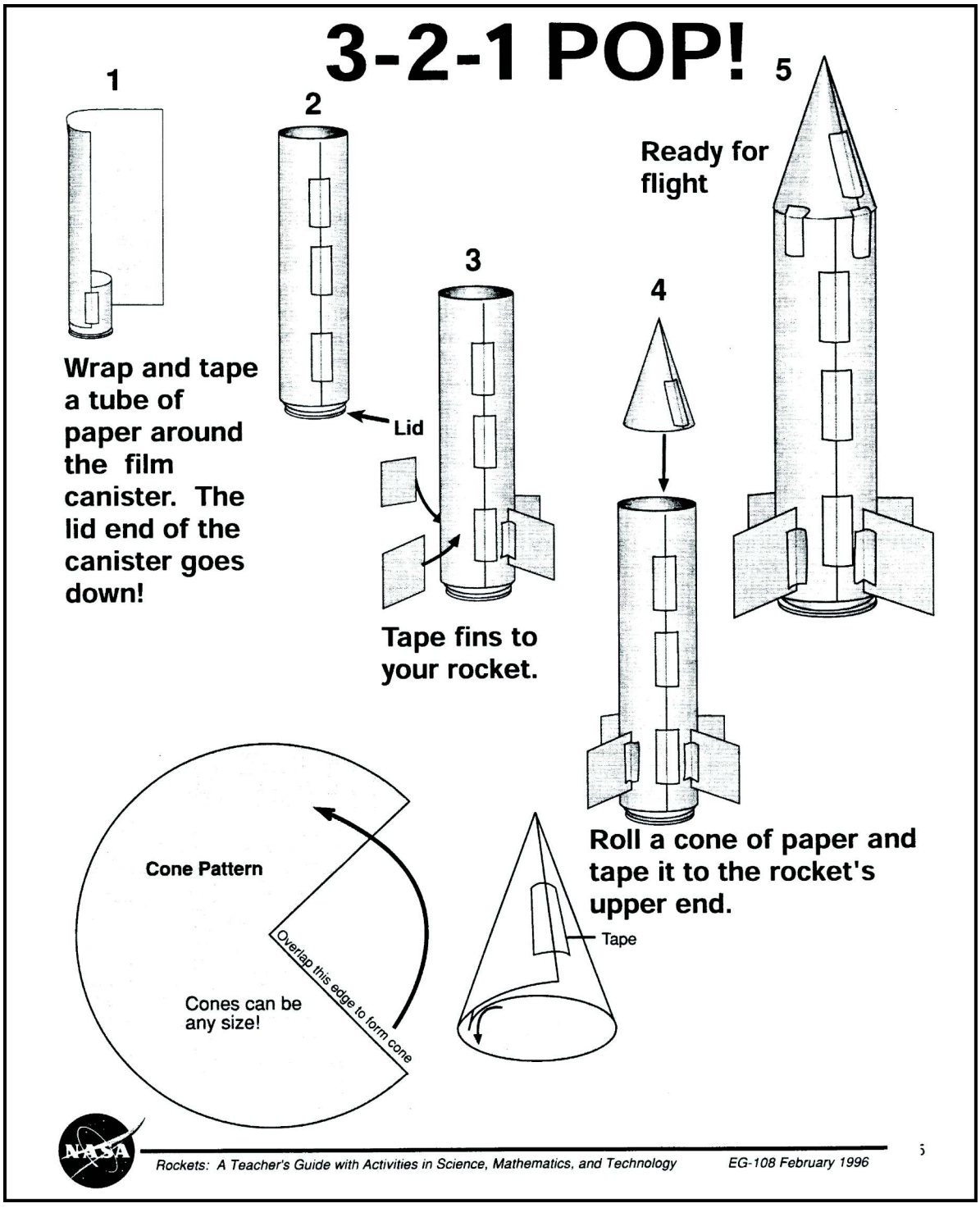
LIFTOFF!



What three ways can you improve your rocket?

1. _____
2. _____
3. _____

MODEL ROCKET – LAUNCHING PROCESS



Film canisters are available from camera shops and stores where photographic processing takes place. These businesses recycle the canisters and are often willing to donate them for educational use. Be sure to obtain canisters with the internal sealing lid. These are usually translucent canisters. Canisters with the external lid (lid that wraps around the canister rim) will not work. These are usually opaque canisters.

Background Information:
This activity is a simple but exciting demonstration of Newton's Laws of Motion. The rocket lifts off because it is acted upon by an unbalanced force (First Law). This is the force produced when the lid blows off by the gas formed in the canister. The rocket travels upward with a force that is equal and opposite to the downward force propelling the water, gas, and lid (Third Law). The amount of force is directly proportional to the mass of water and gas expelled from the canister and how fast it accelerates (Second Law). For a more complete discussion of Newton's Laws of Motion, see pages 13-17 in this guide.

Procedure:
Refer to the Student Sheet.

Discussion:
- How does the amount of water placed in the cylinder affect how high the rocket will fly?
- How does the temperature of the water affect how high the rocket will fly?
- How does the amount of the tablet used affect how high the rocket will fly?
- How does the length or empty weight of the rocket affect how high the rocket will fly?
- How would it be possible to create a two-stage rocket?

Assessment:
Ask students to explain how Newton's Laws of Motion apply to this rocket. Compare the rockets for skill in construction. Rockets that use excessive paper and tape are likely to be less efficient fliers because they carry additional weight.

Extensions:
- Hold an altitude contest to see which rockets fly the highest. Launch the rockets near a wall in a room with a high ceiling. Tape a tape measure to the wall. Stand back and observe how high the rockets travel upward along the wall. Let all students take turns measuring rocket altitudes
- What geometric shapes are present in a rocket?
- Use the discussion questions to design experiments with the rockets. Graph your results.

BIOGRAPHICAL DATA – MARC GARNEAU

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas 77058

BIOGRAPHICAL DATA

MARC GARNEAU (PH.D.)

ASTRONAUT, CANADIAN SPACE AGENCY (FORMER)

Born in February 1949 in Quebec City, Canada. He received his early education in Quebec City and Saint-Jean-sur-Richelieu in Quebec and in London, England. He received a Bachelor of Science degree in Engineering Physics from the Royal Military College of Kingston in 1970, and a Doctorate in Electrical Engineering from the Imperial College of Science and Technology, London, England, in 1973. He attended the Canadian Forces Command and Staff College of Toronto in 1982 to 1983.

Marc Garneau was a Combat Systems Engineer in HMCS Algonquin from 1974 to 1976. While serving as an instructor in naval weapon systems at the Canadian Forces Fleet School in Halifax, 1976 to 1977, he designed a simulator for use in training weapons officers in the use of missile systems aboard Tribal class destroyers. He served as Project Engineer in naval weapon systems in Ottawa from 1977 to 1980. He returned to Halifax with the Naval Engineering Unit, which troubleshoots and performs trials on ship-fitted equipment, and helped develop an aircraft-towed target system for the scoring of naval gunnery accuracy. Promoted to Commander in 1982 while at Staff College, he was transferred to Ottawa in 1983 and became design authority for naval communications and electronic warfare equipment and systems. In January 1986, he was promoted to Captain. He retired from the Navy in 1989. He is one of six Canadian astronauts selected in December 1983. He was seconded to the Canadian Astronaut Program from the Department of National Defence in February 1984 to begin astronaut training. He became the first Canadian astronaut to fly in space as a Payload Specialist on Shuttle Mission 41-G in October 1984. He was named Deputy Director of the Canadian Astronaut Program in 1989, providing technical and program support in the preparation of experiments to fly during future Canadian missions. He was selected for Mission Specialist training in July 1992.

Marc Garneau reported to the Johnson Space Center in August 1992. He completed a one-year training and evaluation program to be qualified for flight assignment as a Mission Specialist. He initially worked on technical issues for the Astronaut Office Robotics Integration Team and subsequently served as Capsule Communicator (CAPCOM) in Mission Control during Shuttle flights. A veteran of three space flights (STS-41G in 1984, STS-77 in 1996 and STS-97 in 2000), Marc Garneau has logged over 677 hours in space.

In February 2001, Marc Garneau was appointed Executive Vice President, Canadian Space Agency. He was subsequently appointed President of the Canadian Space Agency, effective 22 November 2001.

Honorary Fellow of the Canadian Aeronautics and Space Institute. Member of the Association of Professional Engineers of Nova Scotia, and the Navy League of Canada. He was named Honorary Member of the Canadian Society of Aviation Medicine in 1988 and a Member of the International Academy of Astronautics in 2002. Marc Garneau is the National Honorary Patron of Hope Air and Project North Star and the President of the Board of the McGill Chamber Orchestra.

He was promoted Companion of the Order of Canada in 2003, having been appointed as an Officer in 1984. Named Chancellor of Carleton University (2003). Awarded a Doctor of Science degree, *honoris causa*, by York University (2002) and the University of Lethbridge (2001). Recipient of the Prix Montfort en sciences (2003); Golden Jubilee Medal of Her Majesty Queen Elizabeth II (2002); NASA Exceptional Service Medal (1997); NASA Space Flight Medals (1984, 1996, 2000); the Canadian Decoration (military) (1980); the Athlone Fellowship (1970); and the National Research Council (NRC) Bursary (1972). Awarded Honorary Doctorates by the University of Ottawa (1997); the College militaire royal de Saint-Jean (1990); the Universite Laval, Quebec (1985); the Technical University of Nova Scotia (1985); and the Royal Military College, Kingston, Ontario (1985). Co-recipient of the F.W. (Casey) Baldwin Award in 1985 for the best paper in the Canadian Aeronautics and Space Journal.

June 2004

MARC GARNEAU

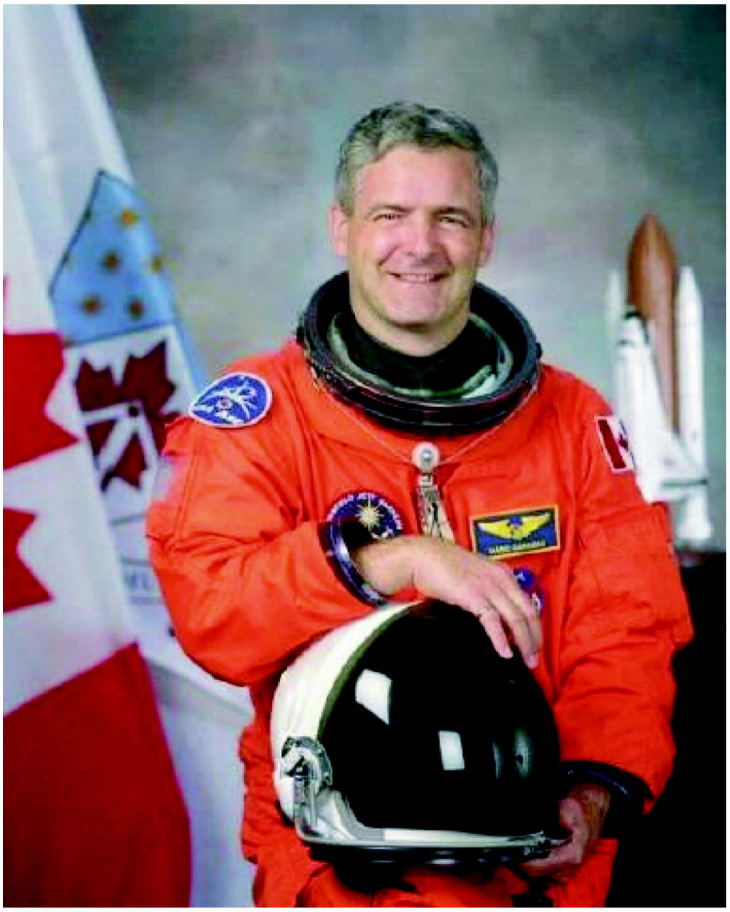


IMAGE CREDIT: NASA

Marc Garneau was born in Quebec City on 23 February 1949. In 1970, he received a Bachelor of Science degree in Engineering Physics from the Royal Military College in Kingston, Ontario. In 1973, he received a Doctorate (Ph.D.) in Electrical Engineering from the Imperial College of Science and Technology in London, England.

In 1983, he was selected as one of the original six Canadian astronauts and in 1984 he became the first Canadian in space. Marc Garneau is a veteran of three space shuttle flights and has logged over 677 hours in space. His first trip into space was aboard the Space Shuttle Challenger, while his next two journeys into space were aboard the Space Shuttle Endeavour.

Doctor Garneau was appointed an Officer of the Order of Canada in 1984 and is currently the President of the Canadian Space Agency.

Mission: STS-41G

Space Shuttle: Challenger

Commander: Robert Crippen

Pilot: Jon McBride

Mission Specialists: Kathryn Sullivan, Sally Ride, David Leestma

Payload Specialists: Marc Garneau, Paul Scully-Power

Launch Date: 5 October 1984

Launch Time: 7:03:00 a.m. EDT

Launch Site: Kennedy Space Center (KSC)

Launch Pad: 39A

Landing Date: 13 October 1984

Landing Time: 12:26:38 p.m. EDT

Landing Site: Kennedy Space Center (KSC)

Mission Duration: 8 days, 5 hours, 23 minutes, 38 seconds

Number of Orbits: 133 orbits

Distance Traveled: 5.47 million kilometres

Mission Highlights: Marc Garneau became the first Canadian to go into space. This was the first time NASA ever sent a seven-person crew into space. The Earth Radiation Budget Satellite (ERBS) was deployed. Scientific observations of the earth were conducted from the payload bay with the Office of Space and Terrestrial Applications (OSTA-3) pallet. An IMAX camera was taken along on this flight as was a package of Canadian Experiments (CANEX).

Mission: STS-77

Space Shuttle: Endeavour

Commander: John Casper

Pilot: Curtis Brown, Jr.

Mission Specialists: Daniel Bursch, Mario Runco, Jr., Marc Garneau, Andrew Thomas

Launch Date: 19 May 1996

Launch Time: 6:30:00 a.m. EST

Launch Site: Kennedy Space Center (KSC)

Launch Pad: 39B

Landing Date: 29 May 1996

Landing Time: 7:09:18 a.m. EST

Landing Site: Kennedy Space Center (KSC)

Mission Duration: 10 days, 0 hours, 39 minutes, 18 seconds

Number of Orbits: 161

Distance Traveled: 6.60 million kilometres

Mission Highlights: Marc Garneau became the first Canadian to make a return trip to space. The SPACEHAB-4 laboratory module, housed in the shuttle's cargo bay, was used to conduct microgravity research in many different fields of study. The Commercial Float Zone Furnace (CFZF), one of the SPACEHAB-4 experiments, was used to produce high-quality crystals that could be used to manufacture products such as computer chips, lasers, and infrared detectors. The Inflatable Antenna Experiment (IAE) was inflated to its full size (approximately 15 meters in diameter) and its performance was documented for later analysis. Afterwards, the IAE was jettisoned. The IAE was attached to the Spartan-207 satellite, which was deployed and retrieved with the Remote Manipulator System (Canadarm). Marc Garneau manoeuvred the Canadarm during the retrieval of this satellite.

Mission: STS-97

Space Shuttle: Endeavour

Commander: Brent Jett

Pilot: Michael Bloomfield

Mission Specialists: Joseph Tanner, Marc Garneau, Carlos Noriega

Launch Date: 30 November 2000

Launch Time: 10:06:00 p.m. EST

Launch Site: Kennedy Space Center (KSC)

Launch Pad: 39B

Landing Date: 11 December 2000

Landing Time: 6:04:20 p.m. EST

Landing Site: Kennedy Space Center (KSC)

Mission Duration: 10 days, 19 hours, 58 minutes, 20 seconds

Number of Orbits: 171

Distance Traveled: 7.20 million kilometres

Mission Highlights: Marc Garneau became the first Canadian Astronaut to make a third journey into space. This mission was the sixth construction flight for the International Space Station (ISS) and the primary goal was to attach the P6 truss, which included the first pair of large solar power arrays for the space station. Marc Garneau used the Remote Manipulator System (Canadarm) to remove the P6 truss from the payload bay and then he positioned it in place while two "space walking" American Astronauts attached it to the ISS. While docked with the ISS, the crew of the Space Shuttle Endeavour and the ISS Expedition One Crew transferred equipment and supplies from the shuttle to the space station. They also transferred refuse from the space station to the shuttle so that it could be returned to Earth and disposed of properly.

In Toronto, there is a high school named in honour of Dr. Marc Garneau. The school formerly known as Overlea Secondary School was renamed Marc Garneau Collegiate Institute on 16 October 1987.

BIOGRAPHICAL DATA – ROBERTA LYNN BONDAR

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas 77058

BIOGRAPHICAL DATA

ROBERTA LYNN BONDAR, O.C., O.ONT., M.D., PH.D., F.R.C.P.©

ASTRONAUT, CANADIAN SPACE AGENCY (FORMER)

Personal Data. Born in Sault Ste. Marie, Ontario, Canada. Dr. Bondar has certification in scuba diving, parachuting, and holds a private pilot's license. She enjoys photography, biking, hot air ballooning, roller blading, and flying.

Current Status. Distinguished Professor, Centre for Advanced Technology Education (CATE), Ryerson Polytechnic University, Toronto, Ontario; CIBC Distinguished Professor, Faculty of Kinesiology, University of Western Ontario, London, Ontario; Visiting Research Scholar, Department of Neurology, University of New Mexico; Visiting Research Scientist, Universities Space Research Association, Johnson Space Centre, Houston, Texas.

Current Activities. Principal investigator, Transcranial Doppler in Patients with Orthostatic Intolerance, University of New Mexico, Deaconess Hospital, Boston; Principal investigator, Transcranial Doppler in Astronauts Before and After Space Flight, Johnson Space Centre, Edwards Air Force Base, and Kennedy Space Centre; Author, Touching the Earth, Key Porter Books, Toronto, Ontario; Chair, Friends of the Environment Foundation (non-profit organization of Canada Trust).

Education. Attended elementary and secondary school in Sault Ste. Marie, Ontario. Degrees: B.Sc. in zoology and agriculture, University of Guelph, 1968, M. Sc. in experimental pathology, University of Western Ontario, 1971, Ph.D. in neurobiology, University of Toronto, 1974, M.D., McMaster University, 1977. Admitted as a Fellow of the Royal College of Physicians and Surgeons of Canada as a specialist in neurology in 1981.

Experience. Dr. Bondar is a neurologist and researcher. After internship in internal medicine at Toronto General Hospital, she completed post-graduate medical training in neurology at the University of Western Ontario; neuro-opthalmology at Tuft's New England Medical Center (Boston) and the Playfair Neuroscience Unit of Toronto Western Hospital; and carotid Doppler ultrasound and transcranial Doppler at the Pacific Vascular Institute (Seattle). She was appointed Assistant Professor of Medicine (Neurology), McMaster University, 1982 to 1984; Scientific staff, Sunnybrook Medical Centre, Toronto, 1988 to present; Visiting Research Scholar, Department of Neurology, University of New Mexico, 1993 to 1995; Adjunct Professor, Department of Biology, University of New Mexico, 1992 to 1994; Distinguished Professor, CATE, Ryerson, 1992 to present; Visiting Distinguished Fellow, Department of Medicine, Faculty of Health Sciences, McMaster University, 1993 to 1994; Visiting Distinguished Professor, Faculty of Kinesiology, University of Western Ontario, 1994 to present.

She was one of the six original Canadian astronauts selected in December, 1983 and began astronaut training in February, 1984. She served as chairperson of the Canadian Life Sciences Subcommittee for Space Station from 1985 to 1989, and as a member of the Ontario Premier's Council on Science and Technology from 1988 to 1989. In early 1990, she was designated a prime Payload Specialist for the first International Microgravity Laboratory Mission (IML-1). Dr. Bondar flew on the space shuttle Discovery during Mission STS-42, 22 to

30 January 1992 where she performed life science and material science experiments in the Spacelab and on the middeck.

Dr. Roberta Bondar left the Canadian Space Agency effective 4 September 1992, to pursue her research.

Honorary Degrees. D.Sc., Mount Allison University, Sackville, New Brunswick, 1989; D.Hum.L., Mount St. Vincent University, Halifax, Nova Scotia, 1990; Senior Fellowship from Ryerson Polytechnical Institute, Toronto, Ontario, 1990; D.Sc., University of Guelph, Guelph, Ontario, 1990; D.Sc., Lakehead University, Thunder Bay, Ontario, 1991; D.Sc., Algoma College, Laurentian University, Sault Ste. Marie, Ontario, 1991; D.Sc., Saint Mary's University, Halifax, Nova Scotia, 1992; D.Sc., McMaster University, Hamilton, Ontario, 1992; L.L.D. University of Regina, Regina, Saskatchewan, 1992; L.L.D., University of Calgary, Calgary, Alberta; D.U., University of Ottawa, Ottawa, Ontario, 1992; D.Sc., University of Toronto, Toronto, Ontario, 1992; D.Sc., McGill University, Montreal, Quebec, 1992; D.Sc., York University, Toronto, Ontario, 1992; D.Sc., Carleton University, Ottawa, Ontario, 1993; D.S.L., Wycliffe College, University of Toronto, Toronto, Ontario, 1993; D.Sc., Royal Roads Military College, Victoria, British Columbia, 1993; D.Sc., Memorial University, St. John's, Newfoundland, 1993; D.Sc., Laval University, Laval, Quebec, 1993; D.Sc., University of Montreal, Montreal, Quebec, 1994; D.Sc., University of Prince Edward Island, Charlottetown, Prince Edward Island, 1994; D.Sc., University of Western Ontario, London, Ontario, 1995.

Special Honors and Awards. Officer of the Order of Canada; the Order of Ontario; Canada 125 Medal; NASA's Space Medal; Hubertus Strughold Award, Space Medicine Branch, Aerospace Medicine Association; Award of Merit, University of Western Ontario; Medaille de L'Excellence, L'Association des Medicins de Langue Francaise du Canada; La Personalite de L'Annee 1992, La Presse; 1995 Women's Intercultural Network International Women's Day Award; 1993 Alumnus of the Year, University of Guelph; Outstanding Canadian, Armenian Community Centre of Toronto; YWCA Woman of Distinction Award, Prince Albert, Saskatchewan, Kurt Hahn Award, Outward Bound; 1992 Paul Harris Recognition Award, Rotary Club of Ancaster, Inductee into the Hamilton Gallery of Distinction. Honorary Life Member, Canadian Federation of University Women, Girl Guides of Canada, Federation of Medical Women of Canada, Science North, and Zonta International.

Honorary Appointments. Patron, World Congress of Neurology (Vancover), Canadian Federation of Business and Professional Women's Clubs, Mission Air Transportation Network, Canadian Bushplane Heritage Centre, Young Scientists of Canada, Aphasia Centre (North York), Ontario Parks Association, Earth Observation Theatre - Fort Whyte Centre (Winnipeg); 1995 International Mathematical Olympiad. Honorary Chairperson, Canadian Coalition for Quality Daily Physical Education, Women's Soccer Competition - World Student Games, The Parkinson Foundation of Canada, Marsville Program - Ontario Science Centre; Honorary Colonel, 22 Wing, Canadian Armed Forces, Hornell Heights, Ontario; Honorary Director, Save Our North Atlantic Resources; Member, Canadian Association for Women in Science, l'Association des Medecins de Langue Francaise du Canada; Bootmakers of Canada, Canadian Aviation Historical Society.

Honors in Name of Roberta Lynn Bondar. Roberta Bondar Public School, Ottawa, Ontario; Dr. Roberta Bondar Public School, Ajax, Ontario; Queen Elizabeth Public School Resource Centre, Sault Ste. Marie; Alex Muir Public School Resource Centre, Sault Ste. Marie; Trophy for Outstanding Male and Female Athlete of the Year, Sir James Dunn Collegiate and Vocational School, Sault Ste. Marie; Roberta Bondar Gymnasium, Sir James Dunn Collegiate and Vocational School, Sault Ste. Marie; Soo College Scholarship, Sault Ste. Marie; Sir James Dunn Collegiate and Vocational School Scholarship, Sault Ste. Marie; Bawating Collegiate and Vocational School Scholarship, Sault Ste. Marie; Girl Guides of Canada Scholarship; Province of Ontario Science and Technology Awards, USS Bondar, The Guelph Trek Club; Roberta Bondar Earth and Space Centre, Seneca College, Toronto, Ontario; Place Roberta Bondar - Province of Ontario, Sault Ste. Marie; YWCA Scholarship, Prince Albert, Saskatchewan; Roberta Bondar Rose, Hortico Nurseries; Roberta Bondar Park and Tent Pavilion, Sault Ste. Marie, Ontario.

Organizations. Fellow, Royal College of Physicians and Surgeons of Canada, Member, American Academy of Neurology, Canadian Aeronautics and Space Institute, Canadian Society of Aerospace Medicine, College of Physicians and Surgeons of Ontario, Canadian Stroke Society, Aerospace Medical Association, Albuquerque Aerostat Ascension Association, American Society for Gravitational and Space Biology, Association for Space

Explorers, Canadian Society of Aerospace Medicine, Greater Albuquerque Medical Association, Canadian Medical Association, Ontario Medical Association, Canadian Association of Sports Medicine.

July 1997

ROBERTA BONDAR

IMAGE CREDIT: NASA

Roberta Bondar was born in Sault Ste. Marie on 4 December 1945. She received a Bachelor of Science degree in zoology and agriculture from the University of Guelph in 1968, a Master of Science degree in Experimental Pathology from the University of Western Ontario in 1971, a doctorate (Ph.D.) in Neurobiology from the University of Toronto in 1974, and a Doctor of Medicine degree from McMaster University in 1977.

In 1983, she was selected as one of the original six Canadian astronauts and in 1992, aboard the Space Shuttle Discovery, Doctor Bondar became the first neurologist in space and also the first Canadian woman in space. Roberta Bondar, the second Canadian astronaut in space, retired from the astronaut corps shortly after returning from her journey into space because she wanted to devote more time to her research.

Doctor Bondar is an Officer of the Order of Canada and has been elected to the Canadian Medical Hall of Fame for her pioneering space medical research.

Mission:	STS-42
Space Shuttle:	Discovery
Commander:	Ronald Grabe
Pilot:	Stephen Oswald
Mission Specialists:	Norman Thagard, William Readdy, David Hilmers
Payload Specialists:	Roberta Bondar, Ulf Merbold
Launch Date:	22 January 1992
Launch Time:	9:52:33 a.m. EST
Launch Site:	Kennedy Space Center (KSC)
Launch Pad:	39A
Landing Date:	30 January 1992
Landing Time:	8:07:17 a.m. PST
Landing Site:	Edwards Air Force Base
Mission Duration:	8 days, 1 hour, 14 minutes, 44 seconds
Number of Orbits:	129
Distance Traveled:	4.70 million kilometres
Mission Highlights:	Roberta Bondar became the first Canadian woman to go into space. The International Microgravity Laboratory (IML) module was taken into space for the first time. The IML was carried in the cargo bay and was connected by a tunnel to the shuttle's middeck. It was used to explore in depth the complex effects of weightlessness on living organisms. The international crew was divided into two teams for around-the-clock research on the human nervous system's adaptation to low gravity and the effects of microgravity on other life forms such as shrimp eggs, fruit fly eggs, lentil seedlings, and bacteria. An IMAX camera was taken along on this flight.

DID YOU KNOW?

In Toronto, there is a planetarium named in honour of Dr. Roberta Bondar. the Roberta Bondar Earth and Space Centre Planetarium is located at Seneca College (Newnham Campus).

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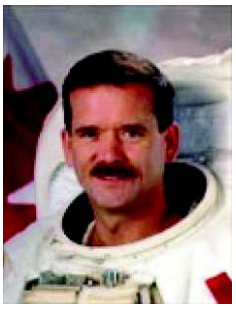
BIOGRAPHICAL DATA – CHRIS A. HADFIELD

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas 77058



BIOGRAPHICAL DATA

CHRIS A. HADFIELD (COLONEL, CAF, RET.)

ASTRONAUT, CANADIAN SPACE AGENCY

Personal Data. Born 29 August 1959, in Sarnia, and raised in Milton, Ontario, Chris Hadfield is married to Helene Hadfield (Walter). They have three children. He enjoys skiing, playing guitar, singing, riding, writing, running, and playing volleyball and squash. His parents, Roger and Eleanor Hadfield, reside near Milton. Her mother, Gwendoline Walter, resides in Victoria, B.C. Her father, Erhard Walter, is deceased.

Education. Graduated as an Ontario Scholar from Milton District High School in 1977; Received a Bachelor Degree in Mechanical Engineering (with honours), Royal Military College, Kingston, Ontario, Canada, in 1982; Conducted post-graduate research at the University of Waterloo, Ontario in 1982; Received a Master of Science in Aviation Systems at the University of Tennessee in 1992.

Affiliations. Royal Military College Club; Society of Experimental Test Pilots; Canadian Aeronautics and Space Institute, Honourary Patron of Lambton College; Trustee of Lakefield College School.

Special Honors. Recipient of the 1988 Liethen-Tittle Award (top pilot graduate of the USAF Test Pilot School); U.S. Navy Test Pilot of the Year (1991); Honorary Doctorate of Engineering from the Royal Military College (1996); Member of the Order of Ontario (1996); Honorary Doctorate of Laws from Trent University (1999); Vanier Award (2001); Meritorious Service Cross (2001); NASA Exceptional Service Medal (2002); Queen's Golden Jubilee Medal (2003); Inducted into Canada's Aviation Hall of Fame (2005).

Experience. Raised on a corn farm in southern Ontario, Chris Hadfield became interested in flying from a young age. As an Air Cadet, he won a glider pilot scholarship at age 15 and a powered pilot scholarship at age 16. He also taught skiing and ski racing part and full-time for 10 years.

Hadfield graduated as an Ontario scholar from Milton District High in 1977 and joined the Canadian Armed Forces in May 1978. He spent two years at Royal Roads Military College, in Victoria, British Columbia, followed by two years at the Royal Military College in Kingston, Ontario, where he received a Bachelor's Degree in Mechanical Engineering (with honors) in 1982. Hadfield underwent basic flight training in Portage La Prairie, Manitoba, for which he was named top pilot in 1980. In 1983, he took honors as the overall top graduate from Basic Jet Training in Moose Jaw, Saskatchewan, and in 1984 to 1985, he trained as a fighter pilot in Cold Lake, Alberta on CF-5s and CF-18s.

For the next three years Hadfield flew CF-18s for the North American Aerospace Defence Command (NORAD) with 425 Squadron, during which time he flew the first CF-18 intercept of a Soviet "Bear" aircraft. He attended the United States Air Force (USAF) Test Pilot School at Edwards Air Force Base, in California, and upon graduation, served as an exchange officer with the U.S. Navy at Strike Test Directorate at the Patuxent River Naval Air Station. His accomplishments from 1989 to 1992 include testing the F/A-18 and A-7 aircraft; performing research work with NASA on pitch control margin simulation and flight; completing the first military flight of

F/A-18 enhanced performance engines; piloting the first flight test of the National Aerospace Plane external burning hydrogen propulsion engine; developing a new handling qualities rating scale for high angle-of-attack test; and participating in the F/A-18 out-of-control recovery test program. In total, Hadfield has flown over 70 different types of aircraft.

In June 1992 Chris Hadfield was selected to become one of four new Canadian astronauts from a field of 5330 applicants. He was assigned by the Canadian Space Agency (CSA) to the NASA Johnson Space Center in Houston, Texas in August of the same year, where he addressed technical and safety issues for Shuttle Operations Development, contributed to the development of the glass shuttle cockpit, and supported shuttle launches at the Kennedy Space Center, in Florida. In addition, Hadfield was NASA's Chief CAPCOM, the voice of mission control to astronauts in orbit, for 25 space shuttle missions. From 1996 to 2000, he represented CSA astronauts and coordinated their activities as the Chief Astronaut for the Canadian Space Agency.

From 2001 to 2003, Hadfield was the Director of Operations for NASA at the Yuri Gagarin Cosmonaut Training Centre (GCTC) in Star City, Russia. His work included coordination and direction of all International Space Station crew activities in Russia, oversight of training and crew support staff, as well as policy negotiation with the Russian Space Program and other International Partners. He also trained and became fully qualified to be a flight engineer cosmonaut in the Soyuz TMA spacecraft, and to perform spacewalks in the Russian Orlan spacesuit.

Currently, Hadfield is a civilian CSA astronaut, having retired as a Colonel from the Canadian Air Force in 2003, after 25 years of military service. He is Chief of Robotics for the NASA Astronaut Office at the Johnson Space Center in Houston, Texas.

In November 1995 Hadfield served as Mission Specialist 1 on STS-74, NASA's second space shuttle mission to rendezvous and dock with the Russian Space Station Mir. During the flight, the crew of Space Shuttle Atlantis attached a five-tonne docking module to Mir and transferred over 1000 kg of food, water, and scientific supplies to the cosmonauts. Hadfield flew as the first Canadian mission specialist, the first Canadian to operate the Canada Arm in orbit, and the only Canadian to ever board Mir. The STS-74 Mission was accomplished in 8 days, 4 hours, 30 minutes and 44 seconds, during which time the shuttle traveled 5.5 million km, and orbited the earth 129 times.

In April 2001 Hadfield served as Mission Specialist 1 on STS-100, International Space Station (ISS) assembly Flight 6A. The crew of Space Shuttle Endeavour delivered and installed Canadaarm2, the new Canadian-built robotic arm, as well as the Italian-made resupply module Raffaello. During the flight, Hadfield performed two spacewalks, which made him the first Canadian to ever leave a spacecraft and float free in space. In total, Hadfield spent 14 hours, 54 minutes outside; 10 times around the world. The entire STS-100 Mission was accomplished in 11 days, 11 hours, and 30 minutes, during which time the shuttle traveled 7.9 million km, and orbited the earth 187 times.

January 2006

CHRIS HADFIELD

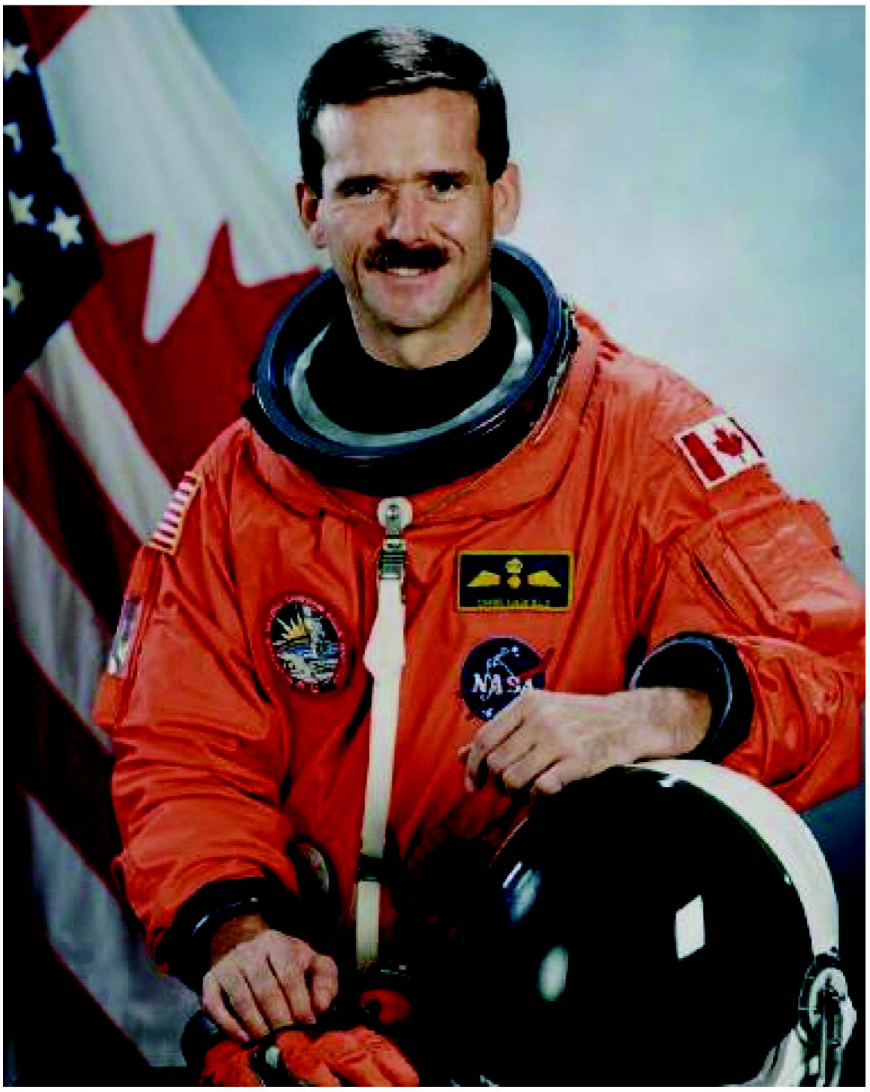


IMAGE CREDIT: NASA

Mission: STS-74

Space Shuttle: Atlantis

Commander: Kenneth Cameron

Pilot: James Halsell, Jr.

Mission Specialists: Jerry Ross, William McArthur Jr., Chris Hadfield

Launch Date: 12 November 1995

Launch Time: 7:30:43 a.m. EST

Launch Site: Kennedy Space Center (KSC)

Launch Pad: 39A

Landing Date: 20 November 1995

Landing Time: 12:01:27 p.m. EST

Landing Site: Kennedy Space Center (KSC)

Mission Duration: 8 days, 4 hours, 31 minutes, 42 seconds

Number of Orbits: 129

Distance Traveled: 5.5 million kilometres

Mission Highlights:

Mission: STS-100

Space Shuttle: Endeavour

Commander: Kent Rominger

Pilot: Jeffrey Ashby

Mission Specialists: Chris Hadfield, John Phillips, Scott Parazynski, Umberto Guidoni, Yuri Lonchakov

Launch Date: 19 April 2001

Launch Time: 2:41:42 p.m. EDT

Launch Site: Kennedy Space Center (KSC)

Launch Pad: 39A

Landing Date: 1 May 2001

Landing Time: 9:11:42 p.m. PDT

Landing Site: Edwards Air Force Base

Mission Duration: 11 days, 21 hours, 30 minutes, 0 seconds

Number of Orbits: 187

Distance Traveled: 7.9 million kilometres

Mission Highlights:

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BIOGRAPHICAL DATA – JULIE PAYETTE

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas 77058

BIOGRAPHICAL DATA

JULIE PAYETTE

ASTRONAUT, CANADIAN SPACE AGENCY

Personal Data. Born 20 October 1963, in Montreal, Quebec. Enjoys running, skiing, racquet sports and scuba diving. Holds a multi-engine commercial pilot license with instrument and float ratings. Ms. Payette plays piano and has sung with the Montreal Symphonic Orchestra Chamber Choir, the Piacere Vocale in Basel, Switzerland, and with the Tafelmusik Baroque Orchestra Choir in Toronto, Canada. Fluent in French and English, and conversational in Spanish, Italian, Russian and German.

Education. Primary and secondary school in Montreal, Quebec. International Baccalaureate (1982) at the United World International College of the Atlantic in South Wales, UK. Bachelor of Electrical Engineering (1986) from McGill University, Montreal and a Master of Applied Science - Computer Engineering (1990) from the University of Toronto.

Organizations. Member of l'Ordre des Ingénieurs du Québec. Appointed member of the Natural Sciences and Engineering Research Council of Canada (NSERC). Fellow of the Canadian Academy of Engineering. Les Amies d'affaire du Ritz. Board of Director – Queen's University.

Special Honors. Received one of six available Canadian scholarships to attend the International UWC of the Atlantic in South Wales, UK (1980); Greville-Smith Scholarship (1982-1986); highest undergraduate award at McGill University; McGill Faculty Scholar (1983-1986); graduated with distinction in 1986. NSERC post-graduate Scholarship (1988-1990); Massey College Fellowship (1988-1990); Canadian Council of Professional Engineers 1994 (distinction for exceptional achievement by a young engineer). Chevalier de l'Ordre de la Pleiade de la francophonie; National Order of Quebec.

Honorary Degrees. Queen's University (1999); University of Ottawa (1999); Simon Fraser University (2000); Universite Laval (2000); University of Regina (2001); Royal Roads University (2001); University of Toronto (2001); University of Victoria (2002); Nipissing University (2002); McGill University (2003); Mount Saint Vincent University (2004); McMaster University (2004), University of Lethbridge (2005), Mount Allison University (2005).

Experience. Before joining the Astronaut Corps, Ms. Payette conducted research in computer systems, natural language processing, automatic speech recognition and the application of interactive technologies to space. System engineer - IBM Canada (1986 to 1988). Research Assistant - University of Toronto (1988 to 1990). Visiting scientist – IBM Research Laboratory, Zurich, Switzerland (1991). Research engineer - Speech Research Group, Bell-Northern Research/Nortel, Montreal (1992).

Ms. Payette was selected by the Canadian Space Agency (CSA) as one of four astronauts amongst a field of 5330 applicants in June 1992. After undergoing basic training in Canada, she worked as a technical advisor for the MSS (Mobile Servicing System), an advanced robotics system and Canada's contribution to the International Space Station.

In preparation for a space assignment, Ms. Payette obtained her commercial pilot license, studied Russian and logged 120 hours as a research operator on board reduced gravity aircraft. In 1996, Ms. Payette was certified as a one-atmosphere deep sea diving suit operator and obtained her captaincy on the CT-114 military jet at the Canadian Air Force Base in Moose Jaw, Saskatchewan. Ms. Payette has logged more than 1100 hours of flight time.

NASA Experience. Ms. Payette reported to the NASA Johnson Space Center in Houston, Texas in August 1996. She completed initial astronaut training in April 1998 and was assigned to work technical issues in robotics for the Astronaut Office.

Julie Payette flew on Space Shuttle Discovery from 27 May to 6 June, 1999 as part of the crew of STS-96. During the mission, the crew performed the first manual docking of the Shuttle to the International Space Station (ISS), and delivered four tons of logistics and supplies to the Station. On Discovery, Ms. Payette served as a mission specialist, held responsibility for the Station systems and operated the Canadarm robotic arm on orbit. The STS-96 mission was accomplished in 153 orbits of the Earth, traveling 4 million miles in 9 days, 19 hours and 13 minutes. Ms. Payette became the first Canadian to participate in an ISS assembly mission and to board the Space Station.

Ms. Payette is the Chief Astronaut for the Canadian Space Agency. She also works as a CAPCOM (Capsule Communicator) at the Mission Control Center in Houston. She divides her time between these responsibilities and astronaut proficiency training.

February 2006

JULIE PAYETTE

IMAGE CREDIT: NASA

Mission:	STS-96
Space Shuttle:	Discovery
Commander:	Kent Rominger
Pilot:	Rick Husband
Mission Specialists:	Ellen Ochoa, Tamara Jernigan, Daniel Barry, Julie Payette, and Valery Ivanovich Tokarev
Launch Date:	27 May 1999
Launch Time:	6:49:42 a.m. EDT
Launch Site:	Kennedy Space Center (KSC)
Launch Pad:	39B
Landing Date:	6 June 1999
Landing Time:	2:02:43 a.m. EDT
Landing Site:	Kennedy Space Center (KSC)
Mission Duration:	9 days, 19 hours, 13 minutes, 57 seconds
Number of Orbits:	
Distance Traveled:	
Mission Highlights:	

QUESTIONS

Answer the following questions on the flipchart paper provided.

1. What is the name of the astronaut at this station?
2. What education does this astronaut have?
3. What awards has this astronaut received?
4. What missions has this astronaut been on? What were the highlights of the mission(s)?

Answer the following questions on the flipchart paper provided.

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